Fundamentals of Capital Budgeting

LEARNING OBJECTIVES

- Identify the types of cash flows needed in the capital budgeting process
- Forecast incremental earnings in a pro forma earnings statement for a project
- Convert forecasted earnings to free cash flows and compute a project’s NPV
- Recognize common pitfalls that arise in identifying a project’s incremental free cash flows
- Assess the sensitivity of a project’s NPV to changes in your assumptions
- Identify the most common options available to managers in projects and understand why these options can be valuable

notation

<table>
<thead>
<tr>
<th>CapEx</th>
<th>capital expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBIT</td>
<td>earnings before interest and taxes</td>
</tr>
<tr>
<td>FCF_t</td>
<td>free cash flow in year t</td>
</tr>
<tr>
<td>IRR</td>
<td>internal rate of return</td>
</tr>
<tr>
<td>NPV</td>
<td>net present value</td>
</tr>
<tr>
<td>NWC_t</td>
<td>net working capital in year t</td>
</tr>
<tr>
<td>PV</td>
<td>present value</td>
</tr>
<tr>
<td>r</td>
<td>projected cost of capital</td>
</tr>
</tbody>
</table>
James King is a financial analyst for Limitless LLC, based in Dubai. He received a bachelor of business degree with a concentration in property economics in 2006 from the University of Western Sydney, New South Wales, Australia.

Limitless L.L.C, a business unit of Dubai World, is an integrated global real estate master developer that delivers distinctive and sustainable developments in three specific areas of expertise: master-planning large urban communities; undertaking waterfront development; and implementing large-scale balanced projects. Reflecting on his own education, James remarked that, “In my finance courses I learned the theory before applying it. For example, I studied the theory of discounted cash flow analysis, as well as the technical mathematics behind it. I use these skills day to day, and this same financial theory is what drives the investment decisions of the business.” His role at Limitless is to prepare feasibility studies on potential projects across the globe to assess their financial viability.

Limitless uses traditional financial tools such as the pro forma net profit and profit margin to assess the financial viability of individual projects. However, James notes that due to the extended time frame of real estate development and delayed return on capital outlay, it relies heavily on performance indicators that allow for the time value of money. These include internal rate of return (IRR) and net present value (NPV). “The rate that a project must achieve is based on an equity cost of capital, or the return on the funds Limitless invests. We have a predetermined rate for each market, which we then adjust based on the type of project and other factors.”

While each company you work for may choose different capital budgeting methods, it’s important that you know and understand them all. James offers you this advice: “Take advantage of every opportunity that education provides. The skill base that you learn from studying will provide a greater range of job opportunities and give you the edge in the ultra-competitive environment of the international work place.”
An important responsibility of corporate financial managers is determining which projects or investments a firm should undertake. Capital budgeting, the focus of this chapter, is the process of analyzing investment opportunities and deciding which ones to accept. In doing so, we are allocating the firm’s funds to various projects—we are budgeting its capital. Chapter 7 covered the various methods for evaluating projects and proved that NPV will be the most reliable and accurate method for doing so. In retrospect, this may not be surprising as it is the only rule directly tied to the Valuation Principle. To implement the NPV rule, we must compute the NPV of our projects and accept only those projects for which the NPV is positive. We spoke in the last chapter about Sony and Toshiba each using investment decision rules to pursue competing high definition DVD standards (and eventually for Toshiba, to decide to abandon HD-DVD). In order to implement the investment decision rules, financial managers from Toshiba, for example, had to first forecast the incremental cash flows associated with the investments and later to forecast the incremental cash flows associated with the decision to stop investing in HD-DVD. The process of forecasting those cash flows, crucial inputs in the investment decision process, is our focus in this chapter.

We begin by estimating the project’s expected cash flows by forecasting the project’s revenues and costs. Using these cash flows, we can compute the project’s NPV—its contribution to shareholder value. Then, because the cash flow forecasts almost always contain uncertainty, we demonstrate how to compute the sensitivity of the NPV to the uncertainty in the forecasts. Finally, we examine the relationship between a project’s flexibility and its NPV.

8.1 The Capital Budgeting Process

The first step in analyzing various investment opportunities is compiling a list of potential projects. A capital budget lists the projects and investments that a company plans to undertake during future years. To create this list, firms analyze alternate projects and decide which ones to accept through a process called capital budgeting. This process begins with forecasts of each project’s future consequences for the firm. Some of these consequences will affect the firm’s revenues; others will affect its costs. Our ultimate goal is to determine the effect of the decision to accept or reject a project on the firm’s cash flows, and evaluate the NPV of these cash flows to assess the consequences of the decision for the firm’s value. Figure 8.1 depicts the types of cash flows found in a typical project. We will examine each of these as we proceed through our discussion of capital budgeting.

Of course, forecasting these cash flows is frequently challenging. We will often need to rely on different experts within the firm to obtain estimates for many of them. For example, the marketing department may provide sales forecasts, the operations manager may provide information about production costs, and the firm’s engineers may estimate the upfront research and development expenses that are required to launch the project. Another important source of information comes from looking at past projects of the firm, or those of other firms in the same industry. In particular, practitioners often base their assessments of a project’s revenues and costs using information on revenues and costs that can be learned from the historical financial statements of the firm or its competitors.
Once we have these estimates, how do we organize them? One common starting point is first to consider the consequences of the project for the firm’s earnings. Thus, we will begin our analysis in Section 8.2 by determining the incremental earnings of a project—that is, the amount by which the firm’s earnings are expected to change as a result of the investment decision. The incremental earnings forecast tells us how the decision will affect the firm’s reported profits from an accounting perspective. However, as we emphasized in Chapter 2, earnings are not actual cash flows. We need to estimate the project’s cash flows to determine its NPV and decide whether it is a good project for the firm. Therefore, in Section 8.3, we demonstrate how to use the incremental earnings to forecast the actual cash flows of the project. Understanding how to compute the cash flow consequences of an investment based on its earning consequences is important for a number of reasons. First, as a practical matter, financial managers often begin by forecasting earnings. Second, if we are looking at historical data, accounting information is often the only information that is readily available.

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### Concept Check

1. What is capital budgeting, and what is its goal?
2. Why is computing a project’s effect on the firm’s earnings insufficient for capital budgeting?
Let’s begin our discussion of incremental earnings with a simple example that we will examine throughout this section. Suppose you are considering whether to upgrade your manufacturing plant and increase its capacity by purchasing a new piece of equipment. The equipment costs $1 million, plus an additional $20,000 to transport it and install it. You will also spend $50,000 on engineering costs to redesign the plant to accommodate the increased capacity. What are the initial earnings consequences of this decision?

**Operating Expenses Versus Capital Expenditures**

Most projects require some form of upfront investment—we may need to conduct a marketing survey, develop a prototype, or launch an ad campaign. These types of costs are accounted for as operating expenses in the year that they are incurred. However, many projects also include investments in plant, property, and/or equipment, called capital expenditures. Recall from Chapter 2 that while investments in plant, property, and equipment are a cash expense, they are not directly listed as expenses when calculating earnings. Instead, the firm deducts a fraction of the cost of these items each year as depreciation. Financial managers use several different methods to compute depreciation. The simplest method is *straight-line depreciation*, in which the asset’s cost is divided equally over its depreciable life (we discuss another common method in Section 8.4).

In our example, the upfront costs associated with the decision to increase capacity have two distinct consequences for the firm’s earnings. First, the $50,000 spent on redesigning the plant is an operating expense reported in year 0. For the $1,020,000 spent to buy, ship, and install the machine, accounting principles as well as tax rules require you to depreciate the $1,020,000 over the depreciable life of the equipment. Assuming that the equipment has a five-year depreciable life and that we use the straight-line method, we would expense $1,020,000 / 5 = $204,000 per year for five years. (The motivation for this accounting treatment is to match the cost of acquiring the machine to the timing of the revenues it will generate.)

As the timeline shows, the upfront cash outflow of $1,020,000 to purchase and set-up the machine is not recognized as an expense in year 0. Instead, it appears as depreciation expenses in years 1 through 5. Remember that these depreciation expenses do *not* correspond to actual cash outflows. This accounting and tax treatment of capital expenditures is one of the key reasons why earnings are not an accurate representation of cash flows. We will return to this issue in Section 8.3.

**Incremental Revenue and Cost Estimates**

Our next step is to estimate the ongoing revenues and costs for the project. Forecasting future revenues and costs is challenging. The most successful practitioners collect as much information as possible before tackling this task—they will talk to members of
marketing and sales teams as well as company economists to develop an estimate of sales, and they will talk to engineering and production teams to refine their estimate of costs.

There are several factors to consider when estimating a project’s revenues and costs, including the following:

1. A new product typically has lower sales initially, as customers gradually become aware of the product. Sales will then accelerate, plateau, and ultimately decline as the product nears obsolescence or faces increased competition.

2. The average selling price of a product and its cost of production will generally change over time. Prices and costs tend to rise with the general level of inflation in the economy. The prices of technology products, however, often fall over time as newer, superior technologies emerge and production costs decline.

3. For most industries, competition tends to reduce profit margins over time.

Our focus here is on how to get from these forecasts to incremental earnings and then to cash flows; Chapter 17 discusses forecasting methods in more detail.

