As discussed in Chapter 2, when an operating budget is prepared, it includes costs that the organization expects to incur for the coming year. Sometimes, however, the organization spends money on the acquisition of resources that will provide benefits beyond the coming year. A capital asset is anything the organization acquires that will help it provide goods or services in more than one fiscal year. When an organization contemplates the acquisition of a capital asset, it often pays special attention to the appropriateness of the decision. The special attention to the decision reflects the fact that a capital acquisition generally requires a large up-front expenditure, followed by some combination of mortgage and interest payments, rent, maintenance, and other ongoing expenses. The process of planning for the purchase of capital assets is capital budgeting. A capital budget is prepared separately from the operating and cash budgets, and it becomes part of the organization’s master budget.

In some organizations, all capital budgeting is done as part of the annual planning process. Specific items are identified, and their purchase is planned for the coming year. In other organizations, an aggregate dollar amount is approved for capital spending for the coming year. Then individual items are evaluated and approved for acquisition throughout the year as the need for those items becomes apparent.

LEARNING OBJECTIVES

The learning objectives of this chapter are to:

- introduce capital budgeting and explain why a separate capital budget is needed;
- define capital assets, in both theory and practice;
- explain the time value of money (TVM) concept and discuss the basic tools of TVM, including compounding and discounting, present and future value, and annuities;
- present the tools of investment analysis, including net present cost, annualized cost, net present value, and internal rate of return;
- define and discuss cost-benefit analysis; and
- define and discuss payback and accounting rate of return.

1. A fiscal year may be a calendar year, or it may be any 12-month period. December 31 is the most common fiscal year-end. However, many not-for-profit organizations and local governments begin their fiscal year on July 1 or September 1, rather than January 1. The federal government begins its year on October 1. Generally, the fiscal year is chosen so that the end of the year coincides with the slowest activity level of the year. This allows accountants to take the time needed to summarize the year’s activity. Governments may choose a fiscal year that allows sufficient time for the body that approves the budget to review, revise, and adopt the budget by the beginning of the fiscal year. This requires coordination between the choice of the fiscal year-end and the time of the year that the legislative body is in session.
One concern in the capital budget process is that adequate attention be paid to the timing of cash payments and receipts. Often large amounts of money are paid to acquire capital items well in advance of the collection of cash receipts earned from the use of those items. When an organization purchases a capital asset, it must recognize that by using cash today to acquire a capital asset, it is forgoing a variety of other potential uses for that money. In other words, there are opportunity costs of acquiring capital assets.

Rather than acquire a capital asset, an organization could put cash in an interest-earning account, and in the future it would have the original amount it invested plus interest. As a result, a $1,000 investment today will be worth more than $1,000 in the future. Each dollar today is worth more than a dollar tomorrow, because today’s dollar can be invested and earn a return between now and some future point in time. This is referred to as the time value of money (TVM) concept. One would only give up $1,000 today if the benefit to be realized from doing so is worth at least the $1,000 plus the interest that could be earned.

Based on the TVM concept discussed in this chapter, an organization can calculate the financial appropriateness of an investment. The discussion in this chapter examines TVM techniques for investment analysis, including net present cost, annualized cost, net present value, and internal rate of return. Then, it examines an approach called cost-benefit analysis that governments often use in evaluating capital budgeting decisions. Finally, the chapter concludes with a discussion of the payback and accounting rate of return approaches. Both approaches have their limitations, but since they are sometimes used, the reader should be aware of the methods and their drawbacks.

WHY DO WE NEED A SEPARATE CAPITAL BUDGET?

Assume that the Hospital for Ordinary Surgery (HOS) is considering adding a new wing. The hospital currently has annual revenues of $150 million and annual operating expenses of $148 million. The cost to construct the new wing is $360 million. Once opened, the new wing is expected to increase the annual revenues and operating costs of HOS by $70 million and $20 million, respectively, excluding the cost of constructing the building itself.

The operating budget for HOS would include $220 million in revenue (i.e., the original $150 million plus the new $70 million). If the entire cost of the new wing is charged to operating expenses, the total operating expenses would be $528 million (i.e., $148 million of expenses, the same as last year, plus $20 million in new operating expenses, plus the $360 million for the new building). This would result in a loss of $308 million for the year. This amount is so large that the project might be rejected as being totally unfeasible.

However, the benefit of the $360 million investment in the new wing will be realized over many years, not just one. When large investments that provide benefits beyond the current year are included in an operating budget, they often look much too costly. However, if one considers their benefits over an extended period of time, they may not be too costly. The role of the capital budget is to pull the acquisition cost out of the operating budget and place it in a separate budget where its costs and benefits can be evaluated over its complete lifetime.

Suppose that the top management of HOS, after careful review and analysis, decides that the benefits of the new hospital wing over its full lifetime are worth its $360 million cost. Based on the recommendation of chief operating officer (COO) Steve Netzer, as well as the hospital’s chief executive officer (CEO) and chief financial officer (CFO), the Board of Trustees of HOS approves the capital budget, including the cost of construction of the new wing. The cost of the new wing will be spread out over its estimated useful life, with a portion included in the operating budget each year.
The process of spreading out the cost of a capital asset over the years the asset will be used is called amortization, a general term that refers to any allocation over a period of time. Amortization of the cost of a physical asset is depreciation. Each year a portion of the cost of the asset is treated as an expense called depreciation expense. The aggregate amount of the cost of an asset that has been charged as an expense over the years the asset has been owned and used is referred to as accumulated depreciation.

For example, if HOS builds the new hospital wing for $360 million and expects it to have a useful life of 40 years, the depreciation expense each year will be $9 million ($360 million ÷ 40 years). Rather than showing the full cost of $360 million as an expense on the operating budget in the first year, only $9 million is shown as an expense for the first year—and every year for the next 39 years after that. After using the building for 3 years, the accumulated depreciation will be $27 million ($9 million × 3 years). If HOS expects that the building will retain some resell value at the end of its useful lifetime, however, that residual, or salvage, value would be deducted from the purchase cost before calculating the annual depreciation expense. For example, if HOS expects the building to be worth $40 million after 40 years, then only $320 million ($360 million cost less $40 million salvage) would be depreciated. The annual depreciation expense would be $8 million ($320 ÷ 40 years) instead of $9 million, and the accumulated depreciation after 3 years would be $24 million ($8 million × 3 years).

Note that the lifetime chosen for depreciating assets is just an estimate, and that estimate is often conservative. Accountants would prefer to err on the side of expecting capital assets to be used up sooner than they actually are, rather than to err on the side of expecting capital assets to last longer than they actually do. If the latter were to occur, then our depreciation expense recorded each year during the years we owned and used the asset would have been too low, and our profits would have been overstated in each of those years. Accountants try to avoid allowing organizations to overstate their profits, even if unintentionally. As a result of these conservative estimates of useful lifetimes for capital assets, there are times that a capital asset will still function as intended and be kept in use after the end of its depreciable lifetime. For instance, many office workers use computers that have exceeded their estimated useful lives, but those computers are not necessarily unusable, nor must they be immediately discarded once they have been fully depreciated (though they might be). Similarly, while some buildings are torn down and replaced at the end of their depreciable lifetime, others may be used for many decades after they have been fully depreciated. Also, depreciation refers only to a particular capital asset per se. In the case of a building, the land on which it sits is a separate asset with its own accounting treatment. Therefore, the salvage value of a building may be the estimated value of the scrap after it is demolished.

**DEFINITION OF CAPITAL ASSETS: THEORY AND PRACTICE**

In theory, a capital asset is any resource that will benefit an organization in more than one fiscal year. This means that, in theory, if one were to buy something that will last for just 6 months, it could be a capital item if part of the 6 months falls in one year and part falls in the next. In practice, however,

---

2. At times, an organization may own a capital asset that does not have physical form, such as a patent. The allocation of the cost of such an asset is simply referred to by the generic term amortization. Some assets literally empty out (e.g., oil wells, coal mines) and amortization of the cost of such assets is referred to as depletion.

3. From an economic perspective, true depreciation represents the amount of the capital asset that has been consumed in a given year. We could measure that by assessing the value of the asset at the beginning and end of the year. The depreciation expense would be the amount that the asset had declined in value. In practice, it is difficult to assess the value of each capital asset each year. Therefore, accounting uses simplifications such as an assumption that an equal portion of the value of the asset is used up each year. Alternatives, referred to as accelerated depreciation methods, are designed to better approximate true economic depreciation. They are discussed in Appendix 11-A at the end of Chapter 11.
organizations only treat items with an estimated useful lifetime of more than 1 year as being capital assets. This is done to keep the bookkeeping simpler.

Similarly, most organizations only treat relatively costly acquisitions as capital assets. In theory, there should be no price limitation. A ballpoint pen purchased for 50 cents can be a capital asset if its life extends from one accounting year into the next. However, no organization would treat the pen as a capital asset. The pen would simply be included in the operating expenses in the year it is acquired. This is because its cost is so low. The cost of allocating 25 cents of depreciation in each of 2 years would exceed the value of the information generated by that allocation.

What about something more expensive, like a $200 laser printer? In practice, most organizations would not treat a $200 machine that is expected to last 10 years as a capital asset, simply because it is relatively inexpensive. If an organization were to depreciate the printer, it would divide the $200 cost by 10 years and add $20 per year to the operating budget. For some very small organizations, the difference between charging $200 in year 1 and zero in the subsequent 9 years versus charging $20 per year for 10 years might be significant. However, that would generally not be the case.

Accounting information rarely perfectly reflects the actual use of an asset. For the sake of uniformity and comparability, accounting conventions forgo precision. Some estimates are unavoidable. Did you use half of the ink of the 50-cent pen in each of 2 years? Perhaps you used 40 percent of the ink 1 year, and 60 percent of the ink the next. A truly correct allocation would therefore require charging 40 percent of the cost of the 50-cent pen in 1 year, and 60 percent of the cost the next year. Similarly, we do not know exactly how much of the laser printer is used each year. Will it really last 10 years, or will it last 11 years? Accounting records should be reasonable representations of what has occurred from a financial perspective and should allow the user of the information to make reasonable decisions.

It is true that charging the full $200 cost of the laser printer in the year it is purchased will overstate the amount of resources that have been used up in that year. However, it is easier to do it that way, and the extent to which expenses are overstated is trivial. The organization must weigh whether the simplified treatment is likely to create a severe enough distortion that it will affect decisions. For the 50-cent pen, that is never likely to happen. For a $360 million building construction project, by contrast, treating the full cost as a current-year expense would likely affect decisions. The hard part is determining where to draw the line.

Organizations must make a policy decision regarding what dollar level is so substantial that it is worth the extra effort of depreciating the asset rather than charging it all as an expense in the year of acquisition. To most organizations, the difference between charging $200 in 1 year or $20 a year for 10 years will not be large enough to affect any decisions. In some organizations, the difference between charging $50,000 in 1 year versus $5,000 per year for 10 years would not be large enough to affect any decisions. A threshold of $1,000, or $5,000, or even $10,000 would be considered reasonable by many public, health, and not-for-profit organizations. Many organizations use even higher levels.

WHY DO CAPITAL ASSETS WARRANT SPECIAL ATTENTION?

It seems reasonable to include just 1 year’s worth of depreciation expense in an operating budget. However, that does not fully explain why a totally separate budget is prepared for capital assets or why there are special approaches to evaluating the appropriateness of individual capital asset acquisitions. Here are some additional reasons that capital assets warrant special attention:

- Their initial acquisition cost is large.
- They are generally used for a long time.
We can understand the financial impact of acquiring them only if we evaluate their entire lifetime.

Since we often pay for them immediately and get cash receipts only as we use them later, the time value of money must be considered.

Since small capital expenditures (e.g., the ballpoint pen, the laser printer) are often not treated as capital assets, generally the items that are included in the capital budgeting process are very expensive. When the cost of an item is high, a mistake can be costly. Long-term acquisitions lock in an organization, and a mistake may have repercussions for many years.

For example, suppose that HOS unwittingly buys 10 inferior patient monitors for $50,000 each. As medical staff use them, they learn of the monitors’ shortcomings and hear of another type of monitor HOS could have purchased that performs better. Although HOS may regret the purchase, it may not have the resources to discard the monitors and replace them. HOS may have to use the inferior machines for a number of years. To avoid such situations, the capital budgeting process requires a thorough review of the proposed investment and a search for alternative options that may be superior.

