Principles of Finance

10 Bonds and Bond Valuation

Figure 10.1 Bonds are very useful investments to add to a portfolio. (credit: modification of “US Treasury Checks - 3D Illustration” by DonkeyHotey/flickr, CC BY 2.0)

Chapter Outline

Why It Matters

When an investor purchases a bond, that person is, for all intents and purposes, making a loan to the bond issuer. Bonds issues are used to raise funds and can be issued by corporations, governments, or even subagencies of governments (including local municipalities).

As with any type of loan, the borrowing party is expected to offer something to the lender in exchange for their time and trouble. In this case, the bond-issuing entity will agree not only to repay the original face value of the loan on a specific date (the maturity of the bond) but also to pay the lender interest—or, in bond terminology, coupon payments.

Coupon payments are designed to make a bond purchase more acceptable for investors by helping compensate them for the time value of money. Because investors are parting with money that they have right now in order to make the initial bond purchase but will not see repayment of principal until the maturity date of the bond, they will experience the negative impact of time value over the bond term. When a bond issuer offers periodic coupon payments, this helps offset the negative effect of the delayed receipt of the principal amount for the investor. Also, because coupon payments will be coming to the investor throughout the term of the bond, essentially in installment payments (an annuity), the time value of money plays a critical role in bond transactions and in calculating bond valuation.

Bonds, along with stocks and mutual funds, are considered to be one of the most basic financial instruments available to any investor. It is quite common for investors to round out their portfolios by purchasing bonds, adding a degree of safety and diversity to their investment mix.

10.1 Characteristics of Bonds

Learning Outcomes

By the end of this section, you will be able to:

- List and define the basic characteristics of bonds.
- List and describe the various types of bonds available.
- Explain how a bond price is inversely related to its return (yield).

Bonds as Investments

One way to look at bond investments is to consider the fact that any investor who purchases a bond is essentially buying a future cash flow stream that the bond issuer (or borrower) promises to make as per agreement.

Because bonds provide a set amount of cash inflow to their owners, they are often called fixed-income securities. Thus, future cash flows from the bond are clearly stated per agreement and fixed when the bond sale is completed.

Bonds are a basic form of investment that typically include a straightforward financial agreement between issuer and purchaser. Nevertheless, the terminology surrounding bonds is unique and rather extensive. Much of the specialized vocabulary surrounding bonds is designed to convey the concept that a bond is similar to other financial instruments in that it is an investment that can be bought and sold. Much of this unique terminology will be covered later in this chapter, but we can set out some of the basics here with an example.

Let's say that you buy a $1,000 bond that was issued by Apple Inc. at 5% interest, paid annually, for 20 years. Here, you are the lender, and Apple Inc. is the borrower.

LINK TO LEARNING

Informational Basics on Bonds

This video (https://openstax.org/r/the-basics-of-bonds) from *MoneyWeek* editor Tim Bennett provides information about the basics of bonds—what they are, how they work, why companies and governments issue them, and why investors might buy them.

Basic Terminology

We need to know the following basic bond terms and pricing in order to apply the necessary time value of money equation to value this Apple, Inc. bond issue:

- **Par value**: A bond will always clearly state its par value, also called face amount or face value. This is equal to the principal amount that the issuer will repay at the end of the bond term or maturity date. In our example, the par value of the bond is $1,000.
- **Coupon rate**: This is the interest rate that is used to calculate periodic interest, or coupon payments, on the bond. It is important to note that coupon rates are always expressed in annual terms, even if coupon payments are scheduled for different periods of time. The most common periods for coupon payments other than annual are semiannual and quarterly. Coupon rates will typically remain unchanged for the entire life of the bond. In our example, the coupon rate is the 5% interest rate.
- **Coupon payment**: This refers to the regular interest payment on the bond. The coupon or periodic interest payment is determined by multiplying the par value of the bond by the coupon rate. It is important to note that no adjustment needs to be made to the coupon rate if the bond pays interest

annually. However, if a bond pays interest on a semiannual or quarterly basis, the coupon rate will have to be divided by 2 or 4, respectively, to convert the stated annual rate to the correct periodic rate. In our example, coupons are paid annually, so the periodic or annual interest that is paid is equal to $\$1{,}000 \times 0.05 = \$50$. You may notice that because these payments are the same amount and made at regular intervals, they constitute an annuity stream (refer to Time Value of Money II: Equal Multiple Payments.