All our revenue and cost estimates should be **incremental**, meaning that we only account for additional sales and costs generated by the project. For example, if we are evaluating the purchase of a faster manufacturing machine, we are only concerned with how many additional units of the product we will be able to sell (and at what price) and any additional costs created by the new machine. We do not forecast total sales and costs because those include our production using the old machine. **Remember, we are evaluating how the project will change the cash flows of the firm. That is why we focus on incremental revenues and costs.**

Let’s return to our plant upgrade example. Assume that after we have bought and installed the machine and redesigned the plant, our additional capacity will allow us to generate incremental revenues of $500,000 per year for five years. Those incremental revenues will be associated with $150,000 per year in incremental costs. In that case our revenue, cost, and depreciation estimates for the project are as shown below (in thousands of dollars):

<table>
<thead>
<tr>
<th>Year</th>
<th>Incremental Revenues</th>
<th>Incremental Costs</th>
<th>Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>500</td>
<td>-50</td>
<td>-204</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>-150</td>
<td>-204</td>
</tr>
<tr>
<td>3</td>
<td>500</td>
<td>-150</td>
<td>-204</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>-150</td>
<td>-204</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
<td>-150</td>
<td>-204</td>
</tr>
</tbody>
</table>

Now that we have these estimates, we are ready to compute the consequences of our project for the firm’s earnings. As we saw in Chapter 2, both depreciation expenses and the actual costs of producing (e.g. cost of goods sold) must be subtracted from revenues, so that:

\[
\text{Incremental Earnings Before Interest and Taxes (EBIT)} = \text{Incremental Revenue} - \text{Incremental Costs} - \text{Depreciation} \quad (8.1)
\]

### Taxes

The final expense we must account for is corporate taxes. The correct tax rate to use is the firm’s **marginal corporate tax rate**, which is the tax rate it will pay on an incremental dollar of pre-tax income. The incremental income tax expense is calculated as:

\[
\text{Income Tax} = \text{EBIT} \times \text{the firm’s marginal corporate tax rate} \quad (8.2)
\]
### Incremental Earnings Forecast

We’re now ready to put the pieces together for an incremental earnings forecast. Assume our firm faces a marginal tax rate of 40%. Then the incremental earnings (or net income) are as follows (in thousands of dollars):¹

<table>
<thead>
<tr>
<th>Year</th>
<th>Incremental Revenues</th>
<th>Incremental Costs</th>
<th>Depreciation</th>
<th>EBIT</th>
<th>Income Tax at 40%</th>
<th>Incremental Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>500</td>
<td>−50</td>
<td>−204</td>
<td>−50</td>
<td>20</td>
<td>−30</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>−150</td>
<td>−204</td>
<td>146</td>
<td>−58.4</td>
<td>87.6</td>
</tr>
<tr>
<td>3</td>
<td>500</td>
<td>−150</td>
<td>−204</td>
<td>146</td>
<td>−58.4</td>
<td>87.6</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>−150</td>
<td>−204</td>
<td>146</td>
<td>−58.4</td>
<td>87.6</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
<td>−150</td>
<td>−204</td>
<td>146</td>
<td>−58.4</td>
<td>87.6</td>
</tr>
</tbody>
</table>

We can also combine Eq. 8.1 and Eq. 8.2 to compute incremental earnings directly. For example, in years 1 through 5 we have:

\[
\text{Incremental Earnings} = (\text{Incremental Revenues} - \text{Incremental Cost} - \text{Depreciation}) \times (1 - \text{Tax Rate})
\]

\[
\text{Incremental Earnings} = (500,000 - 150,000 - 204,000) \times (1 - 0.4) = 87,600
\]

### Example 8.1

**Problem**

Suppose that Linksys is considering the development of a wireless home networking appliance, called HomeNet, that will provide both the hardware and the software necessary to run an entire home from any Internet connection. In addition to connecting PCs and printers, HomeNet will control new Internet-capable stereos, digital video recorders, heating and air-conditioning units, major appliances, telephone and security systems, office equipment, and so on. The major competitor for HomeNet is a product being developed by Brandt-Quigley Corporation.

Based on extensive marketing surveys, the sales forecast for HomeNet is 50,000 units per year. Given the pace of technological change, Linksys expects the product will have a four-year life and an expected wholesale price of $260 (the price Linksys will receive from stores). Actual production will be outsourced at a cost (including packaging) of $110 per unit.

To verify the compatibility of new consumer Internet-ready appliances, as they become available, with the HomeNet system, Linksys must also establish a new lab for testing purposes. It will rent the lab space, but will need to purchase $7.5 million of new equipment. The equipment will be depreciated using the straight-line method over a five-year life.

The lab will be operational at the end of one year. At that time, HomeNet will be ready to ship. Linksys expects to spend $2.8 million per year on rental costs for the lab space, as well as marketing and support for this product. Forecast the incremental earnings from the HomeNet project.

¹While revenues and costs occur throughout the year, the standard convention, which we adopt here, is to list revenues and costs in the year in which they occur. Thus, cash flows that occur at the end of one year will be listed in a different column than those that occur at the start of the next year, even though they may occur only weeks apart. When additional precision is required, cash flows are often estimated on a quarterly or monthly basis.
Pro Forma Statement. The table calculating incremental earnings that we produced for our plant upgrade, and again in Example 8.1, is often referred to as a **pro forma** statement, because it is not based on actual data but rather depicts the firm’s financials under a given set of hypothetical assumptions. In the HomeNet example, the firm’s forecasts of revenues and costs were assumptions that allowed Linksys to forecast incremental earnings in a pro forma statement.

Taxes and Negative EBIT. Notice that in year 0 of our plant upgrade project, and in year 5 of the HomeNet example, EBIT is negative. Why are taxes relevant in this case? Consider the HomeNet example. HomeNet will reduce Linksys’s taxable income in year 5 by $1.5 million. As long as Linksys earns taxable income elsewhere in year 5 against which it can offset HomeNet’s losses, Linksys will owe $1.5 million × 40% = $600,000 less in taxes in year 5 than if it were not undertaking the project. Because the tax savings come from the depreciation expense on equipment for the HomeNet project, the firm should credit this tax savings to the HomeNet project.
What About Interest Expenses? In Chapter 2, we saw that to compute a firm’s net income, we must first deduct interest expenses from EBIT. When evaluating a capital budgeting decision, however, we generally do not include interest expenses. Any incremental interest expenses will be related to the firm’s decision regarding how to finance the project, which is a separate decision. Here, we wish to evaluate the earnings contributions from the project on its own, separate from the financing decision. Ultimately, managers may also look at the additional earnings consequences associated with different methods of financing the project.

Thus, we evaluate a project as if the company will not use any debt to finance it (whether or not that is actually the case), and we postpone the consideration of alternative financing choices until Part V of this book. Because we calculate the net income assuming no debt (no leverage), we refer to the net income we compute using Eq. 8.3, as in the pro forma in Example 8.1, as the unlevered net income of the project, to indicate that it does not include any interest expenses associated with debt.

### Concept Check

3. How are operating expenses and capital expenditures treated differently when calculating incremental earnings?

4. Why do we focus only on incremental revenues and costs, rather than all revenues and costs of the firm?

### Determining Incremental Free Cash Flow

As discussed in Chapter 2, earnings are an accounting measure of the firm’s performance. They do not represent real profits: The firm cannot use its earnings to buy goods, pay employees, fund new investments, or pay dividends to shareholders. To do those things,
the firm needs cash. Thus, to evaluate a capital budgeting decision, we must determine its consequences for the firm’s available cash. The incremental effect of a project on the firm’s available cash is the project’s incremental free cash flow.

Calculating Free Cash Flow from Earnings

As discussed in Chapter 2, there are important differences between earnings and cash flow. Earnings include non-cash charges, such as depreciation, but do not include the cost of capital investment. To determine a project’s free cash flow from its incremental earnings, we must adjust for these differences.

Capital Expenditures and Depreciation. As we have noted, depreciation is not a cash expense that is paid by the firm. Rather, it is a method used for accounting and tax purposes to allocate the original purchase cost of the asset over its life. Because depreciation is not a cash flow, we do not include it in the cash flow forecast. However, that does not mean we can ignore depreciation. The depreciation expense reduces our taxable earnings and in doing so reduces our taxes. Taxes are cash flows, so because depreciation affects our cash flows, it still matters. Our approach for handling depreciation is to add it back to the incremental earnings to recognize the fact that we still have the cash flow associated with it.

For example, a project has incremental gross profit (revenues minus costs) of $1 million and a $200,000 depreciation expense. If the firm’s tax rate is 40%, then the incremental earnings will be $(1,000,000 − 200,000) × (1 − 0.40) = $480,000. However, the firm will still have $680,000 because the $200,000 depreciation expense is not an actual cash outflow. Table 8.1 shows the calculation to get the incremental free cash flow in this case. Blue boxes surround all of the actual cash flows in the column labeled “Correct.” A good way to check to make sure the incremental free cash flow is correct is to sum the actual cash flows. In this case, the firm generated $1,000,000 in gross profit (a positive cash flow), paid $320,000 in taxes (a negative cash flow), and was left with $1,000,000 − $320,000 = $680,000, which is the amount shown as the incremental free cash flow. In the last column, labeled “Incorrect,” we show what would happen if you just ignored depreciation altogether. Because EBIT would be too high, the taxes would be too high as well and consequently, the incremental free cash flow would be too low. (Note that the difference of $80,000 between the two cases is entirely due to the difference in tax payments.)

**Table 8.1**

<table>
<thead>
<tr>
<th></th>
<th>Correct</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incremental Gross Profit</strong></td>
<td>$1,000,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td><strong>Depreciation</strong></td>
<td>−$200,000</td>
<td></td>
</tr>
<tr>
<td><strong>EBIT</strong></td>
<td>$800,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td><strong>Tax at 40%</strong></td>
<td>−$320,000</td>
<td>−$400,000</td>
</tr>
<tr>
<td><strong>Incremental Earnings</strong></td>
<td>$480,000</td>
<td>$600,000</td>
</tr>
<tr>
<td><strong>Add Back depreciation</strong></td>
<td>$200,000</td>
<td></td>
</tr>
<tr>
<td><strong>Incremental Free Cash Flow</strong></td>
<td>$680,000</td>
<td>$600,000</td>
</tr>
</tbody>
</table>
Net Working Capital (NWC). Another way that incremental earnings and free cash flows can differ is if there are changes in net working capital. We defined net working capital in Chapter 2 as the difference between current assets and current liabilities. The main components of net working capital are cash, inventory, receivables, and payables:

\[
\text{Net Working Capital} = \text{Current Assets} - \text{Current Liabilities} = \text{Cash} + \text{Inventory} + \text{Receivables} - \text{Payables} \quad (8.4)
\]

Most projects will require the firm to invest in net working capital. Firms may need to maintain a minimum cash balance\(^2\) to meet unexpected expenditures, and inventories of raw materials and finished product to accommodate production uncertainties and demand fluctuations. Also, customers may not pay for the goods they purchase immediately. While sales are immediately counted as part of earnings, the firm does not receive any cash until the customers actually pay. In the interim, the firm includes the amount

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\(^2\)The cash included in net working capital is cash that is not invested to earn a market rate of return. It includes cash held in the firm’s checking account, in a company safe or cash box, in cash registers (for retail stores), and other sites.
that customers owe in its receivables. Thus, the firm’s receivables measure the total credit that the firm has extended to its customers. In the same way, payables measure the credit the firm has received from its suppliers. The difference between receivables and payables is the net amount of the firm’s capital that is consumed as a result of these credit transactions, known as **trade credit**.