The financial impact of a capital acquisition can be understood only if one considers the asset’s full lifetime. Suppose that a donor offers to pay the full acquisition cost of a new, larger building for an organization. The executive director is ecstatic. The building will be free! However, that is not quite correct. Perhaps the new building will cost money to operate (for heat, power, maintenance, security, etc.) but will not generate any additional revenue or support for the organization beyond the donation to acquire it. The operating costs of the building must be considered. Capital budgets should consider all revenue and expense implications of capital assets over their useful lifetimes.

Governments face similar issues when they decide whether to build a new school. An analysis of the feasibility of the new school building must consider whether the government will be able to afford to run it once it is built. Governments must try to assess the likely impact of the added annual operating costs on their budgets, especially if the new costs may have implications for taxes. Thus, capital budgeting takes a broad view, considering all the likely impacts of making a capital acquisition.

A last, and critical, issue relates to the timing of payments and receipts related to capital assets. Capital assets are often acquired by making a large cash payment at the time of acquisition. However, the cash the organization will receive as it uses the asset comes later. In the meantime, the money that has been invested in the project entails both explicit costs and opportunity costs.

When we use someone’s office or apartment, we pay rent for it. When we use—that is, borrow—someone’s money, we also pay rent for that use. Rent paid for the use of someone’s money is called interest expense. For capital assets, the rental cost for money used over a period of years can be substantial, and its effect must be considered when we decide whether it makes sense to acquire the item. The interest expense is equal to the amount of a loan multiplied by the annual interest rate multiplied by the fraction of the year that the loan is outstanding, as shown in Equation 5-1:

\[
\text{Interest} = \text{Loan Amount} \times \text{Interest Rate per Year} \times \text{Fraction of Year} \quad (5-1)
\]

As above, there also is an opportunity cost for all resources used by an organization. Each resource could be used for some other purpose. We often refer to the opportunity cost of using resources in
an organization as the cost of capital. Part of the cost of capital is reflected in the interest that the organization pays on its debt. In fact, many organizations use their borrowing cost to estimate their opportunity cost. Calculations related to the cost of capital or cost of money are referred to as time value of money calculations.

**THE TIME VALUE OF MONEY**

A dollar today is worth more than a dollar tomorrow. Imagine deciding whether to lend someone $10,000 today with the expectation that they would give us back $10,000 in 5 years. Would we consider that to be a reasonable investment? Probably not. If we had instead invested the money in an insured bank account or U.S. Treasury security that pays interest, at the end of 5 years we would have our initial $10,000 plus interest. Getting $10,000 in 5 years is not as good as having $10,000 today, simply because if we have $10,000 today it can be invested and earn a return.

This is the concept of the time value of money (TVM). Suppose that the Museum of Technology is considering buying $50,000 of computers for an exhibit. The money would come from cash that the museum currently has on hand. It will be able to charge $12,000 per year in special admissions fees for the exhibit for 5 years. At that point, the exhibit will be closed, and the computers will be obsolete and will be thrown away.

If the museum uses a capital budget, it will show the initial cash outlay of $50,000 in addition to the full 5 years of revenues. The $12,000 of admission revenues per year for 5 years total $60,000. However, can the museum compare the $50,000 to acquire the exhibit with the $60,000 that it will receive and conclude that there will be a $10,000 profit from the exhibit? No. The two numbers appear to be comparable, but the cash is paid and received at different times. A dollar received at some point in the future is not worth as much as a dollar today. TVM provides a mechanism to help make a reasoned comparison.

It is sometimes easier to understand TVM mechanics using a timeline such as the following:

```
<table>
<thead>
<tr>
<th>Time Period</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash Flow</td>
<td>($50,000)</td>
<td>$12,000</td>
<td>$12,000</td>
<td>$12,000</td>
<td>$12,000</td>
<td>$12,000</td>
</tr>
</tbody>
</table>
```

The initial $50,000 outlay is made at the very beginning of the project, or time 0. It is shown in parentheses to indicate that the museum is paying $50,000, rather than receiving it. Each year the museum collects $12,000 in admissions fees. In this example, we are assuming that $12,000 is collected at the end of each of the 5 years. For example, the $12,000 shown at time period 1 on the timeline is received at the end of the first year.

Although a timeline, as it appears above, is a helpful conceptual tool, in practice managers tend to do their calculations in a spreadsheet, such as Excel. The same information in Excel might be shown as:

```
<table>
<thead>
<tr>
<th>Time Period</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash Flow</td>
<td>($50,000)</td>
<td>$12,000</td>
<td>$12,000</td>
<td>$12,000</td>
<td>$12,000</td>
<td>$12,000</td>
</tr>
</tbody>
</table>
```

To evaluate the investment, we use a methodology that is based on compound interest calculations. If the museum had borrowed the $50,000 for the exhibit, it would be clear that in addition
to covering the cost of constructing the exhibit, the admission fees would have to be enough to pay the interest that the museum would pay on the money it borrowed. In this example, however, the museum has not borrowed money. It is using money it already has.

However, TVM calculations are still required. Why? Because the museum could have put the money into some safe investment and earned a return if it did not open the proposed exhibit. In every case that a capital acquisition is considered, we must recognize that the acquisition is paid for either by borrowing money (and therefore paying interest) or by deciding not to invest the money elsewhere (and therefore opting not to earn a return). There is a cost-of-capital opportunity cost for all capital asset purchases. If this were not the case, we would not mind lending our own money to someone at a zero interest rate.

**Compounding and Discounting**

TVM computations are based on the concepts of compounding and discounting. **Compound interest** simply refers to the fact that when money is invested, at some point going forward in time the interest earned on the money starts to earn interest itself. **Discounting** is just the reversal of this process as we go backward in time. Compounding and discounting can be applied to any returns for an investment, whether they are earned as interest on a bank account or profits on a venture.

For example, suppose that Meals for the Homeless (Meals) invests $100 of cash in a certificate of deposit (CD) that pays 6 percent interest per year for 2 years. Notice that the interest is stated as an annual rate. All interest rates are annual unless specifically stated otherwise. What will be the value of the investment after 2 years? Six percent of $100 is $6. If the investment earns $6 a year for 2 years, will Meals have a total of $12 of interest and end the 2 years with $112? Only if the CD pays **simple interest**. By simple interest, we mean the initial investment earns interest, but any interest earned does not itself earn interest. We can see the simple interest process as follows:

\[
\begin{array}{ccc}
$100.00 & \text{investment} & $6.00 \text{ interest/year} \\
\times 0.06 & \text{interest rate} & \times 2 \text{ years} \\
$6.00 & \text{interest/year} & $12.00 \text{ interest for 2 years} \\
+ 12.00 & \text{interest for 2 years} & $112.00 \text{ ending value}
\end{array}
\]

By contrast, what if the CD compounds interest annually? In that case, at the end of year 1, interest will be calculated on the $100 investment. That interest will be $6 (6% \times $100 = $6). At that point, the $6 of interest will be added to the initial investment. In the second year, HOS will earn 6 percent of $106. That comes to $6.36 (6\% \times $106 = $6.36). At the end of 2 years, the investment will be worth $112.36. The difference between simple and compound interest seems to be trivial, because it adds up to only $0.36 in this example. We can see the compound interest process as follows:

\[
\begin{array}{cccc}
$100.00 & $100.00 & $106.00 & $106.00 \\
\times 0.06 & + 6.00 & \times 0.06 & + 6.36 \\
$6.00 & $106.00 & $6.36 & $112.36
\end{array}
\]

Suppose that you invested $10,000 this year for retirement and that your investment will earn 8 percent interest. Assume that you plan to retire in 40 years. Eight percent of $10,000 is $800. If you earn $800 per year for 40 years, your total earnings will be $32,000. Together with the initial investment of $10,000, you will have $42,000 in the retirement account using simple interest.

By contrast, assume that the 8 percent interest will be compounded annually. That is, every year the interest earned is added to the principal and earns interest itself. Then, the total investment at the
end of 40 years will be worth $217,245. If the interest is instead compounded quarterly, the total will be $237,699 (see Table 5-1)—quite a difference from $42,000. The compounding of interest is a powerful force. Note that with simple interest, it does not matter how frequently the interest is applied to the initial investment. The total is $42,000 with annual or quarterly calculations.

<table>
<thead>
<tr>
<th>$10,000 Invested at 8 Percent for 40 Years</th>
<th>Simple Interest</th>
<th>Compound Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Interest Calculations</td>
<td>$42,000</td>
<td>$217,245</td>
</tr>
<tr>
<td>Quarterly Interest Calculations</td>
<td>$42,000</td>
<td>$237,699</td>
</tr>
</tbody>
</table>

Compound interest is a valuable concept if we would like to know how much a certain amount of money received today is likely to be worth in the future, assuming that we could earn a certain rate of return. Often, however, our concern is figuring out how much an amount to be received in the future is worth today. For example, the Museum of Technology is trying to decide if it makes financial sense to invest $50,000 today to earn admission revenues of $12,000 per year for the next 5 years. Here, the museum is concerned with taking those future payments of $12,000 each year and determining what they are worth today. The approach needed for this calculation is called discounting.

Discounting is merely the reverse of compounding. If we expect an investment to earn $60,000 five years from now, how much is that worth today? Is it worth $60,000 today? No, because if we had $60,000 today, we could earn interest and have more than $60,000 five years from now. $60,000 five years from now is worth less than $60,000 today. A dollar today is still worth more than a dollar tomorrow. Discounting is the process of reversing the compounding of interest.

Present Value Versus Future Value

There are two sides to the time value of money: present value (PV) and future value (FV). The PV is the starting point of the TVM timeline. It is the value of money that will be received or paid in the future. The FV, conversely, is the endpoint of the TVM timeline. It is the value of money after time has passed. In either case, money may be a single lump-sum payment or receipt, or it may be a stream of receipts or payments. Any TVM calculation is a variation of solving for either the PV, the FV, or one of the variables that determines PV and FV.

Time Value of Money Calculations

We use the following notation for TVM calculations:

- $PV = $\text{present value}$
- $FV = $\text{future value}$
- $i$ or $rate = $\text{interest rate}$
- $N$ or $nper = $\text{number of periods}$

The FV can be calculated from the following formula:

$$FV = PV(1 + i)^N \quad (5-2)$$
This formula says that the amount that we will have in the future (FV) is equal to the amount we start with (PV), multiplied by the sum of one plus the interest rate (i) raised to a power equal to the number of compounding periods (N). For example, suppose that we want to calculate the amount of money we would have after 2 years if we invested $100 today (called time period 0) at 6 percent compounded annually. A timeline for this problem would look like this:

\[
\begin{array}{cccccc}
0 & 1 & 2 \\
\uparrow & 6\% & \uparrow & \uparrow \\
($100) & \text{FV}
\end{array}
\]

We are investing (paying out) $100 at the start, time period 0, and expect to get an amount of money, FV, 2 years in the future (by retrieving or money from the investment). The 6 percent interest rate is shown on the timeline between the start and the end of the first compounding period. We could use the formula from Equation 5-1 to solve this problem as follows:

\[
FV = 100 \times (1 + .06)^2 = 100 \times [(1.06) \times (1.06)] = 100 \times (1.1236) = 112.36
\]

This simply formalizes the process that we followed earlier. Similarly, for the retirement investment calculated earlier with quarterly compounding, the timeline would be as follows:

\[
\begin{array}{cccccccccc}
0 & 1 & 2 & 159 & 160 \\
\uparrow & 2\% & \uparrow & \uparrow & \uparrow & \uparrow \\
($10,000) & \text{FV}
\end{array}
\]

The number of compounding periods, N, is 160. This is because the investment is compounded quarterly for 40 years. There are four quarters in a year. Therefore, four compounding periods each year for 40 years results in a total of 160 periods (4 \times 40 = 160).

Note that time periods and interest rates must be adjusted for the compounding period. The annual interest rate must be divided by the number of compounding periods per year to get the interest rate per period. The number of compounding periods per year must be multiplied by the total number of years to get the total number of compounding periods.