- **Maturity date**: The maturity date is the expiration date of the bond, or the point in time when the term of a bond comes to an end. On the maturity date, the issuer will make the final interest or coupon payment on the bond and will also pay off its principal, or face value. In our example, the maturity date is at the end of the 20-year period.
- **Yield to maturity (YTM)**: The YTM is essentially the discount rate used to bring the future cash flows of a bond into present value terms. It also equals the return that the investor will receive if the bond is held to maturity. The YTM helps quantify the overall investment value of a bond. We will explore how to compute this rate later in the chapter.

Table 10.1 displays a selected listing of bonds available for purchase or sale. First, let's review the columns so you can learn how to read this table.

Issuer	Bond Type	Current Price %	Callable?	Coupon Rate %	Maturity Date	Yield%	Rating
3M Co.	Corp	105.120	Yes	2.25	9/19/2026	1.240	A+
Alteryx	Corp	98.818	No	1.00	8/1/2026	1.206	None
Anheuser-Busch Cos. LLC	Corp	125.319	Yes	5.95	1/25/2033	3.340	BBB+
City of Chicago	Muni	103.164	Yes	5.00	1/1/2033	1.030	BBB+
Coca-Cola Co.	Corp	95.206	Yes	1.00	3/15/2028	1.731	A+
DuPont De Nemours Inc.	Corp	100.815	Yes	2.17	5/1/2023	1.775	BBB+
Exxon Mobil Corp.	Corp	107.325	Yes	3.18	3/15/2024	0.483	AA-
Ford Motor Co.	Corp	114.880	No	7.13	11/15/2025	3.623	BB+
Nordstrom Inc.	Corp	112.905	No	6.95	3/15/2028	4.758	BB+
Tennessee Energy Acquisition Corp.	Muni	102.168	No	5.25	9/1/2021	0.451	BBB+

Table 10.1 **Bond Information, March 2021** (source: FINRA-Markets.Morningstar.com)

- **Column 1: Issuer.** The first column shows the company, city, or state issuing the bond. This bond listing includes two municipal issuers (City of Chicago and Tennessee Energy) as well as several corporate issuers.
- **Column 2: Bond Type.** This describes the issue of the bond and indicates whether it is a corporation or a municipality.
- **Column 3: Current Price.** The third column shows the price as a percent of par value. It is the price someone is willing to pay for the bond in today's market. We quote the price in relation to $100. For example, the Nordstrom bond is selling for 112.905% of its par value, or $112.905 per $100.00 of par value. If this bond has a $1,000.00 par value, it will sell for $\$1{,}129.05$ $(\$1{,}000 \times 1.12905)$. Note: Throughout this chapter, we use $1,000 as the par value of a bond because it is the most common par value for corporate bonds.
- **Column 4: Callable?** This column states whether or not the bond has a call feature (if it can be retired or ended before its normal maturity date).
- **Column 5: Coupon Rate.** The fifth column states the coupon rate, or annual interest rate, of each bond.
- **Column 6: Maturity Date.** This column shows the maturity date of the issue—the date on which the

corporation will pay the final interest installment and repay the principal.

- **Column 7: Yield.** The seventh column indicates each bond's yield to maturity—the yield or investment return that you would receive if you purchased the bond today at the price listed in column 3 and held the bond to maturity. We will use the YTM as the discount rate in the bond pricing formula.
- **Column 8: Rating.** The final column gives the bond rating, a grade that indicates credit quality. As we progress through this chapter, we will examine prices, coupon rates, yields, and bond ratings in more detail

Types of Bonds

There are three primary categories of bonds, though the specifics of these different types of bond can vary depending on their issuer, length until maturity, interest rate, and risk.

Government Bonds

The safest category of bonds are short-term **US Treasury bills (T-bills)**. These investments are considered safe because they have the full backing of the US government and the likelihood of **default** (nonpayment) is remote. However, T-bills also pay the least interest due to their safety and the economics of risk and return, which state that investors must be compensated for the assumption of risk. As risk increases, so should return on investment. Treasury notes are a form of government security that have maturities ranging from one to 10 years, while Treasury bonds are long-term investments that have maturities of 10 to 30 years from their date of issue.

Savings bonds are debt securities that investors purchase to pay for certain government programs. Essentially, the purchase of a US savings bond involves the buyer loaning money to the government with a guaranteed promise that they will earn back the face value of the bond plus a certain amount of interest in the future. Savings bonds are backed by the US government, meaning that there is virtually no possibility of the buyer losing their investment. For this reason, the return on savings bonds is relatively low compared to other forms of bonds and investments.