We care about net working capital because it reflects a short-term investment that ties up cash flow that could be used elsewhere. For example, when a firm holds a lot of unsold inventory or has a lot of outstanding receivables, cash flow is tied up in the form of inventory or in the form of credit extended to customers. It is costly for the firm to tie up that cash flow because it delays the time until the cash flow is available for reinvestment or distribution to shareholders. Since we know that money has time value, we cannot ignore this delay in our forecasts for the project. Thus, whenever net working capital increases, reflecting additional investment in working capital, it represents a reduction in cash flow that year.

It is important to note that only changes in net working capital impact cash flows. For example, consider a three-year project that causes the firm to build up initial inventory by $20,000 and maintain that level of inventory in years 1 and 2, before drawing it down as the project ends and the last product is sold. It is often necessary for the initial increase in inventory to occur prior to the first sale so that the higher level of inventory would be achieved by the end of year 0. The level of the incremental net working capital in each year, the associated change in net working capital and the cash flow implications, would be:

<table>
<thead>
<tr>
<th>Year</th>
<th>Level of Incremental NWC</th>
<th>Change in Incremental NWC</th>
<th>Cash Flow from Change in NWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20,000</td>
<td>0</td>
<td>-20,000</td>
</tr>
<tr>
<td>1</td>
<td>20,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>20,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>-20,000</td>
<td>0</td>
</tr>
</tbody>
</table>

Note that the cash flow effect from a change in net working capital is always equal and opposite in sign to the change in net working capital. For example, an increase in inventory represents an investment or cash outflow, while a reduction in that inventory frees up that investment of capital and represents a cash inflow. Thus in capital budgeting we subtract changes in net working capital to arrive at the cash flows. Also notice that since the level of incremental net working capital did not change in years 1 and 2, there was no new cash flow effect. Intuitively, as the firm is using up inventory and replenishing it, the net new investment in inventory is zero, so no additional cash outflow is required. Finally, note that over the life of the project, the incremental net working capital returns to zero so that the changes (+20,000 in year 0 and −20,000 in year 3) sum to zero. Accounting principles ensure this by requiring the recapture of working capital over the life of the project.

More generally, we define the change in net working capital in year $t$ as:

$$ \text{Change in NWC in year } t = \text{NWC}_t - \text{NWC}_{t-1} \tag{8.5} $$

When a project causes a change in NWC, that change must be subtracted from incremental earnings to arrive at incremental free cash flows.
sales is $1.95 million and 15% of $5.5 million in COGS is $825,000. HomeNet’s net working capital requirements are shown in the following table:

<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>1. Net Working Capital Forecast ($000)/</td>
<td>0</td>
<td>1,125</td>
<td>1,125</td>
<td>1,125</td>
<td>1,125</td>
<td>0</td>
</tr>
<tr>
<td>2. Change in NWC</td>
<td>+1,125</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Cash Flow Effect</td>
<td>-1,125</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0+1,125</td>
</tr>
</tbody>
</table>

How does this requirement affect the project’s free cash flow?

**Solution**

- **Plan**

  Any increases in net working capital represent an investment that reduces the cash available to the firm and so reduces free cash flow. We can use our forecast of HomeNet’s net working capital requirements to complete our estimate of HomeNet’s free cash flow. In year 1, net working capital increases by $1.125 million. This increase represents a cost to the firm. This reduction of free cash flow corresponds to the fact that $1.950 million of the firm’s sales in year 1, and $0.825 million of its costs, have not yet been paid.

  In years 2–4, net working capital does not change, so no further contributions are needed. In year 5, when the project is shut down, net working capital falls by $1.125 million as the payments of the last customers are received and the final bills are paid. We add this $1.125 million to free cash flow in year 5.

- **Execute (in $000s)**

  The incremental free cash flows would then be:

<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>1. Revenues</td>
<td>13,000</td>
<td>13,000</td>
<td>13,000</td>
<td>13,000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2. Costs of Goods Sold</td>
<td>-5,500</td>
<td>-5,500</td>
<td>-5,500</td>
<td>-5,500</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3. Gross Profit</td>
<td>7,500</td>
<td>7,500</td>
<td>7,500</td>
<td>7,500</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4. Selling, General, and Administrative</td>
<td>-2,800</td>
<td>-2,800</td>
<td>-2,800</td>
<td>-2,800</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5. Depreciation</td>
<td>-1,500</td>
<td>-1,500</td>
<td>-1,500</td>
<td>-1,500</td>
<td>-1,500</td>
<td></td>
</tr>
<tr>
<td>6. EBIT</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td></td>
</tr>
<tr>
<td>7. Incremental Earnings</td>
<td>1,920</td>
<td>1,920</td>
<td>1,920</td>
<td>1,920</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>8. Add Back Depreciation</td>
<td>1,500</td>
<td>1,500</td>
<td>1,500</td>
<td>1,500</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>9. Purchase of Equipment</td>
<td>-7,500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Subtract Changes in NWC</td>
<td>-1,125</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,125</td>
<td></td>
</tr>
<tr>
<td>11. Incremental Free Cash Flows</td>
<td>-7,500</td>
<td>2,295</td>
<td>3,420</td>
<td>3,420</td>
<td>3,420</td>
<td>1,725</td>
</tr>
</tbody>
</table>

- **Evaluate**

  The free cash flows differ from unlevered net income by reflecting the cash flow effects of capital expenditures on equipment, depreciation, and changes in net working capital. Note that in the first two years, free cash flow is lower than unlevered net income, reflecting the upfront investment in equipment and net working capital required by the project. In later years, free cash flow exceeds unlevered net income because depreciation is not a cash expense. In the last year, the firm ultimately recovers the investment in net working capital, further boosting the free cash flow.
Calculating Free Cash Flow Directly

As we noted at the outset of this chapter, because practitioners usually begin the capital budgeting process by first forecasting earnings, we have chosen to do the same. However, we can calculate a project’s free cash flow directly by using the following shorthand formula:

\[
\text{Free Cash Flow} = \frac{(\text{Revenues} - \text{Costs} - \text{Depreciation}) \times (1 - \text{tax rate}) + \text{Depreciation} - \text{CapEx} - \text{Change in NWC}}{\text{Unlevered Net Income}}
\]  

(8.6)

Note that we first deduct depreciation when computing the project’s incremental earnings and then add it back (because it is a non-cash expense) when computing free cash flow. Thus, the only effect of depreciation is to reduce the firm’s taxable income. Indeed, we can rewrite Eq. 8.6 as:

\[
\text{Free Cash Flow} = (\text{Revenues} - \text{Costs}) \times (1 - \text{tax rate}) - \text{CapEx} - \text{Change in NWC} + \text{tax rate} \times \text{Depreciation}
\]

(8.7)

The last term in Eq. 8.7, \(\text{tax rate} \times \text{Depreciation}\), is called the **depreciation tax shield**, which is the tax savings that results from the ability to deduct depreciation. As a consequence, depreciation expenses have a positive impact on free cash flow. Returning to our example in Table 8.1, if the firm ignored depreciation, its taxes were $400,000 instead of $320,000, leaving it with incremental free cash flow of $600,000 instead of $680,000. Notice that the $80,000 difference is exactly equal to the tax rate (40%) multiplied by the depreciation expense ($200,000). Every dollar of depreciation expense saves the firm 40 cents in taxes, so the $200,000 depreciation expense translates into an $80,000 tax savings.

Firms often report a different depreciation expense for accounting and for tax purposes. Because only the tax consequences of depreciation are relevant for free cash flow, we should use the depreciation expense that the firm will use for tax purposes in our forecast. For tax purposes, many firms use a system called **Modified Accelerated Cost Recovery System**, which we discuss in the next section.

Calculating the NPV

The goal of forecasting the incremental free cash flows is to have the necessary inputs to calculate the project’s NPV. To compute a project’s NPV, we must discount its free cash flow at the appropriate cost of capital. As discussed in Chapter 5, the cost of capital for a project is the expected return that investors could earn on their best alternative investment with similar risk and maturity. We will develop the techniques needed to estimate the cost of capital in Part IV of the text, when we discuss risk and return. For now, we take the cost of capital as given.

We compute the present value of each free cash flow in the future by discounting it at the project’s cost of capital. As explained in Chapter 4, using \(r\) to represent the cost of capital, the present value of the free cash flow in year \(t\) (or \(FCF_t\)) is:

\[
P(FCF_t) = \frac{FCF_t}{(1 + r)^t} = FCF_t \times \frac{1}{(1 + r)^t}
\]

(8.8)
Other Effects on Incremental Free Cash Flows

When computing the incremental free cash flows of an investment decision, we should include all changes between the firm’s free cash flows with the project versus without the project. These include opportunities forgone due to the project and effects of the project on other parts of the firm. In this section, we discuss these other effects, some of the pitfalls and common mistakes to avoid, and finally the complications that can arise when forecasting incremental free cash flows.