Using the formula to solve for the FV, we find the following:

\[
FV = 10,000 \times (1 + .02)^{160} = 10,000 \times (1.02)^{160} = 10,000 \times (23.7699) = 237,699
\]

This is the result seen in Table 5-1. The interest rate, i, is .02, or 2 percent. This is because of the quarterly compounding. The interest rate of 8 percent per year (as used earlier for this retirement example) must be divided by four, the number of quarters in each year, to get the quarterly interest rate. For discounting, the process is the reverse. If we start with the same formula,

\[
FV = PV(1 + i)^N
\]  

\text{(5-2)}
we can rearrange the equation in terms of the PV:

\[ PV = \frac{FV}{(1+i)^N} \]  

(5-3)

If someone offered to pay us $237,699 in 40 years, how much would that be worth to us today if we anticipate that we could invest money at 8 percent per year, compounded quarterly? The timeline would be as follows:

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>159</th>
<th>160</th>
</tr>
</thead>
</table>
| 2%↑ | ↑ | ↑ | ↑↑↑↑ | 237,699
| PV |

We could use Equation 5-2 to solve for the PV, as follows:

\[ PV = \frac{\$237,699}{(1+.02)^{160}} \]

\[ PV = \frac{\$237,699}{237,699} \]

\[ = $10,000 \]

As we can see, discounting is merely a reverse of the compounding process. If we invest $10,000 today, it would grow to $237,699 forty years in the future at 8 percent interest with quarterly compounding. Making the same assumptions, then, $237,699 paid 40 years in the future is worth only $10,000 today. Financial calculators and electronic spreadsheet software programs have been programmed to perform TVM computations. Since most managers usually do their TVM calculations using a spreadsheet program, that is the approach we will take in this chapter. For those interested in learning how to use calculators for TVM computations, see Appendix 5-A.

Using Computer Spreadsheets for TVM Computations

A number of different computer spreadsheet software programs can be used to solve TVM problems. They are particularly useful for the more complicated calculations where using a calculator may be tedious. Some of the most popular spreadsheet programs are Microsoft Excel, Apple Numbers, and Google Sheets. Appendix 5-B provides examples of how to solve TVM problems with Excel. The approach is similar in other spreadsheet programs.

Consider the problem of finding the future value of $100 invested for 2 years at 6 percent interest. Using Excel, begin by entering the data that will be used to solve the problem. In this example, the problem could be set up as shown in Figure 5-1. This figure shows the data you have, the variable FV that you are looking for, and indicates where the answer will be shown.
Once data have been entered, move the cursor to the cell where you want the solution to appear (in this case, Cell D10). Type an equal sign followed by the variable we are trying to find, followed by an open parenthesis, as follows:

\[ = \text{FV(} \]

Once you have done that, Excel will show the complete formula for computing the present value. On the screen near the cell you are working on, you will see:

\[ \text{FV(rate, nper, pmt, } \text{PV}, \text{ type)} \]

This will guide you in providing Excel with the data needed to solve for the FV. Following the open parenthesis you have typed, you next insert the rate (interest rate), nper (number of compounding periods), and PV (present value). We have not yet discussed pmt, but for now we can leave a blank space and extra comma for that variable, or we can use a value of zero for the pmt variable. Type refers to whether the payments come at the beginning or end of each period. This pertains primarily to annuities, which will be discussed below. For now, we can ignore it as well and the value for type can be omitted.

Two things should be noted in Figure 5-1. First, the interest rate should be shown in the spreadsheet as 6% (see Cell D5). In Excel, it is critical that the rate be entered either with a percent sign, such as 6%, or as a decimal, such as .06. If you enter 6 rather than 6% the answer will be grossly incorrect.

Second, the PV in the formula should be entered as a negative number. Excel follows the logic that if you pay out money today, you will get back money in the future. So if the FV is to be a positive amount, representing a receipt of cash in the future, the PV must be a negative amount, representing a payment of cash today. You cannot have a positive number for both the PV and the FV because that
would imply that you receive money at both the beginning and end of the investment. That is not logical. Either you pay out money at the start and receive money later, or vice versa. We can handle this in several ways. In Figure 5-1, we could show the value for the PV in Cell D4 as being negative $100, or when we complete the formula for FV, we can put a minus sign in front of our reference to the cell with the PV. That is, we can enter the PV into the FV formula as either $–100 or by the cell reference to – D4. It is important to get into this habit. In many TVM calculations, not entering opposing signs for cash inflows and outflows will produce an error.

Each variable can be inserted as either a numeric value or a cell reference. Given the cell locations of the raw data in the worksheet in Figure 5-2, a cell reference formula to solve the above problem would be:

\[= \text{FV(D5, D6, D7, –D4)}\]

An advantage of a formula that uses cell references is that it will automatically recalculate the future value if the numeric value in any of the indicated cells is changed. If we were to change the rate in Cell D5 from 6% to 8%, a new future value would automatically appear on the worksheet.

Alternatively, we could insert the values directly with rate as 6%, nper as 2, and PV as $–100 as shown below.

\[= \text{FV}(6\%, 2, 0, –100)\]

The advantage of this approach is that it not only will calculate the answer in your Excel spreadsheet, but it can also be communicated to a colleague who can tell exactly what information you have and what you are trying to calculate. Anyone can drop this into their spreadsheet without needing to know the specific cells in which the raw data appear in your spreadsheet. TVM Excel problems will be discussed in the form of providing the basic Excel formula, as well as the numeric value formula, for a variable, such as:

\[= \text{FV(rate, nper, pmt, pv, type)}\]
be discussed in the form of providing the basic Excel formula, as well as the *numeric value formula*, for a variable, such as:

\[
= FV(rate, nper, pmt, [pv], [type])
\]

\[
= FV(6\%, 2, 0, –100)
\]

Note that if you enter \(= FV(6\%, 2, 0, –100)\) into an Excel spreadsheet cell and press the Enter key, the solution of 112.36 will automatically be calculated. Excel can be used to solve for other TVM variables as well as the FV. See Appendix 5-B for a detailed discussion.

### Annuities

Although there are many times that we anticipate paying or receiving a single amount of money paid at one point in time, sometimes capital assets result in a number of cash flows over a number of different compounding periods. For example, one might wish to determine the maximum amount that should be paid for a piece of equipment that will result in receipts of $3,000, $5,000, and $7,000 over the next 3 years.

![Timeline diagram](image)

To find out how much this is worth today, we would have to add up the present value of each of the three payments. Essentially, one could break the preceding timeline down into three separate problems, as illustrated below:

![Timeline breakdown diagram](image)

Then, add the PV solutions from the three problems together.

However, if all three payments are exactly the same and come at equally spaced periods of time, the payments are referred to as an *annuity*. Computations are somewhat easier for this special case.

Although we may think of annuities as being annual payments, that is not necessarily the case for TVM computations. An annuity is any amount of money paid at equal time intervals in the same amount each time. For example, $110 per week, $500 per month, and $1,250 per year each represent annuities.
In notation, an annuity is often referred to as PMT, an abbreviation for payment. Formulas have been developed that can be used to calculate both the future value and the present value of a stream of annuity payments. These formulas have been included in computer spreadsheet programs and in handheld calculators that perform TVM computations. Note that annuities generally assume the first payment is made at time period 1, not time period 0. An annuity with the first payment at time period 1 is referred to as an ordinary annuity or an annuity in arrears. Some annuities, such as the rent one pays on an apartment, are called annuities in advance, and the first payment is made at the start, or time period 0. Computer spreadsheets assume annuities are ordinary (first payment at time period 1), unless the user indicates the type of annuity.

Suppose that we expect to receive $100 per year for the next 2 years. We could normally invest money at an interest rate of 10 percent compounded annually. What is the present value of those payments? If we put our cursor in an Excel cell and type =PV we will then see the formula that needs to be completed for Excel to solve for the PV. It will appear as:

$$PV(rate, nper, pmt, [fv], [type])$$

Using the timeline and a spreadsheet, we can solve the problem as follows:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PV)</td>
<td></td>
<td>$100</td>
<td>$100</td>
</tr>
<tr>
<td>↑</td>
<td>10%</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

$$PV = PV(rate, nper, pmt, [fv], [type])$$

$$= PV(10\%, 2, 100)$$

$$= -173.55$$

The result shows that receiving two annual payments of $100 each for the next 2 years is worth $173.55 today if the interest rate is 10 percent. The $173.55 is shown as a negative number because you would have to pay that amount today to receive $100 a year for 2 years. How much would those two payments of $100 each be worth at the end of the 2 years?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(FV)</td>
<td></td>
<td>$100</td>
<td>$100</td>
</tr>
<tr>
<td>↑</td>
<td>10%</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

$$FV = FV(rate, nper, pmt, [pv], [type])$$

$$= FV(10\%, 2, 100)$$

$$= -210.00$$

Observe that there is a great deal of flexibility. If we know the periodic payment, interest rate, and number of compounding periods, we can find the FV. However, if we know how much we need to have in the future and know how many times we can make a specific periodic payment, we can calculate the interest rate that must be earned. Or we could find out how long we would have to keep making payments to reach a certain future value goal. Given three variables, we can find the fourth.

---

4. The present value of an annuity of $1 equals \( (1 - (1/(1 + i)^n)))/i \) and the future value of an annuity of $1 equals \( (1 + i)^n - 1)/i \).
For example, suppose that we are going to invest $100 a year for 5 years and we want it to be worth $700 at the end of the fifth year; what interest rate must we earn? If we put our cursor in an Excel cell and type =Rate( we will then see the formula that needs to be completed for Excel to solve for the rate. It will appear as:

$$Rate(nper, pmt, pv, [fv], [type], [guess])$$

Using the timeline and a spreadsheet, we can solve the problem as follows:

$\begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 & 5 \\
\uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow \\
($100) & ($100) & ($100) & ($100) & ($100) & ($100) \\
\end{array}$

\[Rate = Rate(5, -100, 0, 700)\]
\[= 16.9\%\]

If we are investing $100 each year, we pay that money out into the investment, so it is shown as a negative amount. The $700 will be received at the end, so it shown as a positive amount. As you can see, we have calculated that if we pay out $100 a year for 5 years, in order to receive $700 at the end of the fifth year, we would have to earn a rate of 16.9 percent per year. If we did not enter opposing signs for the PMT and FV, the spreadsheet would not be able to calculate Rate and would give you an error message.

Similarly, we can solve for the number of periods. Suppose we know that if we are investing $100 a year, we can earn a 16.9 percent annual rate of return, and we want to have $700 at the end of our investment. We can find the number of periods before we will accumulate the desired amount. If we put our cursor in an Excel cell and type =Nper( we will then see the formula that needs to be completed for Excel to solve for the Nper. It will appear as:

$$Nper(rate, pmt, pv, [fv], [type])$$

Using the timeline and a spreadsheet, we can solve the problem as follows:

$\begin{array}{cccccc}
0 & 1 & 2 & N & \cdots & 5 \\
\uparrow & 16.9\% & \uparrow & \uparrow & \uparrow & \uparrow \\
($100) & ($100) & ($100) & ($100) & ($100) & ($100) \\
\end{array}$

\[Nper = Nper(16.9\%, -100, 0, 700)\]
\[= 5\]

We see that if we invested $100 a year at 16.9 percent, it would take 5 years for it to grow to $700.

We can also solve for the payment. Suppose we need $700 in 5 years and believe that we can earn 16.9 percent per year on our investment. We can find the amount we will need to invest each year to
reach that goal. If we put our cursor in an Excel cell and type \( \text{PMT} \) we will then see the formula that needs to be completed for Excel to solve for the PMT. It will appear as:

\[
\text{PMT}(\text{rate, nper, pv, [fv], [type]})
\]

Using the timeline and a spreadsheet, we can solve the problem as follows:

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑</td>
<td>16.9%</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>PMT</td>
<td>PMT</td>
<td>PMT</td>
<td>PMT</td>
<td>PMT</td>
<td>PMT</td>
</tr>
</tbody>
</table>

\[
\text{PMT} = \text{PMT}(16.9\%, 5, 0, 700)
= -100.00
\]

We would have to invest $100 a year for 5 years at 16.9 percent in order to have $700 at the end of the 5-year period.

**Cash Flow versus Revenue and Expense**

Note that TVM computations are always done based on cash flow rather than accrual-based revenues and expenses. This is because we can only earn a return on resources that are actually invested. For example, interest on a bank account is calculated from the time that money is deposited. Therefore, one should remember that all TVM computations are based on the timing of cash receipts and payments rather than the recording of revenues and expenses. For this reason, TVM calculations are often referred to as discounted cash flow analyses.