LINK TO LEARNING

Government Bonds

Review this introductory video (https://openstax.org/r/treasury-bonds-prices) about government bonds.

Municipal bonds ("munis") are issued by cities, states, and localities or their agencies. Munis typically will return a little more than Treasury bills while being just a bit riskier.

Corporate Bonds

Corporate bonds are issued by companies. They carry more risk than government bonds because corporations can't raise taxes to pay for their bond issues. The risk and return of a corporate bond will depend on how creditworthy the company is. The highest-paying and highest-risk corporate bonds are often referred to as non-investment grade or, more commonly, **junk bonds**.

Corporate bonds that do not make regular coupon payments to their owners are referred to as **zero-coupon bonds**. These bonds are issued at a deep discount from their par values and will repay the full par value at their maturity date. The difference between what the investor spends on them in original purchase price and the par value paid at maturity will represent the investor's total dollar value return.

Convertible bonds are similar to other types of corporate bonds but have a feature that allows for their conversion into a predetermined number of common stock shares. The conversion from the bond to stock can be done at certain times during the bond's life, usually at the discretion of the bondholder.

The Global Bond Market versus the Global Stock Market

Bonds have long been a trusted investment vehicle for many investors. Though the global fixed-income debt market remains considerably larger than the global stock market, this is not an entirely fair comparison. Bond markets include sovereign bonds, or bonds that are issues by governments, while stock markets do not. Some experts believe that a more relevant comparison is between the value of corporate bond markets only (excluding sovereign bonds) and total stock market value.

The chart in Figure 10.2 provides global market value information by category so that we may make our own conclusions about these markets.

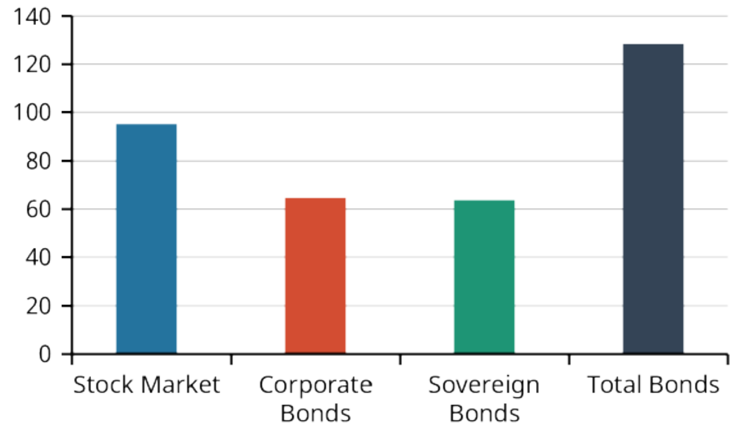

Figure 10.2 Global Bonds versus Stocks: Total Market Values ($Trillions), November 2020 (data source: Nasdaq)

While the total value of bond markets continues to exceed that of stocks, the prevailing trend over the past several years has been that stock markets are gaining in terms of total market size. The primary reason for this is that stocks have traditionally outperformed bonds in terms of return on investment over extended periods of time and are likely to continue to do so. This makes them more attractive to investors, despite the higher risk associated with stock.

The Two Sides of a Bond Investment

There are essentially two sides to a bond investment, meaning the bondholder will receive two types of cash inflow from the bond investment over its term. These are the payment of the par value at maturity (often referred to as payment of the face value of the bond at term end), and the periodic coupon payments (also called **interest income**) from the bond. These coupon payments are contractually determined and clearly indicated in the bond issue documentation received by the bondholder upon purchase.

As a result of these two types of inflow, bond valuation requires two different time value of money techniques—specifically, present value calculations—to be computed separately and then added together.

The Relationship between Bond Prices and Interest Rates

Bond price and interest rate have an inverse relationship. When interest rates fall, bond prices rise, and vice versa (see Figure 10.3). If interest rates increase, the value of bonds sold at lower interest rates will decline. Similarly, if interest rates decline, the value of fixed-rate bonds will increase. An exception to this general rule is **floating-rate bonds** (often referred to as “floaters,” floating-rate notes, or FRNs).