Opportunity Costs

Many projects use a resource that the company already owns. Because the firm does not need to pay cash to acquire this resource for a new project, it is tempting to assume that the resource is available for free. However, in many cases the resource could provide value for the firm in another opportunity or project. The **opportunity cost** of using a resource is the value it could have provided in its best alternative use. \(^3\) Because this

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\(^3\)In Chapter 5, we defined the opportunity cost of capital as the rate you could earn on an alternative investment with equivalent risk. We similarly define the opportunity cost of using an existing asset in a project as the cash flow generated by the next-best alternative use for the asset.
A common mistake is to conclude that if an asset is currently idle, its opportunity cost is zero. For example, the firm might have a warehouse that is currently empty or a machine that is not being used. Often, the asset may have been idled in anticipation of taking on the new project, and would have otherwise been put to use by the firm. Even if the firm has no alternative use for the asset, the firm could choose to sell or rent the asset. The value obtained from the asset’s alternative use, sale, or rental represents an opportunity cost that must be included as part of the incremental cash flows.

**Project Externalities**

Project externalities are indirect effects of a project that may increase or decrease the profits of other business activities of the firm. For instance, some purchasers of Apple’s iPhone would otherwise have bought Apple’s iPod nano. When sales of a new product displace sales of an existing product, the situation is often referred to as cannibalization. The lost sales of the existing project are an incremental cost to the company of going forward with the new product.

**Sunk Costs**

A sunk cost is any unrecoverable cost for which the firm is already liable. Sunk costs have been or will be paid regardless of the decision whether or not to proceed with the project. Therefore, they are not incremental with respect to the current decision and should not be included in its analysis. You may hire a market research firm to do market analysis to determine whether there is demand for a new product you are considering and the analysis may show that there is not enough demand, so you decide not to go forward with the project. Does that mean you do not have to pay the research firm’s bill? Of course you still have to pay the bill, emphasizing that the cost was sunk and incurred whether you went forward with the project or not.

A good rule to remember is that if your decision does not affect a cash flow, then the cash flow should not affect your decision. If the cash flow is the same regardless of the decision, then it is not relevant to your decision. Following are some common examples of sunk costs you may encounter.

**Fixed Overhead Expenses.** Overhead expenses are associated with activities that are not directly attributable to a single business activity but instead affect many different areas of the corporation. Examples include the cost of maintaining the company’s headquarters and the salary of the CEO. These expenses are often allocated to the different business activities for accounting purposes. To the extent that these overhead costs are fixed and will be incurred in any case, they are not incremental to the project and should not be included. Only include as incremental expenses the additional overhead expenses that arise because of the decision to take on the project.
Being influenced by sunk costs is such a widespread mistake that it has a special name: sunk cost fallacy. The most common problem is that people “throw good money after bad.” That is, people sometimes continue to invest in a project that has a negative NPV because they have already invested a large amount in the project and feel that by not continuing it, the prior investment will be wasted. The sunk cost fallacy is also sometimes called the “Concorde effect,” a term that refers to the British and French governments’ decision to continue funding the joint development of the Concorde aircraft even after it was clear that sales of the plane would fall far short of what was necessary to justify its continued development. The project was viewed by the British government as a commercial and financial disaster. However, the political implications of halting the project—and thereby publicly admitting that all past expenses on the project would result in nothing—ultimately prevented either government from abandoning the project.

The Sunk Cost Fallacy

Past Research and Development Expenditures. A pharmaceutical company may spend tens of millions of dollars developing a new drug, but if it fails to produce an effect in trials (or worse, has only negative effects), should it proceed? The company cannot get its development costs back and the amount of those costs should have no bearing on whether to continue developing a failed drug.

When a firm has already devoted significant resources to develop a new product, there may be a tendency to continue investing in the product even if market conditions have changed and the product is unlikely to be viable. The rationale that is sometimes given is that if the product is abandoned, the money that has already been invested will be “wasted.” In other cases, a decision is made to abandon a project because it cannot possibly be successful enough to recoup the investment that has already been made. In fact, neither argument is correct: Any money that has already been spent is a sunk cost and therefore irrelevant. The decision to continue or abandon should be based only on the incremental costs and benefits of the product going forward.

Adjusting Free Cash Flow

Here, we describe a number of complications that can arise when estimating a project’s free cash flow.

Timing of Cash Flows. For simplicity, we have treated the cash flows in our examples as if they occur at annual intervals. In reality, cash flows will be spread throughout the year. While it is common to forecast at the annual level, we can forecast free cash flow on a quarterly or monthly basis when greater accuracy is required. In practice, firms often choose shorter intervals for riskier projects so that they might forecast cash flows at the monthly level for projects that carry considerable risk. For example, cash flows for a new facility in Europe may be forecasted at the quarterly or annual level, but if that same facility were located in a politically unstable country, the forecasts would likely be at the monthly level.

Accelerated Depreciation. Because depreciation contributes positively to the firm’s cash flow through the depreciation tax shield, it is in the firm’s best interest to use the most accelerated method of depreciation that is allowable for tax purposes. By doing so, the firm will accelerate its tax savings and increase their present value. In the United States, the most accelerated depreciation method allowed by the IRS is MACRS (Modified Accelerated Cost Recovery System) depreciation. With MACRS depreciation, the firm first categorizes assets according to their recovery period. Based on the recovery period,
MACRS depreciation tables assign a fraction of the purchase price that the firm can recover each year. We provide MACRS tables and recovery periods for common assets in the appendix.

**Example 8.6**  
**Problem**  
What depreciation deduction would be allowed for HomeNet’s $7.5 million lab equipment using the MACRS method, assuming the lab equipment is designated to have a five-year recovery period? (See the appendix for information on MACRS depreciation schedules.)

**Solution**  
**Plan**  
The table in this chapter’s Appendix A provides the percentage of the cost that can be depreciated each year. Under MACRS, we take the percentage in the table for each year and multiply it by the original purchase price of the equipment to calculate the depreciation for that year.

**Execute**  
Based on the table, the allowable depreciation expense for the lab equipment is shown below (in thousands of dollars):

<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>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>MACRS Depreciation</td>
<td>-7,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Lab Equipment Cost</td>
<td>-7,500</td>
<td>-1,500</td>
<td>-1,440</td>
<td>-864</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>MACRS Depreciation Rate</td>
<td>20.00%</td>
<td>32.00%</td>
<td>19.20%</td>
<td>11.52%</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Depreciation Expense</td>
<td>-1,500</td>
<td>-2,400</td>
<td>-1,440</td>
<td>-864</td>
</tr>
</tbody>
</table>

**Evaluate**  
Compared with straight-line depreciation, the MACRS method allows for larger depreciation deductions earlier in the asset’s life, which increases the present value of the depreciation tax shield and thus will raise the project’s NPV. In the case of HomeNet, computing the NPV using MACRS depreciation leads to an NPV of $3.179 million.

**Liquidation or Salvage Value.** Assets that are no longer needed often have a resale value, or some salvage value if the parts are sold for scrap. Some assets may have a negative liquidation value. For example, it may cost money to remove and dispose of the used equipment.

In the calculation of free cash flow, we include the liquidation value of any assets that are no longer needed and may be disposed of. When an asset is liquidated, any capital gain is taxed as income. We calculate the capital gain as the difference between the sale price and the book value of the asset:

\[
\text{Capital Gain} = \text{Sale Price} - \text{Book Value} \quad (8.9)
\]

The book value is equal to the asset’s original cost less the amount it has already been depreciated for tax purposes:

\[
\text{Book Value} = \text{Purchase Price} - \text{Accumulated Depreciation} \quad (8.10)
\]

We must adjust the project’s free cash flow to account for the after-tax cash flow that would result from an asset sale:

\[
\text{After-Tax Cash Flow from Asset Sale} = \text{Sale Price} - (\text{Tax Rate} \times \text{Capital Gain}) \quad (8.11)
\]
Example 8.7
Computing After-Tax Cash Flows from an Asset Sale

Problem
As production manager, you are overseeing the shutdown of a production line for a discontinued product. Some of the equipment can be sold for a total price of $50,000. The equipment was originally purchased four years ago for $500,000 and is being depreciated according to the five-year MACRS schedule. If your marginal tax rate is 35%, what is the after-tax cash flow you can expect from selling the equipment?

Solution
\[ \text{Plan} \]
In order to compute the after-tax cash flow, you will need to compute the capital gain, which, as Eq. 8.9 shows requires you to know the book value of the equipment. The book value is given in Eq. 8.10 as the original purchase price of the equipment less accumulated depreciation. Thus, you need to follow these steps:
1. Use the MACRS schedule to determine the accumulated depreciation.
2. Determine the book value as purchase price minus accumulated depreciation.
3. Determine the capital gain as the sale price less the book value.
4. Compute the tax owed on the capital gain and subtract it from the sale price, following Eq. 8.11.

\[ \text{Execute} \]
From the chapter appendix, we see that the first five rates of the five-year MACRS schedule (including year 0) are:

<table>
<thead>
<tr>
<th>Year</th>
<th>Depreciation Rate</th>
<th>Depreciation Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>20.00%</td>
<td>100,000</td>
</tr>
<tr>
<td>2</td>
<td>32.00%</td>
<td>160,000</td>
</tr>
<tr>
<td>3</td>
<td>19.20%</td>
<td>96,000</td>
</tr>
<tr>
<td>4</td>
<td>11.52%</td>
<td>57,600</td>
</tr>
</tbody>
</table>

Thus, the accumulated depreciation is $100,000 + $160,000 + $96,000 + $57,600 + $57,600 = $471,200, such that the remaining book value is $500,000 − $471,200 = $28,800. (Note we could have also calculated this by summing the rates for years remaining on the MACRS schedule (Year 5 is 5.76%, so .0576 \times 500,000 = 28,800).

The capital gain is then $50,000 − $28,800 = $21,200 and the tax owed is 0.35 \times $21,200 = $7,420.