**CAPITAL ASSET INVESTMENT ANALYSIS**

Investment analysis for the acquisition of capital assets requires careful consideration of the item to be acquired. Alternatives should be examined so that we can be assured that we are making an appropriate selection. Several different analytical approaches can help evaluate alternatives: net present cost, annualized cost, net present value, and internal rate of return.

In some cases, there may be qualitative benefits from an investment, even though it does not have a solid financial result. Public, health, and not-for-profit organizations may decide that something is worth doing, even if it loses money, because of its benefit to the organization’s clientele. Management must decide whether to invest in a capital asset because of its nonfinancial benefits after considering all factors.

Four general issues should always be considered in the evaluation of alternative capital investments. First, the evaluation should include all cash flows. The consideration of all cash inflows and cash outflows is essential to the calculation. Second, the time value of money must be considered. Since dollars are not equally valuable at all points in time, the analysis should clearly consider not only the amount, but also the timing of the cash flows. Third, there should be some consideration of risk. The expected receipt of a cash interest payment in 10 years from a U.S. Treasury bond investment is much less risky than a similar amount expected to be received in 10 years from a current start-up business, which may not even survive for 10 years. There should be a mechanism to incorporate different levels of risk into the calculation. Fourth, there should be a mechanism to rank projects based on the organization’s priorities. These issues are addressed below.
Net Present Cost

Many times, an organization will find that it must acquire a new piece of equipment and is faced with a choice among several possible alternatives. For example, suppose that Leanna Schwartz, executive director of Meals for the Homeless, is trying to decide between two new industrial-size refrigerators. It has already been decided that the unit currently owned is on its last leg and must be replaced. However, several good units are available. Either of the two models would be acceptable, and Schwartz has decided to choose the less costly option.

The two units under consideration are Model A, which is expensive to acquire but costs less to operate, and Model B, which is less expensive to acquire but costs more to operate:

<table>
<thead>
<tr>
<th></th>
<th>Model A Refrigerator</th>
<th>Model B Refrigerator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Price</td>
<td>$105,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Annual Outlay</td>
<td>$10,000</td>
<td>$20,000</td>
</tr>
<tr>
<td></td>
<td>$10,000</td>
<td>$20,000</td>
</tr>
<tr>
<td></td>
<td>$10,000</td>
<td>$20,000</td>
</tr>
<tr>
<td></td>
<td>$10,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$155,000</td>
<td>$160,000</td>
</tr>
</tbody>
</table>

At first glance, Model A appears less expensive because it requires a total outlay of only $155,000 as opposed to the Model B total cost of $160,000. However, since payments are made over a period of years for each model, we cannot simply add the costs together. Rather, it is necessary to find the PV of each of the future payments. We can add those PVs to the initial outlay to determine the total cost in equivalent dollars today. The total of the initial outlay and the PV of the future payments is called the net present cost (NPC). Whichever project has a lower NPC is less expensive.

To determine the present values, we will need to have a discount rate, which is what we call the interest rate when discounting cash flows, to use to bring the future payments back to the present. For this example, we will assume a rate of 10 percent. (Later in this chapter, the appropriate choice of rates is discussed.) Since each of the annual payments is identical, they can be treated as an annuity:

\[
\begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 & 5 \\
\uparrow & 10\% & \uparrow & \uparrow & \uparrow & \uparrow \\
PV & ($10,000) & ($10,000) & ($10,000) & ($10,000) & ($10,000) \\
\end{array}
\]

\[
\begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 & 5 \\
\uparrow & 10\% & \uparrow & \uparrow & \uparrow & \uparrow \\
PV & ($20,000) & ($20,000) & ($20,000) & ($20,000) & ($20,000) \\
\end{array}
\]

The answers can be obtained solving the problem with Excel using the following formulas:

\[
\text{Model A: } = \text{PV(rate, nper, pmt, [fv], [type])} \\
= \text{PV(10\%, 5, -10000)} \\
= $37,908
\]
Model B: \[ PV(rate, nper, pmt, [fv], [type]) \]
\[ = PV(10\%, 5, \text{-}20000) \]
\[ = $75,816 \]

The resulting present values for Models A and B tell us what the periodic payments are equivalent to in total today. To find the NPC, we must also consider the initial acquisition price:

Model A NPC = $105,000 + $37,908
\[ = $142,908 \]

Model B NPC = $60,000 + $75,816
\[ = $135,816 \]

Based on this, we see that the NPC of Model B is less than the cost of Model A, even though Model A had initially looked less expensive before the TVM was taken into account. If we were to acquire and pay for all of the other costs related to Model A, we could pay a lump sum today of $142,908, while Model B would require a lump sum of only $135,816. We are indifferent between paying the NPC and paying the initial acquisition cost followed by the periodic payments. The lump-sum NPC total for Model B is clearly less expensive than the lump-sum NPC for Model A.

This analysis can only assess the financial implications of the two alternatives. If it turned out that Model A was a more reliable unit, Schwartz would have to make a decision weighing the better reliability of Model A against the lower cost of Model B. The preceding example also assumes that the cost of operating each piece of equipment is the same each year. This is likely to be an unrealistic assumption. If the estimated costs aren’t constant, then the annuity approach could not be used. We would have to calculate the PV for each year and sum them to find the NPC.

### Annualized Cost

The NPC method is very helpful for comparing projects that have identical lifetimes. What if investments aimed at the same ends have different lifetimes? Suppose that Model A has a 5-year lifetime, but Model B has only a 4-year lifetime, as follows:

<table>
<thead>
<tr>
<th>Model</th>
<th>Refrigerator</th>
<th>Refrigerator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Price</td>
<td>$105,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Annual Outlay</td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td></td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td></td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td></td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$155,000</td>
<td>$140,000</td>
</tr>
</tbody>
</table>

One approach would be to try to equalize the lifetimes. We could assume that each time a unit wears out it is replaced. If we repeat that process four times for Model A and five times for Model B, at the end of 20 years the two alternatives will have equal lifetimes (see Table 5-2).

We could then proceed to find the NPC for each of these two 20-year alternatives. However, the uncertainties going forward 20 years are substantial. The purchase prices will likely change, as will the annual operating costs. Our needs might change drastically in 10 years, making the acquisitions in the future unnecessary.
As an alternative to the process of equalizing the lifetimes, we can use an the annualized cost method. In that approach, one first finds the NPC for each alternative. Then, that cost is translated into a periodic payment for the number of years of the project’s lifetime. The periodic payment is essentially the average expenditure, with the time value of money taken into account. The project with the lower annualized cost is less expensive on an annual basis in today’s dollars.

Consider the refrigerator example. Assume that Model A lasts for 5 years and Model B lasts for 4 years. All of the assumptions for Model A are the same as they were originally, so the NPC is still $142,908, as calculated earlier. Model B is different, because it now has only a 4-year life:
Model B:

\[
\begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 \\
\uparrow & \uparrow & \uparrow & \uparrow & \uparrow \\
PV & \text{($20,000)} & \text{($20,000)} & \text{($20,000)} & \text{($20,000)} \\
\end{array}
\]

The Excel spreadsheet formula to find the PV would be:

\[
= PV(rate, nper, pmt, [fv], [type])
= PV(10\%, 4, \,-20000)
= \$63,397
\]

To find the NPC, we must also consider the initial acquisition price.

\[
\text{Model B NPC} = \$60,000 + \$63,397
= \$123,397
\]

Although the \$123,397 NPC for Model B is lower than the \$142,908 NPC for Model A, we are comparing apples and oranges if we don’t account for the difference in their useful lives. Model B will last for only 4 years, while Model A will last for 5 years. We need to account for the fact that we will have to replace it sooner. This is done by treating each NPC as a present value of an annuity and finding the equivalent periodic payment over its lifetime.

Model A:

\[
\begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 & 5 \\
\uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow \\
\text{($142,908)} & \text{PMT} & \text{PMT} & \text{PMT} & \text{PMT} & \text{PMT} \\
\end{array}
\]

\[
= PMT(rate, nper, pv, [fv], [type])
= PMT(10\%, 5, \,-142908)
= \$37,699
\]

Model B:

\[
\begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 \\
\uparrow & \uparrow & \uparrow & \uparrow & \uparrow \\
\text{($123,397)} & \text{PMT} & \text{PMT} & \text{PMT} & \text{PMT} \\
\end{array}
\]

\[
= PMT(10\%, 4, \,-123397)
= \$38,928
\]

Thus, adjusted for their relative lifetimes, including both the acquisition and annual outlays, Model A is less expensive per year than Model B (\$37,699 versus \$38,928).\(^5\)

---

5. In the case of annuities, an alternative annualization approach would be to find the annuity payment equivalent to the initial outlay and add that amount to the annual payments. That will provide an annualized cost. However, that will work only in cases in which the payments after the initial outlay are an annuity.
Net Present Value

The NPC and annualized cost methods discussed previously require assuming that the capital assets would cost money to acquire. However, neither assumes that the capital asset would have a direct effect on revenues or support. Often, one of the major reasons to acquire a capital asset is to use it to earn more revenues or generate additional financial support. In such cases, we need to consider both the revenues and costs as measured by the present value of their cash inflows and outflows. The net present value (NPV) method is one of the most common approaches for making calculations of the present value of inflows and outflows.

The NPV approach calculates the PV of inflows and outflows and compares them. If the PV of the inflows exceeds the PV of the outflows, then the NPV is positive, and the project is considered to be a good investment from a financial perspective:

\[ \text{NPV} = \text{PV Inflows} - \text{PV Outflows} \]

and if \( \text{NPV} > 0 \), the project is economically viable.

For example, assume that HOS is contemplating opening a new type of lab. The equipment for the lab will cost $5 million. Each year there will be costs of running the lab and revenues resulting from the lab. As a result of general financial constraints, the hospital wants to make this investment only if it is financially attractive. The hospital’s borrowing cost is 8 percent. In addition, since the hospital feels that projected revenues are often not achieved by new projects, it wants to build in an extra 2 percent margin for safety. It has decided to do the project only if it earns a return of at least 10 percent.

That 10 percent rate is considered to be a hurdle rate, or a required rate of return. Only if the project can do better than this rate will it be accepted. Therefore, the NPV must be calculated using a 10 percent discount rate. If the project has a positive NPV, that means that it earns more than 10 percent and will be acceptable.

Assume the following projected cash flows from the project:

<table>
<thead>
<tr>
<th>Proposed New Investment</th>
<th>Capital Equipment Has a 4-Year Life</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start</td>
</tr>
<tr>
<td>Cash In</td>
<td>$2,700,000</td>
</tr>
<tr>
<td>Cash Out</td>
<td>$5,000,000</td>
</tr>
<tr>
<td>Total</td>
<td>$5,000,000</td>
</tr>
</tbody>
</table>

Although we are just assuming these cash flows, it should be noted that estimating future cash flows is often a difficult task that requires a careful budgeting effort. In total, the project shows a $1,100,000 profit. However, that profit does not account for the timing of the cash flows. The hospital will be spending the full $5,000,000 at the start. However, the cash receipts available to repay the cost of the investment and to pay for the cost of capital used are spread out in the future. To determine whether the investment is worthwhile, we will have to find the NPV.

This can be accomplished by finding the PV of each cash inflow and then finding the total PV of the inflows. Then the same procedure can be done for the outflows. The PV of the inflows and the PV of the outflows can be compared to determine the NPV. Alternatively, we can simply find the PV of the net flows for each year. That is, we can take the PV of the $5,000,000 net cash outflow at the start plus...
the PV of the $1,700,000 net cash inflow from the end of the first year plus the PV of the $1,500,000 net cash inflow from the second year and so on. In Excel this would appear as:

$$\text{PV(B1,C3,B2,–C8)}$$

Notice that the present values in Row 10 in the above Excel spreadsheet are the values of each combined cash inflow and outflow. For example, in column C, the inflows were $2,700,000 in Cell C6 and the outflows were $1,000,000 in Cell C7. Cell C8 shows that the net cash flows for Year 1 were $1,700,000, found by subtracting the outflows for that year from the inflows for that year. In Cell C10, the present value of the net Year 1 cash flow is found. Looking to the right of the fx at the top of the spreadsheet, we see the formula used to find the present value is $= \text{PV(B1, C3, B2, –C8)}$. Cell B1 contains the discount rate, Cell C3 contains the nper for the computation, Cell B2 gives the PMT, which is 0, since there is no PMT in this computation, and Cell C8 contains the net cash flow for Year 1. There is a minus sign in front of C8 in the formula, which forces Excel to display the present value for Year 1 cash flows as a positive number, since Excel requires that cash inflows and outflows have opposite signs.