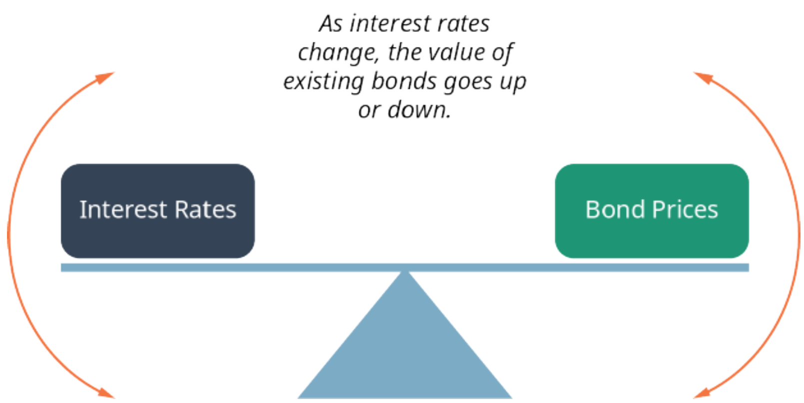

Figure 10.3 The Seesaw Effect of Bond Prices and Interest Rates

A floating-rate note is a form of debt instrument that is similar to a standard fixed-rate bond but has a variable interest rate. Rates for floating-rate bonds are typically tied to a benchmark interest rate that exists in the economy. Common benchmark rates include the **US Treasury note rate**, the **Federal Reserve funds rate (federal funds rate)**, the **London Interbank Offered Rate (LIBOR)**, and the **prime rate**.

So, investors who decide to purchase normal (fixed rate) bonds may not be thrilled to hear that the economy is signaling inflation and that interest rates are forecasted to rise. These bond investors are aware that when interest rates rise, their bond investments will lose value. This is not the case with floating- or variable-rate bonds.

Bonds with very low coupon rates are referred to as **deep discount bonds**. Of course, the bond that has the greatest discount is the zero-coupon bond, with a coupon rate of zero. The smaller the coupon rate, the greater the change in price when interest rates move.

LINK TO LEARNING

Relationship between Bond Prices and Interest Rates

Review this video (https://openstax.org/r/relationship-bond-prices) explaining the relationship between bond prices and interest rates within financial and capital markets.

10.2 Bond Valuation

Learning Outcomes

By the end of this section, you will be able to:

- Determine the value (price) of a bond.
- Understand the characteristics of and differences between discount and premium bonds.
- Draw a timeline indicating bond cash flows.
- Differentiate between fixed-rate and variable-rate bonds.
- Determine bond yields.

Pricing a Bond in Steps

Why do we want to learn how to price a bond? The answer goes to the heart of finance: the valuation of assets. We need to ascertain what a given bond is worth to a willing buyer and a willing seller. What is its value to these interested parties? Remember that a bond is a financial asset that a company sells to raise money from willing investors. Whether you are the company selling the bond or the investor buying the bond, you want to make sure that you are selling or buying at the best available price.

Let’s begin our pricing examples with the 3M Company corporate bond listed in Table 10.1 above. The table information tells us that 3M issued a series of corporate bonds that promise to pay coupons annually on September 19 and to pay back the principal, or face value, on the maturity date of September 19, 2026. While this is not specified in the table, let's say these are 15-year corporate bonds. In that case, we know that they were issued on September 20, 2011.

The 3M bonds have an annual coupon rate of 2.25%, which indicates that the annual interest payment on the bond will be the face value (assumed to be $1,000.00 multiplied by 2.25%), or $22.50. The appropriate discount rate to apply to these future payments is the yield to bond maturity, 1.24%.

Note that the 3M bond is selling at a premium (above par or face value) due to the fact that its coupon rate is greater than the YTM percentage. This means that the bond earns more value in interest than it loses due to discounting its cash flows to allow for the time value of money principle.

Finally, the table tells us some of the bond's features. For example, Standard & Poor's, an international rating agency, rates 3M Co. as A+ (high credit quality). Additionally, the bonds are designated as callable, meaning that 3M has the option of redeeming them before their maturity on September 19, 2026.

We can price a bond using the same methods from earlier chapters: an equation, a calculator, and a spreadsheet. Let's start with the equation method (see Figure 10.4).