Your after-tax cash flow is then found as the sale price minus the tax owed: $50,000 − $7,420 = $42,580.

\[ \text{Evaluate} \]
Because you are only taxed on the capital gain portion of the sale price, figuring the after-tax cash flow is not as simple as subtracting the tax rate multiplied by the sale price. Instead, you have to determine the portion of the sale price that represents a gain and compute the tax from there. The same procedure holds for selling equipment at a loss relative to book value—the loss creates a deduction for taxable income elsewhere in the company.

Tax Carryforwards. A firm generally identifies its marginal tax rate by determining the tax bracket that it falls into based on its overall level of pre-tax income. Two additional features of the tax code, called tax loss carryforwards and carrybacks, allow corporations to take losses during a current year and offset them against gains in nearby years. Since 1997, companies can “carry back” losses for two years and “carry forward” losses for 20 years. This tax rule means that a firm can offset losses during one year against income for the last two years, or save the losses to be offset against income during the next 20 years. When a firm can carry back losses, it receives a refund for back taxes in the current year. Otherwise, the firm must carry forward the loss and use it to offset
future taxable income. When a firm has tax loss carryforwards well in excess of its current pre-tax income, then additional income it earns today will simply increase the taxes it owes after it exhausts its carryforwards.

**Replacement Decisions**

Often the financial manager must decide whether to replace an existing piece of equipment. The new equipment may allow increased production, resulting in incremental revenue, or it may simply be more efficient, lowering costs. The typical incremental effects associated with such a decision are salvage value from the old machine, purchase of the new machine, cost savings and revenue increases, and depreciation effects.

**EXAMPLE 8.8**

**Problem**

You are trying to decide whether to replace a machine on your production line. The new machine will cost $1 million, but will be more efficient than the old machine, reducing costs by $500,000 per year. Your old machine is fully depreciated, but you could sell it for $50,000. You would depreciate the new machine over a five-year life using MACRS. The new machine will not change your working capital needs. Your tax rate is 35%.

**Solution**

**Plan**

Incremental revenues: 0

Incremental costs: $500,000 (a reduction in costs will appear as a positive number in the costs line of our analysis)

Depreciation schedule (from the appendix):

<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>1</td>
<td></td>
<td>20.00%</td>
<td>32.00%</td>
<td>19.20%</td>
<td>11.52%</td>
<td>11.52%</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>200,000</td>
<td>320,000</td>
<td>192,000</td>
<td>115,200</td>
<td>115,200</td>
</tr>
</tbody>
</table>

Capital gain on salvage = $50,000 − $0 = $50,000

Cash flow from salvage value: +50,000 − (50,000)(.35) = 32,500

**Execute**

<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>1</td>
<td></td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>200</td>
<td>180</td>
<td>308</td>
<td>384.8</td>
<td>384.8</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>-200</td>
<td>-320</td>
<td>-192</td>
<td>-115.2</td>
<td>-115.2</td>
</tr>
<tr>
<td>6</td>
<td>EBIT</td>
<td>-200</td>
<td>117</td>
<td>200.2</td>
<td>250.12</td>
<td>250.12</td>
</tr>
<tr>
<td>7</td>
<td>Income Tax at 35%</td>
<td>70</td>
<td>-63</td>
<td>-107.8</td>
<td>-134.68</td>
<td>-134.68</td>
</tr>
<tr>
<td>8</td>
<td>Incremental Earnings</td>
<td>-130</td>
<td>117</td>
<td>200.2</td>
<td>250.12</td>
<td>250.12</td>
</tr>
<tr>
<td>9</td>
<td>Add Back Depreciation</td>
<td>200</td>
<td>320</td>
<td>192</td>
<td>115.2</td>
<td>115.2</td>
</tr>
<tr>
<td>10</td>
<td>Purchase of Equipment</td>
<td>-1,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Salvage Cash Flow</td>
<td>32.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Incremental Free Cash Flows</td>
<td>-897.5</td>
<td>437</td>
<td>392.2</td>
<td>365.32</td>
<td>365.32</td>
</tr>
</tbody>
</table>

**Evaluate**

Even though the decision has no impact on revenues, it still matters for cash flows because it reduces costs. Further, both selling the old machine and buying the new machine involve cash flows with tax implications.
When evaluating a capital budgeting project, financial managers should make the decision that maximizes NPV. As we have discussed, to compute the NPV for a project you need to estimate the incremental free cash flows and choose a discount rate. Given these inputs, the NPV calculation is relatively straightforward. The most difficult part of capital budgeting is deciding how to estimate the cash flows and cost of capital. These estimates are often subject to significant uncertainty. In this section, we look at methods that assess the importance of this uncertainty and identify the drivers of value in the project.

**Sensitivity Analysis**

An important capital budgeting tool for assessing the effect of uncertainty in forecasts is sensitivity analysis. Sensitivity analysis breaks the NPV calculation into its component assumptions and shows how the NPV varies as the underlying assumptions change. In this way, sensitivity analysis allows us to explore the effects of errors in our NPV estimates for a project. By conducting a sensitivity analysis, we learn which assumptions are the most important; we can then invest further resources and effort to refine these assumptions. Such an analysis also reveals which aspects of a project are most critical when we are actually managing the project.

In fact, we have already performed a type of sensitivity analysis in Chapter 7 when we constructed an NPV profile. By graphing the NPV of a project as a function of the discount rate, we are assessing the sensitivity of our NPV calculation to uncertainty about the correct cost of capital to use as a discount rate. In practice, financial managers explore the sensitivity of their NPV calculation to many more factors than just the discount rate.

To illustrate, consider the assumptions underlying the calculation of HomeNet's NPV in Example 8.5. There is likely to be significant uncertainty surrounding each revenue and cost assumption. In addition to the base case assumptions about units sold, sale price, cost of goods sold, net working capital, and cost of capital, Linksys's managers would also identify best and worst case scenarios for each. For example, assume that they identified the best and worst case assumptions listed in Table 8.2. Note that these are best and worst case scenarios for each parameter rather than representing one worst case scenario and one best case scenario.

To determine the importance of this uncertainty, we recalculate the NPV of the HomeNet project under the best- and worst-case assumptions for each parameter. For example, if the number of units sold is only 35,000 per year, the NPV of the project falls

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial Assumption</th>
<th>Worst Case</th>
<th>Best Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units Sold (thousands)</td>
<td>50</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>Sale Price ($/unit)</td>
<td>260</td>
<td>240</td>
<td>280</td>
</tr>
<tr>
<td>Cost of Goods ($/unit)</td>
<td>110</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>NWC ($ thousands)</td>
<td>1125</td>
<td>1525</td>
<td>725</td>
</tr>
<tr>
<td>Cost of Capital</td>
<td>12%</td>
<td>15%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Should we include sunk costs in the cash flows of a project? Why or why not?

Explain why it is advantageous for a firm to use the most accelerated depreciation schedule possible for tax purposes.
to $-1.24 million. We repeat this calculation for each parameter. The result is shown in Figure 8.2, which reveals that the parameter assumptions with the largest effect on NPV are the number of units sold and the sale price per unit. As a result, these assumptions deserve the greatest scrutiny during the estimation process. In addition, as the most important drivers of the project's value, these factors deserve close attention when managing the project after it starts.

Break-Even Analysis

A natural extension of the sensitivity analysis is to ask at what level of each parameter would the project just break-even, which is the level for which the investment has an NPV of zero. One example that we have already considered is the calculation of the internal rate of return (IRR). Recall from Chapter 7 that the difference between the IRR of a project and the cost of capital tells you how much error in the cost of capital it would take to change the investment decision. By either graphing the NPV profile or using the Excel function IRR, we would find that the incremental cash flows of HomeNet given in Example 8.5 imply an IRR of 26.6%. Hence, the true cost of capital can be as high as 26.6% and the project will still have a positive NPV.

We can determine the uncertainty of other parameters as well. In a break-even analysis, for each parameter we calculate the value at which the NPV of the project is zero. This would be tedious to do by hand, so in practice it is always done with a spreadsheet. As with the NPV profile for the discount rate, we can graph the NPV as a function of each of the critical assumptions. In each case, we keep all of the other parameters fixed at their base case values and vary only the parameter in question. Figure 8.3 does this for HomeNet.

Accounting Break-Even. We have examined the break-even levels in terms of the project's NPV, which is the most useful perspective for decision making. Other accounting notions of break-even are sometimes considered, however. For example, we could compute the EBIT break-even for sales, which is the level of sales for which the project's EBIT is zero.
Recall from Eq. 8.1 that the project’s EBIT is Revenues − Costs − Depreciation. Costs include cost of goods sold and selling, and general and administrative expense (SG&A). Revenues equal Units Sold × Sale Price, and cost of goods sold equals Units Sold × Cost per Unit, so we have EBIT = (Units Sold × Sale Price) − (Units Sold × Cost per Unit) − SG&A − Depreciation. Setting this equal to zero and solving for units sold:

\[
\text{Units Sold} \times (\text{Sale Price} - \text{Cost per unit}) - \text{SG&A} - \text{Depreciation} = 0
\]

\[
\text{Units Sold} = \frac{\text{SG&A} + \text{Depreciation}}{\text{Sales Price} - \text{Cost per unit}} = \frac{2,800,000 + 1,500,000}{260 - 110} = 28,667
\]
However, this EBIT break-even number is misleading. While HomeNet’s EBIT break-even level of sales is only 28,667 units per year, given the large upfront investment required in HomeNet, its NPV is −$2.97 million at that sales level.

Scenario Analysis

Scenario analysis An important capital budgeting tool that determines how the NPV varies as a number of the underlying assumptions are changed simultaneously.