The NPV is the PV of the inflows less the present value of the outflows. If we total the results of the individual present value computations shown in summary form in the above Excel spreadsheet, we find that the NPV is $-$131,685. Since the NPV is negative, the investment is earning less than the 10 percent required rate of return. It is therefore not an acceptable project.

Spreadsheets typically have an NPV function to solve this more directly. In Excel, the formula to solve an NPV problem is $= \text{NPV(rate, value1, [value2], . . .)}$. The values refer to each of the future values in the problem. For the earlier proposed investment, the $5,000,000 outlay occurs in the present and is not included in the formula. So value 1 would be $1,700,000, value 2 would be $1,500,000, and so on. Once the NPV is found for the future values, however, the initial $5,000,000 outlay needs to be subtracted to find the answer. This can be combined into one formula as follows:

$$\text{NPV(rate, value1, [value2], . . .)} - \text{Initial Outlay}$$
Note the formula for Cell B9, which can be seen on the formula bar above columns A and B. The NPV formula requires the rate, 10 percent from Cell B1, and the range where the future cash flows are located in the spreadsheet, C6:F6, or Cell C6 to Cell F6. Excel will generate an error message if you enter the individual future cash flow values into the formula rather than providing the cell range in a format such as C6:F6. The initial cash outflow from Cell B6 is shown in Cell B10 and is then subtracted to finish the NPV calculation.

Organizations are often faced with multiple investment opportunities. Because resources are limited, they cannot do everything and must choose which projects to undertake. To do that, managers will sort projects based on their net present values. If decisions are made on a purely financial basis, they will reject all projects with NPVs less than zero and rank projects with NPVs greater than zero based on the size of their returns—choosing investments with higher NPVs before those with lower projected returns.

However, public service organizations may not always follow these conventions. If they feel some projects advance the organization’s mission and they have sufficient funds to subsidize any anticipated NPV shortfalls, management might choose to undertake projects with negative NPVs. Similarly, managers might choose investments with lower NPVs over those with higher expected returns if they feel those projects are more important to the organization’s social goals. The NPV should be computed in any case, however, so if a project is selected for other than its financial contribution, the organization’s managers will be aware of the extent to which it falls short on the financial merits. Since losses on one project will have to be made up elsewhere, the manager needs to know the size of the potential loss that the organization is committing to accept.

Internal Rate of Return

The NPV approach indicates whether a project performs better than a specific hurdle rate. However, it does not indicate the rate of return that the project actually earns. The internal rate of return (IRR) is the percentage return earned by an investment. Many managers are more comfortable ranking projects of different sizes by their rates of return rather than by the NPV. Suppose that we evaluate two projects using a 10 percent hurdle rate. A small project with a 35 percent rate of return might have a lower NPV than a much larger project with a 12 percent rate of return. Both projects have a positive NPV. However, because of the relatively modest magnitude of the smaller project, its exceptional profitability may go unnoticed when compared with another project with a very large NPV. Some managers, therefore, like to use a method that assesses the project’s rate of return, in addition to using the NPV approach. The IRR method can be used to generate that information.

The IRR method is derived from the NPV approach. Assume we start with the following equation:

$$NPV = PV\text{ Inflows} - PV\text{ Outflows}$$

Then

if NPV > 0, the project earns more than the discount rate, and
if NPV < 0, the project earns less than the discount rate.

Therefore,

if NPV = 0, the project earns exactly the discount rate.
So if we want to know the rate of return that a project earns, we simply need to determine the discount rate at which the NPV is equal to zero. And, since

\[
\text{NPV} = \text{PV Inflows} - \text{PV Outflows}
\]

for NPV to be equal to zero,

\[
0 = \text{PV Inflows} - \text{PV Outflows}
\]

or

\[
\text{PV Outflows} = \text{PV Inflows}.
\]

So we need to set the PV of the outflows equal to the PV of the inflows and find the discount rate at which that is true. Suppose we invest $6,700 today to get a cash flow of $1,000 a year for 10 years (i.e., invest $6,700 to get back a total of $10,000 in the future). What is the IRR for this investment?

\[
\begin{align*}
0 & \quad 1 & \quad 2 & \quad 9 & \quad 10 \\
\uparrow & \quad ?\% & \quad \uparrow & \quad \uparrow & \quad \uparrow \\
($6,700) & \quad $1,000 & \quad $1,000 & \quad \ldots & \quad $1,000 & \quad $1,000
\end{align*}
\]

\[
= \text{Rate}(\text{nper}, \text{pmt}, \text{pv}, [\text{fv}], [\text{type}], [\text{guess}])
\]

\[
= \text{Rate}(10, 1000, -6700)
\]

\[
= 8\%
\]

It turns out that the IRR for this investment would be 8 percent.

Note that the preceding problem assumes an annuity. If the cash flows are different each year, it is mathematically harder to determine the IRR.

Suppose, for instance, that the preceding example does not provide payments of $1,000 per year, but rather $1,000 in the first year and then increases by $100 in each subsequent year as follows:

\[
\begin{align*}
0 & \quad 1 & \quad 2 & \quad 9 & \quad 10 \\
\uparrow & \quad ?\% & \quad \uparrow & \quad \uparrow & \quad \uparrow \\
($6,700) & \quad $1,000 & \quad $1,100 & \quad \ldots & \quad $1,800 & \quad $1,900
\end{align*}
\]

Using Excel, this problem can be solved using the IRR function. The Excel formula for internal rate of return is:

\[
= \text{IRR}(\text{values}, [\text{guess}])
\]

The values represent all of the cash inflows and outflows, including the initial time 0 payments or receipts. The guess is the user’s best guess of the rate of return. The computer uses this as a starting point as it cycles in on the actual rate. Assume that the user guesses 5 percent. If a numeric value formula is used, the values must be provided to Excel within curly brackets so that the spreadsheet program can distinguish the values from the guess, as follows:

\[
= \text{IRR}([-6700,1000,1100,1200,1300,1400,1500,1600,1700,1800,1900], 5%) \]

\[
= 15\%
\]
Note that the IRR function also will not work unless there is at least one inflow or positive number and at least one outflow or negative number in the series of values. However, it is generally not necessary to enter a guess value for the rate of return. A step-by-step Excel solution for an IRR problem is provided in Appendix 5-B.

**LIMITATIONS OF IRR** Managers should be aware of three important limitations of IRR. First of all, it assumes that cash inflows during the project are reinvested at the same rate that the project earns. Second, sometimes it will cause managers to choose incorrectly from two mutually exclusive projects. Finally, it can create erroneous results if the investment does not have a conventional pattern of cash flows.

Implicit in the NPV technique is an assumption that all money coming from a project during its lifetime is reinvested at the hurdle rate. That is reasonable since the hurdle rate in some way measures the organization’s other alternative opportunities. We may want a project to earn at least 10 percent because we have other opportunities that can earn 10 percent.

By contrast, the IRR method assumes that as cash flows are received, they are reinvested at the same rate as the project earns (i.e., the IRR). Suppose that a project has an IRR of 25 percent. Suppose further that this represents an unusually high rate of return for any of the organization’s investments. It may be unrealistic to expect to be able to reinvest cash as it is received from the project in additional projects at 25 percent. In effect, then, the IRR method may overstate the true rate that will be earned on the project.

Another problem may arise when one is evaluating two mutually exclusive projects. It is possible that a small project may have a very high rate of return, whereas a larger project has a very good, but somewhat smaller, rate of return. For example, suppose that the golf course in Millbridge is trying to decide whether to put up a “19th Hole” restaurant and bar on a piece of land or to pave it over for additional parking. Only one piece of land is available on the golf course property to use for any kind of development.

Assume that the parking lot will cost $50,000 and will earn an annual net return of $20,000 per year for 20 years. The IRR for that investment is 39.95 percent. Alternatively, the 19th Hole will cost $500,000 to build and will earn an annual profit of $150,000 for 20 years. This results in an IRR of 29.84 percent. Normally the town and the golf course do not have any investments that earn a higher rate of return than 15 percent.

Both projects are very attractive, but we cannot do both since they both use the same piece of land. Often, when IRR is used to evaluate investments, managers rank the projects in order of IRR, first selecting those with the highest IRR. If that were done in Millbridge, it would be a mistake. Although a 39.95 percent return may appear better than a 29.84 percent return, overall the town would be better off with the 19th Hole. Why? Because if it invests in the parking lot, the town will earn 39.95 percent on an investment of $50,000 but will then invest the remainder of the money at 15 percent. If the managers decide to invest $500,000 for the year, they can put the entire amount into the 19th Hole and earn a 29.84 percent return on the total amount versus investing $50,000 at 39.95 percent and $450,000 at 15 percent.

Consider the following annual returns:

- $20,000 for the parking lot (given previously)
- 71,893 for other projects (PV = $450,000; N = 20; i = 15%; PMT = $71,893)
- $91,893 total annual return

versus

- $150,000 for the 19th Hole (given previously)
Clearly, the returns are better by investing in the 19th Hole. We would fail to see that if we simply chose the project with the highest IRR first. By contrast, the NPV method gives the correct information. The NPV for the 19th Hole evaluated at a hurdle rate of 15 percent is $438,900, whereas the NPV for the parking lot and other projects is $75,187.

Finally, many investment projects consist of an initial cash outflow followed by a series of cash inflows. This is referred to as a conventional pattern of cash flows. However, it is possible that some of the subsequent cash flows will be negative. In that case, the method can produce multiple answers, and the actual rate of return becomes ambiguous. In such cases, one is better off relying on the NPV technique.

A modified IRR method addresses some of these concerns.

## Selecting an Appropriate Discount Rate

The rate used for PV calculations is often called the hurdle rate or required rate of return, or simply the discount rate. The discount or hurdle or required rate should be based on the organization’s cost of capital.

Often not-for-profit organizations receive donations that can be used for capital investments. This complicates the measurement of the cost of capital. For projects that are specifically funded by donations, it may not be necessary to calculate the NPV. However, that involves assuming that all costs are covered by the donation. To the extent that the organization must bear other costs, it should employ TVM techniques with a hurdle rate based on its overall cost of capital.

Selection of an appropriate discount rate for governments to use is difficult. According to Mikesell, “There is . . . no single discount rate that is immediately obvious as the appropriate rate for analysis.”

The two methods he proposes are using the interest rate the government must pay to borrow funds and the rate that the funds could earn if they were employed in the private sector. The problem with the former approach is that the government may be able to borrow money at a substantially lower interest rate than could be earned on money invested in the private sector. This might unduly siphon money out of the private sector. The latter approach (using the rate the funds could earn in the private sector) may be more appropriate, but is likely to be much harder to determine.

In practice, there is little consistency in the discount rate used across governments and even within different branches of the same government. Yet, despite these difficulties in agreeing on the most appropriate rate for a government to use, there appears to be agreement that taking into account the TVM is clearly appropriate for all types of organizations.

### INFLATION

In calculating the TVM, the question often arises regarding how to treat inflation. One approach would be to include the anticipated inflation rate in the discount rate. However, the weakness of that approach is that not all cash inflows and outflows will necessarily be affected by inflation to the same extent, that the “inflation rate” as we know it really represents an average impact of inflation rather than one consistent inflation rate for all things. A preferred method is to try to anticipate the impact of inflation on the various cash inflows and outflows and adjust each individual flow before calculating the PV or FV. In that case, inflation would not be included in the discount rate itself.

For example, suppose that we think that it will cost $1,000 to operate a machine each year, but that does not take into account inflation. Then we may want to adjust the cash flows for the succeeding years to $1,030, and then $1,061, and so on, multiplying the cash flow each year by 103 percent.

---

if we think the cost will rise 3 percent per year due to inflation (be careful to compound the impact of inflation—note that the third-year expected cost is $1,061 rather than $1,060). Other cash inflows and outflows might be expected to rise faster or slower, depending on how inflation affects them.