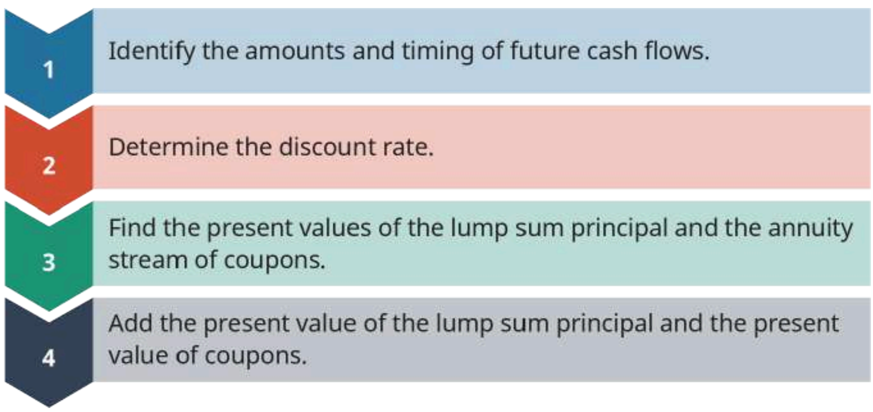

Figure 10.4 Steps in Pricing a Bond

The first step is to identify the amounts and the timing of the two types of future cash flows to be received on the bond. Any bond that pays interest or coupon payments (coupon bonds) will have two sources of future cash flow to its bondholder/investor: the periodic coupon payments, which are a form of annuity, and the final lump sum payment of the face value amount at maturity.

As discussed above, the principal or face value is paid in a one-time lump sum payment at bond maturity. In our example with 3M Co., this is the $1,000 par value of the bond that will be paid on the maturity date of September 19, 2026. Step 1 is to lay out the timing and amount of the future cash flows. The first future cash flow we need to determine is the annual interest payment. Here, it is the coupon rate of 2.25% times the par value of the bond. As mentioned above, we will use $1,000 as the par value of this bond, so the annual coupon or interest payment will equal $22.50:

$$\text{Par Value} \times \text{Annual Coupon Rate} = \text{Annual Coupon Payment}$$

$$\$1{,}000 \times 2.25\% = \$22.50$$

The next future cash flow that we need to determine is the payment of the par value or principal—in this case, the $1,000 par value of the bond—at the maturity date of September 19, 2026. We can set out the future cash flows for the bond as shown in Table 10.2:

Year (Period)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Coupons	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50	$22.50
Principal															$1,000

Table 10.2

Note that annual coupon payments are made each year on September 19, and the first annual coupon payment date is September 19, 2012. The annual payments continue for 15 years, with the last payment being made on September 19, 2026. At this point, we can apply previously learned concepts: the coupon payments constitute an annuity stream, or payments of the same amount at regular intervals.

The principal of $1,000 is also paid out at maturity. Here, we recognize another key concept: the final amount is a lump sum payment. So, we now have the promised set of future cash flows for the 3M Co. bond.

In Step 2, we will need to decide on a discount rate to use on these future bond cash payments. For now, we will jump to the answer and simply use the YTM of 1.24% from the bond data in Table 10.1. Later in the chapter, we will develop the concepts behind how an appropriate discount rate is determined.

For Step 3, we now apply two equations to the set of future cash flows from the bond. This will then provide us with the present values of these cash flows, or the expected present-day value of the bond. Because we know that the coupon payments constitute an annuity stream, we can use the equation for the present value of an annuity (discussed in Time Value of Money II: Equal Multiple Payments. To value the one-time par value payment, we use the equation for the present value of a lump sum payment. So, by combining these, we will have the present value of the coupon payment stream, or

$$\text{Coupon Payment Amount} \times \frac{\left[1 - \frac{1}{(1+r)^n}\right]}{r} = \text{PV}_{\text{Coupon}}$$

So, for our example above, this becomes

$$\begin{aligned} \$22.50 \times \frac{\left[1 - \frac{1}{(1+0.0124)^{15}}\right]}{0.0124} &= \text{PV}_{\text{Coupon}} \\ \$22.50 \times 13.61099 &\approx \$306.25 \end{aligned}$$

Next, we need to determine the present value of the payment of the par or face value of the bond at maturity. This is calculated as follows:

$$\text{Par Value} \times \frac{1}{(1+r)^n} = \text{PV}_{\text{Principal}}$$

Inserting our values into this formula gives us

$$\begin{aligned} \$1{,}000 \times \frac{1}{(1+0.0124)^{15}} &= \text{PV}_{\text{Principal}} \\ \$1{,}000 \times 0.831224 &\approx \$831.22 \end{aligned}$$

Adding the present values of the two payment streams gives us

$$\$306.25 + \$831.22 = \$1{,}137.47$$

Our bond price is $1,137.47. This bond price represents the value of the financial asset to both a willing buyer and a willing seller.