In the analysis thus far, we have considered the consequences of varying only one parameter at a time. In reality, certain factors may affect more than one parameter. Scenario analysis considers the effect on NPV of changing multiple project parameters. For example, lowering HomeNet’s price may increase the number of units sold. We can use scenario analysis to evaluate alternative pricing strategies for the HomeNet product in Table 8.3. In this case, the current strategy is optimal. Figure 8.4 shows the combinations of price and volume that lead to the same NPV of $2.862 million for HomeNet as the current strategy. Only strategies with price and volume combinations above the line will lead to a higher NPV.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Sale Price ($/unit)</th>
<th>Expected Units Sold (thousands)</th>
<th>NPV ($ thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Strategy</td>
<td>260</td>
<td>50</td>
<td>2862</td>
</tr>
<tr>
<td>Price Reduction</td>
<td>245</td>
<td>55</td>
<td>2725</td>
</tr>
<tr>
<td>Price Increase</td>
<td>275</td>
<td>45</td>
<td>2725</td>
</tr>
</tbody>
</table>

TABLE 8.3
Scenario Analysis of Alternative Pricing Strategies

FIGURE 8.4
Price and Volume Combinations for HomeNet with Equivalent NPV

The graph shows alternative price per unit and annual volume combinations that lead to an NPV of $2.862 million. Pricing strategies with combinations above this line will lead to a higher NPV and are superior. For example, if Linksys managers think they will be able to sell 48,000 units at a price of $275, this strategy would yield a higher NPV ($3,627 million).

9. What is sensitivity analysis?
10. How does scenario analysis differ from sensitivity analysis?
Real Options in Capital Budgeting

Our approach to capital budgeting thus far has focused on the initial investment decision without explicitly considering future decisions that may need to be made over the life of a project. Rather, we assumed that our forecast of a project’s expected future cash flows already incorporated the effect of future decisions that would be made. In truth, most projects contain real options. A real option is the right, but not the obligation, to make a particular business decision. Because you are not obligated to take the action, you will only do so if it increases the NPV of the project. In particular, because real options allow a decision maker to choose the most attractive alternative after new information has been learned, the presence of real options adds value to an investment opportunity. The tools to estimate the actual value created by real options are beyond the scope of this chapter and are contained later in the book. However, we introduce the concept here to give you a sense of the types of real options you may encounter and establish the intuition that flexibility (more options) is valuable. Let’s look at some of the most common real options in the context of Linksys’s HomeNet project.

Option to Delay

The option to delay commitment (the option to time the investment) is almost always present. Linksys could wait to commit to the HomeNet project. Waiting could be valuable if Linksys expects prices of the components to decrease substantially, soon-to-be-released new technology that will make the existing components obsolete, or increased sales of Web-ready appliances (heightening the demand for HomeNet). In addition, Linksys may simply want more time to gather information about the potential market for HomeNet. As with any other capital budgeting decision, Linksys would only choose to delay if doing so would increase the NPV of the project by more than the cost of capital over the time of delay.

Option to Expand

In the section on sensitivity analysis, we looked at changes in our assumptions about units sold. All of the analysis was performed, however, under the assumption that Linksys would fully commit to and roll-out the HomeNet product worldwide. We did not consider the option to expand, which is the option to start with limited production and expand only if the product is successful. Linksys could, instead, test market the product in limited release before committing to it fully. Doing so would create an option to expand worldwide only if HomeNet were successful in limited release. It is possible that, by reducing its upfront commitment and only choosing to expand if the product is successful, Linksys will increase the NPV of the HomeNet product. However, in this particular case, there are large costs of development that would be paid whether Linksys sells one or one million units, so limiting the initial market does not reduce the financial commitment substantially. Thus, in the case of HomeNet, it is unlikely that Linksys would choose a limited release with an option to expand.

Option to Abandon

An abandonment option is the option to walk away. Abandonment options can add value to a project because a firm can drop a project if it turns out to be unsuccessful. Imagine that a competitor developed new technology that allowed it to introduce a competing product priced at $170. At that price, HomeNet would produce negative cash flows every year. But would Linksys continue to sell HomeNet if it had to do so at a loss? Probably
not. Linksys has an option to abandon the project. It could stop producing HomeNet and sell the equipment. Depending on how much Linksys believes the equipment would sell for if it abandoned the project, the abandonment option could make HomeNet attractive even if there was a substantial risk of a competing product.

All these options point to the same conclusion: *if you can build greater flexibility into your project, you will increase the NPV of the project.* In Chapter 20, we will discuss how to value options so that you can estimate just how much more valuable the project is with greater flexibility.

11. What are real options?
12. Why do real options increase the NPV of the project?
### Part 3 Valuation and the Firm

#### 8.3 Determining Incremental Free Cash Flow
- We compute free cash flow from incremental earnings by eliminating all non-cash expenses and including all capital investment.
- Depreciation is not a cash expense, so it is added back.
- Actual capital expenditures are deducted.
- Increases in net working capital are deducted and decreases are added. Net working capital is defined as:
  \[ \text{Cash} + \text{Inventory} + \text{ Receivables} - \text{Payables} \]  
  (8.4)
- The basic calculation for free cash flow is:
  \[ \text{Free Cash Flow} = \frac{\text{Unlevered Net Income}}{(\text{Revenues} - \text{Costs} - \text{Depreciation}) \times (1 - \text{tax rate}) + \text{Depreciation} - \text{CapEx} - \text{Change in NWC}} \]  
  (8.6)

#### 8.4 Other Effects on Incremental Free Cash Flows
- An opportunity cost is the cost of using an existing asset.
- Project externalities are cash flows that occur when a project affects other areas of the company’s business.
- A sunk cost is an unrecoverable cost that has already been incurred.
- Depreciation expenses affect free cash flow only through the depreciation tax shield. The firm should use the most accelerated depreciation schedule possible.
- The discount rate for a project is its cost of capital: the expected return of securities with comparable risk and horizon.
- When you sell an asset, the portion of the proceeds above its book value is taxed:
  \[ \text{After-Tax Cash Flow from Asset Sale} = \text{Sale Price} - (\text{Tax Rate} \times \text{Capital Gain}) \]  
  (8.11)

#### 8.5 Analyzing the Project
- Sensitivity analysis breaks the NPV calculation down into its component assumptions, showing how the NPV varies as the values of the underlying assumptions change.
- Break-even analysis computes the level of a parameter that makes the project’s NPV equal zero.
- Scenario analysis considers the effect of changing multiple parameters simultaneously.
8.6 Real Options in Capital Budgeting

Real options are options to make a business decision, often after gathering more information. The presence of real options in a project increases the project’s NPV.

abandonment option, p. 266
option to expand, p. 266
option to delay commitment, p. 266
real option, p. 266

MyFinanceLab Study Plan 8.6

Review Questions

1. What are pro forma incremental earnings?
2. What is the difference between pro forma incremental earnings and pro forma free cash flow?
3. What is the role of net working capital in projects?
4. How does net working capital affect the cash flows of a project?
5. Why is it important to adjust project sales and costs for externalities?
6. Does accelerated depreciation generally increase or decrease NPV relative to straight-line depreciation?
7. How is sensitivity analysis performed and what is its purpose?

Problems

All problems in this chapter are available in MyFinanceLab. An asterisk (*) indicates problems with a higher level of difficulty.

The Capital Budgeting Process

1. $2,010,000
   Daily Enterprises is purchasing a $10 million machine. It will cost $50,000 to transport and install the machine. The machine has a depreciable life of five years and will have no salvage value. If Daily uses straight-line depreciation, what are the depreciation expenses associated with this machine?

2. $513,500
   The machine in Problem 1 will generate incremental revenues of $4 million per year along with incremental costs of $1.2 million per year. If Daily’s marginal tax rate is 35%, what are the incremental earnings associated with the new machine?

3. $400,000
   You are upgrading to better production equipment for your firm’s only product. The new equipment will allow you to make more of your product in the same amount of time. Thus, you forecast that total sales will increase next year by 20% over the current amount of 100,000 units. If your sales price is $20 per unit, what are the incremental revenues next year from the upgrade?
4. Pisa Pizza, a seller of frozen pizza, is considering introducing a healthier version of its pizza that will be low in cholesterol and contain no trans fats. The firm expects that sales of the new pizza will be $20 million per year. While many of these sales will be to new customers, Pisa Pizza estimates that 40% will come from customers who switch to the new, healthier pizza instead of buying the original version.
   a. Assume customers will spend the same amount on either version. What level of incremental sales is associated with introducing the new pizza?
   b. Suppose that 50% of the customers who would switch from Pisa Pizza’s original pizza to its healthier pizza will switch to another brand if Pisa Pizza does not introduce a healthier pizza. What level of incremental sales is associated with introducing the new pizza in this case?

5. Kokomochi is considering the launch of an advertising campaign for its latest dessert product, the Mini Mochi Munch. Kokomochi plans to spend $5 million on TV, radio, and print advertising this year for the campaign. The ads are expected to boost sales of the Mini Mochi Munch by $9 million this year and by $7 million next year. In addition, the company expects that new consumers who try the Mini Mochi Munch will be more likely to try Kokomochi’s other products. As a result, sales of other products are expected to rise by $2 million each year.

   Kokomochi’s gross profit margin for the Mini Mochi Munch is 35%, and its gross profit margin averages 25% for all other products. The company’s marginal corporate tax rate is 35% both this year and next year. What are the incremental earnings associated with the advertising campaign?

6. Hyperion, Inc. currently sells its latest high-speed color printer, the Hyper 500, for $350. It plans to lower the price to $300 next year. Its cost of goods sold for the Hyper 500 is $200 per unit, and this year’s sales are expected to be 20,000 units.
   a. Suppose that if Hyperion drops the price to $300 immediately, it can increase this year’s sales by 25% to 25,000 units. What would be the incremental impact on this year’s EBIT of such a price drop?
   b. Suppose that for each printer sold, Hyperion expects additional sales of $75 per year on ink cartridges for the next three years, and Hyperion has a gross profit margin of 70% on ink cartridges. What is the incremental impact on EBIT for the next three years of a price drop this year?

**Determining Incremental Free Cash Flow**

7. You are forecasting incremental free cash flows for Daily Enterprises. Based on the information in Problems 1 and 2, what are the incremental free cash flows associated with the new machine?