**UNCERTAINTY** There is no way that management can totally predict future cash inflows and outflows in many capital budgeting decisions. Things do not always go as planned. To protect against unexpectedly poor results, many organizations increase their required discount rate. The greater the chance of unexpected negative events, the more the discount rate would be adjusted. For example, in buying a new refrigeration unit, the chances of problems may be small. However, in opening an entire new soup kitchen location, the potential for unexpected problems may be substantially higher. Thus, the hurdle rate is adjusted upward based on the riskiness of the project. The greater the risk, the higher the hurdle rate is raised.

**Cost-Benefit Analysis**

Cost-benefit analysis (CBA) is another technique widely used by governments for evaluating capital budget decisions. CBA compares the costs of an action or program to its benefits. The method takes into account not only private costs and benefits but public ones as well. Many people think that cost-benefit analysis is associated with large-scale public projects, such as the building of a dam. However, the technique can be extremely useful even for evaluating small purchases such as a personal computer.

Any organization attempts to determine if the benefits from spending money will exceed the cost. If the benefits do outweigh the costs, it makes sense to spend the money; otherwise it does not. In the case of the government, the benefits and costs must be evaluated broadly to include their full impact on society. In the political arena that government managers find themselves in, the careful measurement of costs and benefits provides the information needed to support a spending decision.

There are several key elements in performing a cost-benefit analysis:

- determining project goals
- estimating project benefits
- estimating project costs
- discounting cost and benefit flows at an appropriate rate
- completing the decision analysis

**DETERMINING PROJECT GOALS** To determine the benefits, it is first necessary to understand what the organization hopes the project will accomplish. So identification of goals and objectives is essential. Suppose that Millbridge’s town manager, Dwight Ives, is considering buying a new garbage truck. The first question is why he feels that the town would be better off with a new garbage truck. The goals may be few or numerous, depending on the specific situation. Perhaps the old truck breaks down frequently and has high annual repair costs. One goal will be to lower repair costs. Perhaps the old truck is much smaller than newer ones. As a result, it has to make frequent trips to unload. A second goal may be to save labor costs related to the frequent unloading trips. A third goal may relate to reduction of the costs of hauling recyclables. If the new truck is appropriate for multiple uses, it may eliminate the need to pay for an outside service to haul recyclable materials such as paper or bottles.
ESTIMATING PROJECT BENEFITS  Once the goals have been identified, the specific amount of the benefits must be estimated. The benefits should include only the incremental benefits that result from the project. For instance, the manager would not include the benefit to citizens of having their garbage collected, since that will be accomplished (in this example) whether the town uses the old truck or the new truck.7 However, all additional benefits should be considered, estimated, and included in the cost-benefit calculation.

In the Millbridge example, it is likely that the town manager or one of his assistants will be able to calculate the benefits fairly directly. For example, the town knows how many trips the current truck makes to unload its garbage. Based on the capacity of the new truck, the number of trips the new truck would need to make can be calculated. The estimated number of trips saved can then be calculated. The town can measure how long it takes for the driver to make trips to unload the truck and use that information along with the driver’s pay rate to estimate labor savings. This assumes that the driver is an hourly employee and that there really would be reduced labor payments. If the driver is to be paid the same amount no matter how many hours of work are required, then there would be no labor benefit.

The labor savings is one component of the benefits. The town manager will also have to estimate the repair cost savings, the savings from not using an outside service to haul recyclables, and so on. All impacts of the change, as well as future circumstances, must be considered. For example, if the town is growing in population, it is likely to have more garbage in the future. That could mean the new truck would result in saving even more trips in the future.

However, the estimation of benefits is a potentially difficult process. Many times the benefits cannot be measured by simply evaluating saved costs. In such situations, it is helpful to determine the value of benefits in a private market situation, if possible. If the benefits have a comparable value in the private sector, that can be used as an estimate. However, a private sector comparison is not always available. Suppose that there is a proposal for Millbridge to convert a wooded area into a park with a baseball field. Many people will enjoy playing ball on the field. How much is that benefit worth? What would people be willing to pay for the benefit? Mikesell notes,

When the government product or service is a final product or when prices of marketed commodities change as a result of the project, a different approach is used. That approach is the estimation of consumers’ surplus—the difference between the maximum price consumers would willingly pay for . . . a commodity and the price that the market demands. . . . The underlying logic of consumer surplus is relatively simple. . . . Points along an individual’s demand curve . . . represent the value the person places on particular amounts of the product . . . . Consumer surplus [is] the difference between the [total] maximum price the individual would have paid and the price he or she actually pays.8 (emphasis in original)

As part of the cost-benefit analysis, it is necessary to estimate consumer surplus. An in-depth discussion of demand curves and estimation of consumer surplus is beyond the scope of this book. More complexity is added if the project either is lifesaving or may cost lives.

---

7. The example assumes that the old truck is reliable enough to remove garbage on schedule. If collections are occasionally delayed by several days because of the unreliability of the old truck, then the benefit of prompt collection would also need to be measured.
ESTIMATING PROJECT COSTS Projects have costs as well as benefits, and these costs must also be estimated as part of the cost-benefit analysis. In the case of the garbage truck, the primary cost relates to the acquisition of the truck. The truck has a market price, so this estimation is fairly straightforward. But how about the park and baseball field? Certainly, we can assign market-based prices to the cost of clearing the woods and preparing the field. However, in cost-benefit analysis it is also critical to consider opportunity costs. Opportunity cost refers to the fact that when a decision is made to do something, other alternatives are sacrificed. In the case of converting a wooded area for use as a park and baseball field, Millbridge and its residents will have to sacrifice other possible uses for the land, including preservation of the wooded area. The opportunity cost of the wooded area in its next best use to being a park should be estimated.

Suppose that several houses currently look out on woods and, after the park is made, will look out on a park with lots of people in it. The homeowners might view the ready accessibility of the park to be a benefit. It is possible, however, that since they chose to live near woods, they will be made unhappy by their loss. This is a cost to society and therefore is something that must be included in the analysis. This can be done in the same way as benefits are estimated. While some users of the park will have a consumer surplus, those who prefer the wooded area will have a negative consumer surplus if the project is carried out.

DISCOUNTING COST AND BENEFIT FLOWS Often projects evaluated using CBA require flows of benefits and costs that occur over a period of years. The time value of money techniques discussed earlier in the chapter would have to be applied to these cash flows to find their present value.

COMPLETING THE DECISION ANALYSIS Once all of the relevant costs and benefits of a project have been estimated and adjusted in a discounting process, they can be compared to each other in the form of a ratio. Generally, benefits are divided by costs. If the result is greater than 1, it means that the benefits exceed the costs, and the project is desirable. The greater the benefit to cost ratio, the more desirable the project is.

Other Techniques of Capital Budgeting In addition to the techniques for evaluating capital acquisitions that have been discussed previously, there are two other widely known techniques, both of which have serious flaws. Although we do not recommend use of these techniques by themselves, the reader should be aware of their existence and limitations. These two methods are the payback approach and the accounting rate of return (ARR) approach.

The payback approach argues that the sooner we get back our money, the better the project will be. This is a risk-averse method. Essentially, it focuses on recovery of the initial investment as soon as possible. Then any additional flows are viewed as being profits. The investor is safe at that point, having recovered all the money invested. However, consider the following three projects:

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment A ($)</th>
<th>Investment B ($)</th>
<th>Investment C ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>(100,000)</td>
<td>(100,000)</td>
<td>(100,000)</td>
</tr>
<tr>
<td>Year 1</td>
<td>90,000</td>
<td>10,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Year 2</td>
<td>10,000</td>
<td>90,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Year 3</td>
<td>20,000</td>
<td>20,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Year 4</td>
<td>0</td>
<td>0</td>
<td>150,000</td>
</tr>
</tbody>
</table>
The payback technique argues that A and B are equally good and are better than C. In both A and B, the $100,000 initial investment is recovered by the end of the second year. In C, the investment is not recovered until sometime during the third year. The objection to the payback method is that it ignores everything that happens after the payback period. It also does not consider the TVM. We would argue that A is better than B because of the TVM. Further, C is better than A or B. For project B, getting $90,000 in the second year instead of the first will result in a lower NPV than that of Project A. Further, the NPV of C is better than A or B because of the large returns in the third and fourth years.

Some organizations employ payback together with one of the TVM techniques discussed earlier. They argue that TVM techniques are good for evaluating profitability, accounting for the timing of cash flows. However, payback adds information about risk. Among differing projects with similar NPVs or IRRs, the one with the shortest payback period involves the least risk. Since the further we project into the future, the greater the uncertainties, employing payback as an additional tool for capital budgeting rather than the primary tool is a potentially useful approach.

The other capital budgeting method not yet discussed is the ARR approach. In this approach, the profits that are expected to be earned from a project are divided by the total investment, as follows:

\[
\frac{\text{Profit}}{\text{Investment}} = \text{Return on Investment}
\]

For example, suppose that we invest $100,000 today in a project that will have revenues of $50,000 and expenses of $40,000 each year. The project therefore earns annual profits of $10,000 per year for 5 years. The total profit is $50,000 and the calculation of the accounting rate of return would then be as follows:

\[
\frac{50,000}{100,000} \times 100\% = 50\%
\]

This is clearly unrealistic for a number of reasons. First, it is a return for the entire project life. This is sometimes corrected by dividing the return by the number of years in the project’s life, as follows:

\[
\frac{50\%}{5} = 10\%
\]

However, this still does not resolve the problems related to the failure to account for the TVM. The failure to account for the fact that the investment is made today and the profits are earned in future time periods will typically cause the ARR to be overstated.

These methods do not consider all cash flows, they do not account for the TVM, and they do not rank the projects in terms of their ability to make the organization better off financially. As such, they violate a number of the conditions for a good capital investment analysis tool.

9. Assume that each year the expenses include a pro rata (proportional) share of the cost of the capital investment.
SUMMARY

Assets with lifetimes of more than 1 year are often referred to as capital assets. The process of planning for their purchase is often referred to as capital budgeting. A capital budget is prepared as a separate document, which becomes part of the organization’s master budget.

Capital assets are considered separately from the operating budget, because it is not appropriate to charge the entire cost of a resource that will last more than 1 year to the operating budget of the year it is acquired. Who could ever justify buying a new building if the entire cost of the building were included as an operating expense in the year it was acquired? Capital items also require special attention because (1) the initial cost is large, making a poor choice costly; (2) the items are generally kept a long time, so the organization often lives with any poor choices for a long time; (3) we can understand the financial impact only if we evaluate the entire lifetime of the assets; and (4) since we often pay for the asset early and receive payments as we use it later, the time value of money must be considered.

Consideration of the time value of money requires careful attention to the principles of compounding and discounting. Present values and future values must be determined where appropriate to allow managers to make informed decisions. Often it is necessary to employ TVM techniques such as net present cost, annualized cost, net present value, and internal rate of return when assessing potential capital investments.

Key Terms from This Chapter

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- time value of money (TVM), 176

Questions for Discussion

5-1. Can capital budgets be consolidated into operating budgets to simplify the budget process?
5-2. Do capital budgets have any impact on operating budgets?
5-3. In theory, a capital asset must last at least 1 year and cost a substantial amount of money. True or false? Explain.
5-4. What are some reasons that capital asset acquisition decisions receive particular attention?
5-5. Wimpy, a character in the Popeye cartoons, offers to “gladly pay you Tuesday for a hamburger today.” Why might Burger King find this to be an unattractive offer?
5-6. Explain compounding and discounting.
5-7. What are the relationships between compounding and discounting and present and future values?

5-8. What is a potential problem with the net present cost method? How can this be overcome?

Exercises (TVM)

5-11. How much will $1,000 invested at 2 percent simple interest be worth in 10 years? What will it be worth if the interest rate is 3 percent?

5-12. If you put $15,000 in the bank today to save for college, and leave it for 20 years, what quarterly rate of interest will you have to earn in order to be able to pay a $50,000 tuition bill when you take the money out?

5-13. If you put $500 in the bank today and leave it for 10 years, will you have more money if the bank pays you 4.25 percent per annum in simple interest or 3.65 percent per year and compounds the interest daily? Support your answer.

NOTE: For Exercises 5-14 through 5-20:

A. Solve using a spreadsheet program such as Excel. Indicate the spreadsheet formula showing numeric values rather than cell references. For example, for the value that $100 today could grow to in 2 years, assuming 10 percent annual compounding, the spreadsheet solution formula would be = PV(10%, 2, 0, 100). Note that since there is no annuity payment (PMT) in this problem, it is necessary to show the blank between two commas or a zero after the number of periods. In addition, answer the questions using formulas with cell references.

B. Solve using a financial calculator. This is optional.

5-14. How much will $20,000 invested today at 3 percent interest be worth in 5 years if it is compounded annually? Monthly?

5-9. What are the limitations of the internal rate of return method?

5-10. What are the problems with the payback method?

5-15. If we receive $5,000 eight years from now, how much is that equivalent to today, if we believe that we can earn 5 percent on other opportunities?

5-16. If you have $8,500 today, and you could earn 3 percent interest per year, how many years would it be before you would accumulate $10,000 (assume annual compounding)?

5-17. How much must you put into a 5 percent investment annually to have $75,000 eight years from now? Assume all payments are made at the end of each period.

5-18. If you could put $5,000 into a 6 percent investment at the end of each year, how much money could you take out at the end of 7 years?

5-19. Suppose your parents have just retired and have $1,000,000 in a retirement account. For how many years can they withdraw $5,000 at the beginning of each month for expenses, assuming that the account will continue to earn a 5% annual return until it’s exhausted?

5-20. Now, suppose your parents have decided that they will depend on their retirement savings for 20 years. Everything else remains the same. How much money can they afford to withdraw at the beginning of each month?

5-21. Paula Morduch is considering purchasing a new van for Meals for the Homeless. She expects to buy the van for $50,000 four years from today. Solve the following using a calculator or spreadsheet.
a. If she can invest money at 5 percent compounded quarterly, how much must she invest today?

b. Suppose that Morduch believes that Meals for the Homeless can put aside only $37,500 today to buy the new van in 3 years. However, she thinks that she can invest the money at 7.20 percent compounded monthly. Determine if she will have the $50,000 she will need for the new van.

c. Assuming that Morduch can put aside $37,000 today and needs to have $50,000 available in 4 years, what interest rate must be earned? Use quarterly compounding.

d. Assume that Morduch believes that she can earn only 6 percent per year on the money that Meals for the Homeless invests. Assuming monthly compounding, how much must be put aside today to provide $50,000 in 4 years?

Problems

5-22. Choose from the methods listed below to answer the following questions.
   a. Net present value
   b. Net present cost
   c. Annualized cost
   d. Break-even
   e. Internal rate of return
   f. Cost-benefit analysis

1. The Public Water Works Department (PWW) is trying to decide whether to replace the crumbling water pipes below Metro City’s streets with plastic pipe that it believes will last 20 years or the more expensive concrete pipe that has a useful life of 100 years. PWW should use the __________ method to choose between the two alternatives.

2. The Independent Advisory Commission (IAC) is evaluating the economic viability of Metro’s proposed bid for the 2024 Olympics. Proponents of the games argue that the Olympics will generate substantial economic benefits for the city. Opponents point to the high cash outlays associated with the bid and subsequent costs of hosting the games. IAC should use the __________ method to evaluate the financial implications of Metro’s bid for the Olympics.

3. The __________ is the discount rate that sets the present value of the cash inflows from a project equal to the present value of the cash outflows from a project.

4. If you were asked to analyze the state’s decision to invest $100 million in a new auto plant, where state officials expect their investment to generate future tax revenues and other economic and social benefits, you would do a(n) __________.

5. The __________ method is used to evaluate decisions where there are no incremental cash inflows and all alternatives have the same useful lives.

6. The __________ method is used to evaluate investments that generate both cash inflows and cash outflows.

5-23. At any interest rate above 0 percent, the future value of an investment will always be
   a. less than the original amount invested
   b. greater than the original amount invested
   c. equal to the original amount invested

5-24. A stream of 60 monthly payments of $1,000 each is an example of a(n) __________.

5-25. If the net present value of the cash flows from an investment is greater than zero and
you base your decision solely on financial considerations, you should ________ the investment. (Circle the correct answer.)

- accept
- reject
- do nothing (not enough information) about

5-26. If compounding changes from quarterly to weekly for a $100 investment earning 8 percent per annum, the future value at the end of 5 years will (select from the answers below)

- increase
- decrease
- stay the same
- cannot tell from the information given

5-27. The internal rate of return is the discount rate that sets the ________ value of the ________ equal to the ________ value of the ________.

**NOTE:** For the following problems:

A. Solve using a spreadsheet program such as Excel.

B. Solve using a financial calculator (optional).

5-28. What is the internal rate of return for the stream of cash flows shown below?

<table>
<thead>
<tr>
<th>Period</th>
<th>Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$(10,000)</td>
</tr>
<tr>
<td>1</td>
<td>1,000</td>
</tr>
<tr>
<td>2</td>
<td>1,000</td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
</tr>
<tr>
<td>4</td>
<td>7,000</td>
</tr>
<tr>
<td>Total</td>
<td>$0</td>
</tr>
</tbody>
</table>

5-29. The city museum will have a Picasso exhibit on loan for 3 years. As part of the conditions of the loan, a specialized alarm and security system must be installed. High Security Company will install a suitable system for a $75,000 initial payment and $1,675 per month in monitoring fees. Both security systems would be used for 3 years. Assuming an annual discount rate of 9 percent with monthly compounding, which contract has the lowest net present cost?

5-30. The City Transit Authority (CTA) is trying to decide between railcars manufactured by French Corp and Japan Rail Car. The French Corp cars cost more to buy initially, but they are expected to last for 10 years. The Japan Rail Car cars are cheaper initially, but they will wear out in 6 years. The cash flows related to each of the choices are presented below. If the CTA’s cost of capital is 8 percent, which type of car should the CTA buy? Support your answer.

<table>
<thead>
<tr>
<th>Year</th>
<th>French Corp</th>
<th>Japan Rail Car</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$(275,000)</td>
<td>$(195,000)</td>
</tr>
<tr>
<td>1</td>
<td>(10,000)</td>
<td>(15,000)</td>
</tr>
<tr>
<td>2</td>
<td>(10,000)</td>
<td>(15,000)</td>
</tr>
<tr>
<td>3</td>
<td>(10,000)</td>
<td>(15,000)</td>
</tr>
<tr>
<td>4</td>
<td>(10,000)</td>
<td>(15,000)</td>
</tr>
<tr>
<td>5</td>
<td>(10,000)</td>
<td>(15,000)</td>
</tr>
<tr>
<td>6</td>
<td>(10,000)</td>
<td>(15,000)</td>
</tr>
<tr>
<td>7</td>
<td>(10,000)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>(10,000)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>(10,000)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$(375,000)</td>
<td>$(285,000)</td>
</tr>
</tbody>
</table>

5-31. Old Town needs to resurface a section of its roads this spring. The town council is considering using one of two technologies. The first involves putting down stone and gravel the first year and grading the road on an annual basis for the next 10 years. The second involves the application of a road surface called Sure-Pack. Sure-Pack requires maintenance only every 5 years. Based on experience, the town counselors know the gravel road will last 10 years. The folks in Hiltown,
the next town up Route 1, Sure-Packed their roads and expect to get 15 years from them before they will need to be resurfaced again. The cash flows for each alternative are shown in the table below. If Old Town’s discount rate is 8 percent, which alternative should they choose? Use an annualized cost analysis to support your answer.

<table>
<thead>
<tr>
<th>Year</th>
<th>Gravel</th>
<th>Sure-Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$200,000</td>
<td>$300,000</td>
</tr>
<tr>
<td>1</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>15,000</td>
<td>55,000</td>
</tr>
<tr>
<td>6</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>15,000</td>
<td>55,000</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If Smith uses an annual discount rate of 8 percent, should it pursue the investment? Show calculations to support your answer.

5-34. Duncombe Village Golf Course is considering the purchase of new equipment that will cost $1,250,000 if purchased today and will generate the following cash disbursements and receipts. Should Duncombe pursue the investment if the cost of capital is 8 percent? Why?

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Receipts</th>
<th>Cash Disbursements</th>
<th>Net Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>950,000</td>
<td>500,000</td>
<td>450,000</td>
</tr>
<tr>
<td>2</td>
<td>925,000</td>
<td>475,000</td>
<td>450,000</td>
</tr>
<tr>
<td>3</td>
<td>800,000</td>
<td>450,000</td>
<td>350,000</td>
</tr>
<tr>
<td>4</td>
<td>675,000</td>
<td>430,000</td>
<td>245,000</td>
</tr>
</tbody>
</table>

5-35. The town of Millbridge has just agreed to pay a pension to the town clerk. The pension will be $40,000 per year for the next 20 years. Dwight Ives, the town manager, has decided that the town should put aside enough money today to pay for the entire pension. He has argued that the town will not receive the clerk’s services in the future, so future taxpayers should not have to pay the pension. How much must be put aside, assuming the town earns 6 percent compounded annually? Does this funding approach make sense to you?

5-36. Suppose that you were to receive a $30,000 gift upon graduation from your master’s degree program, when you turn 31 years old. At the end of each working year for 34 years...
years, you put an additional $5,000 into an IRA.

a. Assuming you earn an annual compounded rate of 7.5 percent on the gift and the IRA investments, how much would be available when you retire at age 65?

b. If you hope to draw money out of that investment at the end of every month for 30 years following retirement, how much could you withdraw each month? Assume that during the years you are retired, the money earns an annual rate of 6 percent compounded monthly.

c. You realize that if you draw out that amount each month there will be nothing left for your two children. You decide that you want to leave $250,000 to each of your children 30 years after you retire. How much would you have to invest at your retirement to fund your children’s inheritance? Assume that you will earn 7.5 percent compounded annually on the money invested for your children.

d. If you set aside the money for your children, how much could you draw out each month during your retirement if you can earn 6 percent per annum compounded monthly on the portion that is not set aside for the children?

5-37. The Old School is trying to decide whether it should purchase or lease a new high-speed photocopier machine. It will cost the school $14,000 to purchase the copier and $750 each year to maintain the machine over the course of its 6-year useful life. At the end of the sixth year, Old School expects to be able to sell the copier for $1,000. A dealer has offered to lease the school the same copier for a payment of $750 at the beginning of the lease plus lease payments of $3,450 per year for 4 years. Lease payments include all maintenance. The dealer was unable to offer a lease longer than 4 years. Lease payments would be made at the end of each year. If the Old School’s discount rate is 8 percent, which alternative should it choose and why?

5-38. Rural Consolidated Fire Services (RCFS) is considering applying for a Federal Department of Energy (DOE) grant that would allow it to install solar panels on each of its four firehouses. The roofs on each of the firehouses are big enough to accommodate 30,000 square feet of panels. Panels cost $8 per square foot. In addition, RCFS will have to pay $8,000 per firehouse for batteries and other equipment costs and $10,000 per firehouse for installation. RCFS expects the solar panels on the four buildings to generate a total of $6,000 worth of electricity each month for the next 10 years. If RCFS puts panels on all four firehouses, the DOE will give RCFS $500,000 toward the cost of buying and installing the solar-power system. Federal stimulus money will be received at the start of the project. If RCFS’s discount rate is 6 percent, should RCFS install the panels based solely on financial considerations? Support your answer with the appropriate TVM calculations.

5-39. The Town Pool is considering investing $3,200 today in a popcorn maker. The annual cash profits from the machine will be $500 for each of the 10 years of its useful life. What is the IRR on the investment?

5-40. Urban Housing Agency (UHA) is considering contracts with private developers to provide low-income housing at various locations in the city. The startup costs to UHA for each location are $115,000, all of which must be paid to the developers in cash at the beginning. The housing rents would provide UHA net cash flows of $3,000 per month for the first 12 months, $4,000 per month for the following 12 months, and $5,000 for the remaining 12 months of a 3-year contract. UHA only
invests in projects that earn an annual rate of return of at least 12 percent. What rate of return would UHA earn on the contracts? Should UHA accept the contract? Why? Do not solve this problem using a financial calculator.

5-41. Refer to Problem 2-28 at the end of Chapter 2. Assume that the capital acquisitions in that problem were made at the beginning of fiscal year 2016. It is now the end of fiscal year 2018. Prepare a schedule showing those capital assets, their cost, their useful life, the accumulated depreciation at the beginning of 2018, the depreciation expense charged for 2018 (assuming straight-line depreciation and no salvage value), the accumulated depreciation as of the end of the year, and the net book value (cost less accumulated depreciation) as of the end of 2018. Use a spreadsheet program such as Excel. As River Country may dispose of the items at different times, note that it is necessary to track each item separately.