8. Castle View Games would like to invest in a division to develop software for video games. To evaluate this decision, the firm first attempts to project the working capital needs for this operation. Its chief financial officer has developed the following estimates (in millions of dollars):

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>6</td>
<td>12</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Accounts Receivable</td>
<td>21</td>
<td>22</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Inventory</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Accounts Payable</td>
<td>18</td>
<td>22</td>
<td>24</td>
<td>25</td>
<td>30</td>
</tr>
</tbody>
</table>

Assuming that Castle View currently does not have any working capital invested in this division, calculate the cash flows associated with changes in working capital for the first five years of this investment.
Elmdale Enterprises is deciding whether to expand its production facilities. Although long-term cash flows are difficult to estimate, management has projected the following cash flows for the first two years (in millions of dollars):

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>41.6</td>
<td>29.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>29.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**9.** In the HomeNet example from the chapter, its receivables are 15% of sales and its payables are 15% of COGS. Forecast the required investment in net working capital for HomeNet assuming that sales and cost of goods sold (COGS) will be:

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>29.6</td>
<td>36</td>
</tr>
</tbody>
</table>

**10.** a. What are the incremental earnings for this project for years 1 and 2?

b. What are the free cash flows for this project for the first two years?

**11.** $140 million

**12.** The opportunity cost lowers the incremental earnings by the after-tax earnings that HomeNet would have otherwise earned had it rented out the space instead.

**13.** NPV = $3916; yes

**14.** NPV of renting:

- $218,078

NPV of existing machine:

- $198,183

NPV of new machine:

- $229,478

Beryl’s should purchase new machine.

**15.** Beryl’s Iced Tea currently rents a bottling machine for $50,000 per year, including all maintenance expenses. It is considering purchasing a machine instead and is comparing two options:

a. Purchase the machine it is currently renting for $150,000. This machine will require $20,000 per year in ongoing maintenance expenses.

b. Purchase a new, more advanced machine for $250,000. This machine will require $15,000 per year in ongoing maintenance expenses and will lower bottling costs by $10,000 per year. Also, $35,000 will be spent upfront in training the new operators of the machine.
Suppose the appropriate discount rate is 8% per year and the machine is purchased today. Maintenance and bottling costs are paid at the end of each year, as is the rental of the machine. Assume also that the machines will be depreciated via the straight-line method over seven years and that they have a ten-year life with a negligible salvage value. The marginal corporate tax rate is 35%. Should Beryl’s Iced Tea continue to rent, purchase its current machine, or purchase the advanced machine?

Other Effects on Incremental Free Cash Flows

15. The Jones Company has just completed the third year of a five-year MACRS recovery period for a piece of equipment it originally purchased for $300,000.
   a. What is the book value of the equipment?
   b. If Jones sells the equipment today for $180,000 and its tax rate is 35%, what is the after-tax cash flow from selling it?

16. Just before it is about to sell the equipment from Problem 15, Jones receives a new order. It can take the new order if it keeps the old equipment. Is there a cost to taking the order and if so, what is it? Explain.

17. Home Builder Supply, a retailer in the home improvement industry, currently operates seven retail outlets in Georgia and South Carolina. Management is contemplating building an eighth retail store across town from its most successful retail outlet. The company already owns the land for this store, which currently has an abandoned warehouse located on it. Last month, the marketing department spent $10,000 on market research to determine the extent of customer demand for the new store. Now Home Builder Supply must decide whether to build and open the new store.
   Which of the following should be included as part of the incremental earnings for the proposed new retail store?
   a. The original purchase price of the land where the store will be located.
   b. The cost of demolishing the abandoned warehouse and clearing the lot.
   c. The loss of sales in the existing retail outlet, if customers who previously drove across town to shop at the existing outlet become customers of the new store instead.
   d. The $10,000 in market research spent to evaluate customer demand.
   e. Construction costs for the new store.
   f. The value of the land if sold.
   g. Interest expense on the debt borrowed to pay the construction costs.

18. If Daily Enterprises uses MACRS instead of straight-line depreciation, how would the incremental free cash flows from Problem 7 change?

19. Markov Manufacturing recently spent $15 million to purchase some equipment used in the manufacture of disk drives. The firm expects that this equipment will have a useful life of five years, and its marginal corporate tax rate is 35%. The company plans to use straight-line depreciation.
   a. What is the annual depreciation expense associated with this equipment?
   b. What is the annual depreciation tax shield?
   c. Rather than straight-line depreciation, suppose Markov will use the MACRS depreciation method for the five-year life of the property. Calculate the depreciation tax shield each year for this equipment under this accelerated depreciation schedule.
   d. If Markov has a choice between straight-line and MACRS depreciation schedules, and its marginal corporate tax rate is expected to remain constant, which schedule should it choose? Why?
   e. How might your answer to part (d) change if Markov anticipates that its marginal corporate tax rate will increase substantially over the next five years?
All of the estimates in the report seem correct. You note that the consultants used straight-line depreciation for the new equipment that will be purchased today (year 0), which is what the accounting department recommended. They also calculated the depreciation assuming no salvage value for the equipment, which is the company’s assumption in this case. The report concludes that because the project will increase earnings by $4.875 million per year for ten years, the project is worth $48.75 million. You think back to your halcyon days in finance class and realize there is more work to be done!

First, you note that the consultants have not factored in the fact that the project will require $10 million in working capital upfront (year 0), which will be fully recovered in year 10. Next, you see they have attributed $2 million of selling, general, and administrative expenses to the project, but you know that $1 million of this amount is overhead that will be incurred even if the project is not accepted. Finally, you know that accounting earnings are not the right thing to focus on!

20. You are a manager at Percolated Fiber, which is considering expanding its operations in synthetic fiber manufacturing. Your boss comes into your office, drops a consultant's report on your desk, and complains, “We owe these consultants $1 million for this report, and I am not sure their analysis makes sense. Before we spend the $25 million on new equipment needed for this project, look it over and give me your opinion.” You open the report and find the following estimates (in thousands of dollars):

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales Revenue</th>
<th>Costs of Goods Sold</th>
<th>Gross Profit</th>
<th>General, Sales, and Administrative Expenses</th>
<th>Depreciation</th>
<th>Net Operating Income</th>
<th>Income Tax</th>
<th>Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>2</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>3</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>4</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>5</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>6</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>7</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>8</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>9</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
<tr>
<td>10</td>
<td>30,000</td>
<td>18,000</td>
<td>12,000</td>
<td>2,000</td>
<td>2,500</td>
<td>7,500</td>
<td>2,625</td>
<td>4,875</td>
</tr>
</tbody>
</table>

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First, you note that the consultants have not factored in the fact that the project will require $10 million in working capital upfront (year 0), which will be fully recovered in year 10. Next, you see they have attributed $2 million of selling, general, and administrative expenses to the project, but you know that $1 million of this amount is overhead that will be incurred even if the project is not accepted. Finally, you know that accounting earnings are not the right thing to focus on!

a. Given the available information, what are the free cash flows in years 0 through 10 that should be used to evaluate the proposed project?

b. If the cost of capital for this project is 14%, what is your estimate of the value of the new project?

21. Analyzing the Projects

21. Bauer Industries is an automobile manufacturer. Management is currently evaluating a proposal to build a plant that will manufacture lightweight trucks. Bauer plans to use a cost of capital of 12% to evaluate this project. Based on extensive research, it has prepared the following incremental free cash flow projections (in millions of dollars):

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenues</th>
<th>Manufacturing Expenses (other than depreciation)</th>
<th>Marketing Expenses</th>
<th>Depreciation</th>
<th>EBIT</th>
<th>Taxes at 35%</th>
<th>Unlevered Net Income</th>
<th>Depreciation</th>
<th>Additions to Net Working Capital</th>
<th>Capital Expenditures</th>
<th>Continuation Value</th>
<th>Free Cash Flow</th>
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<td>-35.0</td>
<td>-10.0</td>
<td>-15.0</td>
<td>40.0</td>
<td>-14.0</td>
<td>26.0</td>
<td>+15.0</td>
<td>-5.0</td>
<td>-150.0</td>
<td></td>
<td>-150.0</td>
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<tr>
<td>1–9</td>
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<td></td>
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<td></td>
<td>48.0</td>
</tr>
</tbody>
</table>

Chapter 8 Fundamentals of Capital Budgeting
For this base-case scenario, what is the NPV of the plant to manufacture lightweight trucks?

b. Based on input from the marketing department, Bauer is uncertain about its revenue forecast. In particular, management would like to examine the sensitivity of the NPV to the revenue assumptions. What is the NPV of this project if revenues are 10% higher than forecast? What is the NPV if revenues are 10% lower than forecast?

c. Rather than assuming that cash flows for this project are constant, management would like to explore the sensitivity of its analysis to possible growth in revenues and operating expenses. Specifically, management would like to assume that revenues, manufacturing expenses, and marketing expenses are as given in the table for year 1 and grow by 2% per year every year starting in year 2. Management also plans to assume that the initial capital expenditures (and therefore depreciation), additions to working capital, and continuation value remain as initially specified in the table. What is the NPV of this project under these alternative assumptions? How does the NPV change if the revenues and operating expenses grow by 5% per year rather than by 2%?

d. To examine the sensitivity of this project to the discount rate, management would like to compute the NPV for different discount rates. Create a graph, with the discount rate on the x-axis and the NPV on the y-axis, for discount rates ranging from 5% to 30%. For what ranges of discount rates does the project have a positive NPV?

Billingham Packaging is considering expanding its production capacity by purchasing a new machine, the XC-750. The cost of the XC-750 is $2.75 million. Unfortunately, installing this machine will take several months and will partially disrupt production. The firm has just completed a $50,000 feasibility study to analyze the decision to buy the XC-750, resulting in the following estimates:

- Marketing: Once the XC-750 is operational next year, the extra capacity is expected to generate $10 million per year in additional sales, which will continue for the ten-year life of the machine.
- Operations: The disruption caused by the installation will decrease sales by $5 million this year. As with Billingham’s existing products, the cost of goods for the products produced by the XC-750 is expected to be 70% of their sale price. The increased production will also require increased inventory on hand of $1 million during the life of the project, including year 0.
- Human Resources: The expansion will require additional sales and administrative personnel at a cost of $2 million per year.
- Accounting: The XC-750 will be depreciated via the straight-line method over the ten-year life of the machine. The firm expects receivables from the new sales to be 15% of revenues and payables to be 10% of the cost of goods sold. Billingham’s marginal corporate tax rate is 35%.

Billingham Packaging is considering expanding its production capacity by purchasing a new machine, the XC-750. The cost of the XC-750 is $2.75 million. Unfortunately, installing this machine will take several months and will partially disrupt production. The firm has just completed a $50,000 feasibility study to analyze the decision to buy the XC-750, resulting in the following estimates:

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- Human Resources: The expansion will require additional sales and administrative personnel at a cost of $2 million per year.
- Accounting: The XC-750 will be depreciated via the straight-line method over the ten-year life of the machine. The firm expects receivables from the new sales to be 15% of revenues and payables to be 10% of the cost of goods sold. Billingham’s marginal corporate tax rate is 35%.

22. To examine the sensitivity of this project to the discount rate, management would like to compute the NPV for different discount rates. Create a graph, with the discount rate on the x-axis and the NPV on the y-axis, for discount rates ranging from 5% to 30%. For what ranges of discount rates does the project have a positive NPV?
23. Real options must have positive value because they are only exercised when doing so would increase the value of the investment.

24. Option to expand

25. Option to abandon

Real Options in Capital Budgeting

23. Why is it that real options must have positive value?

24. What kind of real option does the XC-900 machine provide to Billingham in Problem 22?

25. If Billingham knows that it can sell the XC-750 to another firm for $2 million in two years, what kind of real option would that provide?

Data Case

You have just been hired by Dell Computers in its capital budgeting division. Your first assignment is to determine the net cash flows and NPV of a proposed new type of portable computer system similar in size to a Blackberry handheld, but which has the operating power of a high-end desktop system.

Development of the new system will initially require an investment equal to 10% of net property, plant, and equipment (PPE) for the fiscal year ended Feb. 1, 2008. The project will then require an additional investment equal to 10% of the initial investment after the first year of the project, a 5% of initial investment after the second year, and 1% of initial investment after the third, fourth, and fifth years. The product is expected to have a life of five years. First-year revenues for the new product are expected to be 3% of total revenue for Dell’s fiscal year ended Feb. 1, 2008. The new product’s revenues are expected to grow at 15% for the second year, then 10% for the third, and 5% annually for the final two years of the expected life of the project. Your job is to determine the rest of the cash flows associated with this project. Your boss has indicated that the operating costs and net working capital requirements are similar to the rest of the company’s products and that depreciation is straight-line for capital budgeting purposes. Welcome to the “real world.” Since your boss hasn’t been much help, here are some tips to guide your analysis:

1. Obtain Dell’s financial statements. (If you “really” worked for Dell you would already have this data, but at least here you won’t get fired if your analysis is off target.) Download the annual income statements, balance sheets, and cash flow statements for the last four fiscal years from MarketWatch (www.marketwatch.com). Enter Dell’s ticker symbol (DELL) and then go to “Financials.” Export the statements to Excel by right-clicking while the cursor is inside each statement.

2. You are now ready to determine the free cash flow. Compute the free cash flow for each year using Eq. 8.6 from this chapter:

\[
\text{Free Cash Flow} = \frac{\text{Unlevered Net Income}}{1 - \text{tax rate}} - \text{Depreciation} - \text{CapEx} - \text{Change in NWC}
\]

Set up the timeline and computation of the free cash flow in separate, contiguous columns for each year of the project life. Be sure to make outflows negative and inflows positive.
a. Assume that the project’s profitability will be similar to Dell’s existing projects in 2007 and estimate (Revenues – Costs) each year by using the 2007 EBITDA/Sales profit margin.

b. Determine the annual depreciation by assuming Dell depreciates these assets by the straight-line method over a ten-year life.

c. Determine Dell’s tax rate by using the income tax rate in 2007.

d. Calculate the net working capital required each year by assuming that the level of NWC will be a constant percentage of the project’s sales. Use Dell’s 2007 NWC/Sales to estimate the required percentage. (Use only accounts receivable, accounts payable, and inventory to measure working capital. Other components of current assets and liabilities are harder to interpret and not necessarily reflective of the project’s required NWC—e.g., Dell’s cash holdings.)

e. To determine the free cash flow, calculate the additional capital investment and the change in net working capital each year.

3. Determine the IRR of the project and the NPV of the project at a cost of capital of 12% using the Excel functions. For the calculation of NPV, include cash flows 1 through 5 in the NPV function and then subtract the initial cost (i.e., \(NPV(rate, CF_1:CF_5) + CF_0\)). For IRR, include cash flows 0 through 5 in the cash flow range.
The U.S. tax code allows for accelerated depreciation of most assets. The depreciation method that you use for any particular asset is determined by the tax rules in effect at the time you place the asset into service. (Congress has changed the depreciation rules many times over the years, so many firms that have held property for a long time may have to use several depreciation methods simultaneously.)

For most business property placed in service after 1986, the IRS allows firms to depreciate the asset using the MACRS (Modified Accelerated Cost Recovery System) method. Under this method, you categorize each business asset into a recovery class that determines the time period over which you can write off the cost of the asset. The most commonly used items are classified as shown below:

- **3-year property**: Tractor units, racehorses over 2 years old, and horses over 12 years old.
- **5-year property**: Automobiles, buses, trucks, computers and peripheral equipment, office machinery, and any property used in research and experimentation. Also includes breeding and dairy cattle.
- **7-year property**: Office furniture and fixtures, and any property that has not been designated as belonging to another class.
- **10-year property**: Water transportation equipment, single-purpose agricultural or horticultural structures, and trees or vines bearing fruit or nuts.
- **15-year property**: Depreciable improvements to land such as fences, roads, and bridges.
- **20-year property**: Farm buildings that are not agricultural or horticultural structures.
- **27.5-year property**: Residential rental property.
- **39-year property**: Nonresidential real estate, including home offices. (Note that the value of land may not be depreciated.)

Generally speaking, residential and nonresidential real estate is depreciated via the straight-line method, but other classes can be depreciated more rapidly in early years. Table 8.4 shows the standard depreciation rates for assets in the other recovery classes; refinements of this table can be applied depending on the month that the asset was placed into service (consult IRS guidelines). The table indicates the percentage of the asset's cost that may be depreciated each year, with year 1 indicating the year the asset was first put into use. Generally, year 1 is the acquisition year and the table contains the “half-year” convention, allowing for a half year of depreciation in the acquisition year itself. This is why the first year's depreciation percentage is smaller than the second year's.
TABLE 8.4  Depreciation Rate for Recovery Period

<table>
<thead>
<tr>
<th>Year</th>
<th>3 Years</th>
<th>5 Years</th>
<th>7 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
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<td>6.23</td>
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</tr>
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</table>

In this appendix, we illustrate how to build a pro forma statement and perform a sensitivity analysis in Excel.

Building a Pro Forma Statement

The key to frustration-free capital budgeting is to base your analysis on a spreadsheet containing a flexible model of the project’s pro forma free cash flows.

List Assumptions

Start by creating a box in the spreadsheet with all of your assumptions, shown here shaded in gray:

Although this step will take you a little more time upfront, it has two advantages. First, you are forced to present all of your major assumptions clearly, so you can see the drivers of your
analysis. Second, setting them apart this way makes it far easier to change your assumptions later and quickly see the impact on the incremental free cash flows.

### Base Cell Formulas on Assumptions

Once you have listed all of your assumptions, it is time to build the pro forma statement by dynamically referring back to the cells containing your assumptions. Here, we will show how to build the first year’s pro forma cash flows. For example, rather than entering $13,000 into the Sales line of Year 1, you will enter the formula shown in the screen shot.

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales</td>
<td>13000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This formula is simply the cell-referenced version of our calculation from Example 8.1: Unit Sold $\times$ Price per unit $= 50 \times 260 = 13,000$. As you can see from the screen shot, we have referred back to our Assumptions box for each of these inputs (units sold and price per unit). Later, if we want to change the assumption for price per unit, we can change it in our Assumptions box and it will automatically change the calculation for Sales in Year 1.

To complete the pro forma statement for year 1, we continue down the column. Each time we need to draw on an assumed number, we refer back to our Assumptions box. For calculations such as Gross Profit, we simply refer to the cells in the column: summing Sales and the negative Cost of Goods Sold.
As you can imagine, building a pro forma statement like this greatly eases our analysis of the effects of changes in our assumptions. In the next section, we will show how to use a spreadsheet similar to the one we just constructed to perform sensitivity analysis.

**Performing Sensitivity Analysis**

Rather than recalculating HomeNet’s NPV for each possible number of units sold, we can use Excel’s Data Table tool. In Chapter 7, we used the Data Table tool to construct an NPV profile. Recall that a data table shows us how the outcome of a formula (such as the NPV of HomeNet) changes when we change one of the cells in the spreadsheet (such as the number of units sold). In the previous Using Excel box, we showed how to build a pro forma statement of HomeNet that would make it easy to change our assumptions later. That is exactly what we do in sensitivity analysis: change our assumptions and see how the NPV changes. This screen shot shows a completed Excel pro forma statement of the incremental free cash flows of the HomeNet project. It also shows the NPV calculation and a data table (outlined in red) for our assumption on Units Sold:
To set up the data table, we first create a cell that simply repeats the NPV. In this case, cell F1 is set to equal cell C30 to create a new NPV column. Next, we create the column that will contain the different assumptions of Units Sold. This column must be directly to the left of the NPV cell (F1). Finally, we highlight the Units Sold and NPV columns, and select Table from the Data menu.

As the screen shot shows, the Table input box will appear. Since our Units Sold assumptions are in a column, we enter, into the column input cell (not the row input cell), the cell in our spreadsheet containing the base case Units Sold assumption (B2). Once we do this and hit Enter, Excel will create the sensitivity table shown in the first screen shot.