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It is now possible to buy inexpensive handheld calculators to do TVM computations. However, not all calculators are programmed to do TVM calculations. Those that are will generally be labeled as financial calculators and will have keys labeled for the TVM functions as shown throughout Appendix 5-A. You should also be aware that not all financial calculators work the same way. Different calculators may require different keystrokes. It is important to review the instruction booklet.

Calculators are useful adjuncts to spreadsheet programs. They allow you to do quick calculations when you cannot get to a computer or just need an immediate answer. It should be noted, however, that there are apps that download electronic spreadsheets to smartphones and tablets, giving them all the benefits of calculators without the need for an extra device. This will reduce the use of calculators for TVM computations even further.

Calculators can be used to check some of the calculations in complex spreadsheet before using the results of the analysis. These calculators have the formulas built in and can rapidly produce accurate results. For example, given the following information,

- \( FV = ? \)
- \( PV = 100 \)
- \( i = 6\% \)
- \( N = 2 \)

one could simply input the three known pieces of information and have the calculator compute the missing piece of information.

Often calculators that can do TVM computations have a row of buttons that would appear something like this:

- \( N \)
- \( Y \)
- \( P \)
- \( PMT \)
- \( FV \)

Sometimes the interest key is shown as an \( I/Y \) as above, or it might appear as \( r \), \%i, or \( i \). Notice that interest rates are entered into the calculator as whole numbers. Financial calculators automatically divide by 100 to convert that whole number to a percentage. By contrast, you must enter 0.06 or 6\% when using a computer spreadsheet program.

For the time being, we will ignore the PMT button. We will come back to that shortly. Generally, the way to use the calculator is to enter the appropriate information using the keys and then press a compute button followed by the desired variable. On many calculators the compute button appears as COMP or CPT. Each brand of calculator tends to have a different compute button and often a slightly different approach to entering data, so the instructions for the calculator should be carefully reviewed.

For our simple example of $100 invested for 2 years at 6 percent interest compounded annually, one would first clear the TVM registers in the calculator. Then enter the following keystrokes into the calculator:

- 100, then press \( \text{+/−} \)
- press \( PV \)
- 6, then press \( I/Y \)
- 2, then press \( N \)
- then press \( \text{CPT} \)
- then press \( FV \)
- 112.36 would appear on the calculator display.
Some calculators require the initial present value to be entered as a negative number, since $100 is first paid out into the investment and then at the end $112.36 is received from the investment. By pressing the +/- key on the calculator, you convert the initial 100 that you entered to a negative number. Another way to show the calculator approach would be to treat the information that is available and relevant to the problem as the raw data and the desired information as the result in a form such as the following:

<table>
<thead>
<tr>
<th>Raw Data:</th>
<th>2 6 -100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result:</td>
<td>N I/Y PV PMT FV</td>
</tr>
<tr>
<td></td>
<td>112.36</td>
</tr>
</tbody>
</table>

Note that the calculator simply calculates the result using the formulas shown in Equations 5.1 and 5.2. They do the arithmetic for the user. The hard part of working with TVM is determining the data that are relevant to the problem and the variable that one needs to calculate. Once any three of the variables (N, %i, PV, FV) are known, the fourth can be calculated by using a calculator or computer.

Whenever there are both cash inflows and cash outflows in a TVM calculation, the inflows and outflows must have opposing signs. If you do not enter opposing signs, you will get an error message. For example, if you wanted to know how many years it would take for an investment of $100 to grow to $240 with an annual interest rate of 6 percent, you should consider the initial investment of $100 as a negative number and $240 as a positive number. This rule holds for both calculators and spreadsheets. To solve for the number of years the money would have to be invested, you would enter the following keystrokes:

- 100, then press +/-
- press [PV]
- 6, then press I/Y
- 240, then press FV
- then press CPT
- then press N
- 15.025 would appear on the calculator display

Calculators can also be used to do TVM calculations involving annuities. See the discussion of annuities in the chapter. Suppose that we expect to receive $100 per year for the next 2 years. We could normally invest money at an interest rate of 10 percent compounded annually. What is the present value of those payments? Using the calculator, we can solve the problem as follows:

<table>
<thead>
<tr>
<th>Raw Data:</th>
<th>2 10 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result:</td>
<td>N I/Y PV PMT FV</td>
</tr>
<tr>
<td></td>
<td>-173.55</td>
</tr>
</tbody>
</table>

The result shown here indicates that receiving two annual payments of $100 each for the next 2 years is worth $173.55 today if the interest rate is 10 percent. The $173.55 is shown as a negative number because you would have to pay that amount today to receive $100 a year for 2 years.

Remember, it is important to clear your calculator memory before each new calculation. For example, with the Texas Instruments BAII Plus Professional calculator, you would press the second button and then CLR TVM. Check the calculator instruction manual for the proper way to clear the memory of your calculator. If you do not clear the calculator, you run the risk of getting incorrect answers.

How much would those two payments of $100 each be worth at the end of the 2 years?
Payments of $100 a year for 2 years at 10% would accumulate to $210.

Observe that there is a great deal of flexibility. If we know the periodic payment, interest rate, and number of compounding periods, we can find the FV. However, if we know how much we need to have in the future and know how many times we can make a specific periodic payment, we can calculate the interest rate that must be earned. Or we could find out how long we would have to keep making payments to reach a certain future value goal. Given any three variables, we can find the fourth.

For example, suppose that we are going to invest $100 a year for 5 years and we want it to be worth $700 at the end of the fifth year; what interest rate must we earn? Using the calculator, we can solve the problem as follows:

Using the calculator, we can solve the problem as follows:

\[
\begin{array}{c|c|c|c|c}
\text{Raw Data:} & 5 & 10 & 100 \\
\text{Result:} & \text{N} & \text{i/Y} & \text{PV} & \text{FV} \\
\end{array}
\]

Notice that we used opposing signs for the cash inflows—the negative $100 payments—and the cash outflow—the positive $700 FV. If we did not, the calculator would not be able to find N and would show an error message.

Similarly, we can solve for the number of periods. Suppose we know that we can invest $100 a year, we can earn a 16.9 percent annual rate of return, and we want to have $700 at the end of our investment. We can find the number of periods before we will accumulate the desired amount. Using the calculator, we can solve the problem as follows:

\[
\begin{array}{c|c|c|c|c|c}
\text{Raw Data:} & 5 & 16.9 & -100 & 700 \\
\text{Result:} & \text{N} & \text{i/Y} & \text{PV} & \text{PMT} & \text{FV} \\
\end{array}
\]

We can also solve for the payment. Suppose we need $700 in 5 years and believe that we can earn 16.9 percent per year on our investment. We can find the amount we will need to save each year to reach that goal. Using the calculator, we can solve the problem as follows:

\[
\begin{array}{c|c|c|c|c|c}
\text{Raw Data:} & 5 & 16.9 & -100 & 700 \\
\text{Result:} & \text{N} & \text{i/Y} & \text{PV} & \text{PMT} & \text{FV} \\
\end{array}
\]

\[
\begin{array}{c|c|c|c|c|c}
\text{Raw Data:} & 5 & 16.9 & -100 & 700 \\
\text{Result:} & \text{N} & \text{i/Y} & \text{PV} & \text{PMT} & \text{FV} \\
\end{array}
\]
Computer spreadsheet programs such as Microsoft Excel can be used to solve TVM calculations. The chapter provided a detailed example for finding a future value (FV) using Excel. This appendix provides examples of the specific steps required to find present values (PV), annuity payments (PMT), rates (Rate), number of compounding periods (Nper), net present values (NPV), and internal rates of return (IRR), using Excel.

In each case, the basic approach is to enter the appropriate data into the cell where you want to see the results. Start by typing the equal sign followed by the function name and an open parenthesis; you will then see the function and all of the needed input variables directly below the cell. Figure 5-B-1 shows what that would look like for a present value formula. The most commonly used TVM formulas are:

- \( PV(rate, nper, pmt, [fv], [type]) \)
- \( Rate(nper, pmt, pv, [fv], [type]) \)
- \( Nper(rate, pmt, pv, [fv], [type]) \)
- \( PMT(rate, nper, pv, [fv], [type]) \)
- \( NPV(rate, value1, value2, \ldots) \)
- \( IRR(values, [guess]) \)

**APPENDIX 5-B**

**USING COMPUTER SPREADSHEETS FOR TIME VALUE OF MONEY CALCULATIONS—EXAMPLES**

Suppose that we can buy a capital asset that will result in our receiving $15,000 five years from now and that we believe an appropriate discount rate for this specific piece of equipment is 7 percent. We need to decide the most that we would pay for that asset. What is the PV of that future receipt?

We can start the solution by recording the raw data in an Excel spreadsheet. See Figure 5-B-2. Enter the cell references for each variable called for in the formula Excel shows for computing the PV. If you want the solution to appear as a positive number, enter a minus sign before the cell reference for the FV. Note that the present value formula is shown at the top of the screen to the right of fx. When you press the Enter key, Excel computes the PV to be $10,694.79, as shown in Figure 5-B-3. If we wished to show the formula with numeric values, it would be \( PV(7\%, 5, 0, -15000) \).
Suppose that we can earn only 9 percent per year. How many years would it be before our $10,000 will grow to become $20,000? After setting up the data, we would enter =Nper(rate, pmt, pv, fv, type, guess). Then enter the rate, FV, minus PV and hit the Enter key. The result is 8.04, or a little bit longer than 8 years. Notice that the inputs, formula, and result can also be seen in Figure 5-B-5. The formula with numeric values would be =Nper(9%, 0, –10000, 20000).

PERIODIC PAYMENTS (IN ARREARS)

Assume that you can invest money every year for 7 years at 8 percent. If you need $20,000 at the end of 7 years, how much would you have to put aside each year? Assume you make the payments at the end of each year. After setting up the data, enter =PMT(rate, nper, pv, fv, [type]). Enter the appropriate cell references or data values for the formula, and hit the Enter key. We find that we would have to invest $2,241.45 each year. We can see that result at the bottom of Figure 5-B-6. The formula with numeric values would be =PMT(8%, 7, 0, 20000).

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PERIODIC PAYMENTS (IN ADVANCE)

However, what if we could put aside money at the beginning of each year rather than the end? When payments come at the end of each period, as they do in an ordinary annuity or annuity in arrears, the value for “type” is 0. If we leave it blank, as we have so far, Excel assumes that it has a value of 0. For an annuity in advance we must indicate the type as being 1 in the Excel formula. Figure 5-B-7 shows how this would appear. If the periodic payments are made at the start of the year, we would need to put aside only $2,075.41 each year. The formula with numeric values would be

\[ \text{PMT}(8\%, 7, 0, 20000, 1) \]

NET PRESENT VALUE

Suppose that we can invest $1,000 today in a capital asset, and will receive $500, $700, and $800, respectively, at the end of each of the 3 years of the asset’s life. Our discount rate for the project is 6 percent. What is the net present value? After entering the rate and cash flow data, type = NPV( and Excel displays the formula \( \text{NPV}(\text{rate}, \text{value 1}, \text{value 2}, \ldots) \). Note that the initial outlay is not one of the values. This outlay must be subtracted from the Excel NPV calculation. Figure 5-B-8 shows the problem setup and cell references. The formula result is $1,766.39. After subtracting the outlay of $1,000, the NPV is $766.39.

INTERNAL RATE OF RETURN

What is the internal rate of return (IRR) of the cash flows described in the NPV section earlier? Type = IRR( and Excel will display the formula \( \text{IRR(values, [guess])} \). Provide Excel with the values and an initial guess, such as 15 percent (note that the guess can generally be left blank if preferred). Note that the initial outlay is one of the values. In this respect, the IRR function works differently than the NPV function. Figure 5-B-9 shows the problem setup and cell references. The formula result shown at the bottom of the screen is 40.42%. This means that the IRR for the capital asset would be approximately 40.4 percent.
Excel 2007 to Excel 2010, minor changes in the process tend to occur. To some extent, the spreadsheet approaches are quirky. For example, not allowing the initial, time 0, outflow to be directly included in the NPV calculation seems odd. Nevertheless, spreadsheets can handle the more complicated numbers found in real-world situations with ease, and most organizations now rely almost exclusively on computer spreadsheets for their TVM calculations.

CONCLUSION

Each of the major spreadsheet programs handles the TVM process slightly differently. Within any program from one version to the next, such as from

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