In this example, the willing seller is 3M Company. The willing buyer is an investor who is demanding a 1.24% yield on the investment. As per Table 10.1 above, the 3M bond sold for $1,051.20 in March 2021. However, we display the price as a percentage of the par value, so we have the displayed price as

$$\frac{\$1{,}051.20}{\$1{,}000} = 1.05120 \text{ or } 105.120\%$$

Because we round the percent of par, we do not see the cents digit in the quoted price.

Pricing a Bond Using a Financial Calculator

A financial calculator can also be used to solve common types of bond valuations. For example, what would be the current price (value) of a 4% coupon bond, paid semiannually, with a face value of $1,000 and a remaining term to maturity of 15 years, assuming a required YTM rate of 5%? The steps to solve this problem are shown in Table 10.3 below.

Step	Description	Enter	Display	
1	Clear calculator register	CE/C		0.0000
2	Enter future or par value as a negative amount	1000 +|− FV	FV =	-1,000.0000
3	Enter interest rate $\left(\frac{5\%\text{ annual rate}}{2} = 2.5\%\text{ semiannual rate}\right)$	2.5 I/Y	I/Y =	2.5000
4	Enter periods Enter periods $(15\text{ years} \times 2 = 30\text{ semiannual periods})$	30 N	N =	30.0000
5	Enter coupon payment $\frac{\$1{,}000 \times 4\%}{2} = \$20$ as a negative amount	20 +|− PMT	PMT =	-20.0000
6	Compute present value or price	CPT PV	PV =	895.3485

Table 10.3 Calculator Steps for Bond Valuations[1]

The current price is $895.35.

Time Value Connection

As we have briefly discussed, bond valuation is determined by time value of money techniques, most notably present value calculations. This makes logical sense when one considers that an investment in a bond involves a series of future cash inflows, or payments from the bond issuer to the bondholder over the term of the bond's maturity.

To determine the value of a bond today, the two-step time value of money calculation we discussed earlier must be used, and the present value of a series of coupon payments (or an annuity) must be determined. This present value amount will then be added to the present value of a single lump sum payment (the principal or face value) that will come to the bondholder at the end of the bond's term (maturity).

Fixed Income

Because standard fixed-rate bonds have their coupon payments and maturity amounts locked in, they are often referred to as fixed-income investments. This is because their values are relatively straightforward to calculate. Bonds are generally viewed as stable investments that offer income and a lower amount of volatility compared to stocks.

1 The specific financial calculator in these examples is the Texas Instruments BA II Plus™ Professional model, but you can use other financial calculators for these types of calculations.

While yields provided by corporate and government bonds such as US T-bills and municipal bonds are currently low because the **Federal Reserve System (the Fed)** has kept interest rates low for several years, investors may still consider adding bonds to their portfolios.[2] This is especially true as investors enter their retirement years and seek to generate income while avoiding the volatility of the stock market. Such investors can add a mix of individual bonds, mutual funds, or exchange-traded funds to their portfolios, thus generating potential return while keeping risks at a minimum. Fixed-income investments such as intermediate- or longer-term bond funds are still providing good yields despite the low-interest-rate state of the economy.

It is important to note, however, that even though bonds are generally thought of as safer investments, they still are subject to a number of risks. Because income from most bonds is fixed, such instruments can have their values eroded by external factors such as interest rates and inflation. We will discuss some of these risks after the next section.

Period	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
End Date	6/30/20	12/31/20	6/30/21	12/31/21	6/30/22	12/31/22	6/30/23	12/31/23	6/30/24	12/31/24
Coupon	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500
Principal										$100,000

Table 10.4

Table 10.4 shows the cash inflow of a five-year, 9%, $100,000 corporate bond dated January 1, 2020. The bond will have coupon (interest) payment dates of June 30 and December 31 for each of the following five years. Because the bond was issued on January 1, 2020, the year 2020 is the first full year of the bond, followed by the years 2021, 2022, 2023, and 2024, with the bond maturing in December of the latter year.

Cash inflows will be (1) the coupon or interest payments of $\frac{9\% \times \$100{,}000}{2} = \$4{,}500$, paid to the bondholder every six months, and (2) the one-time principal or face-value payment of $100,000 upon maturity on December 31, 2024.

Yields and Coupon Rates

The two interest rates that we associate with a bond are often confusing to students when they first begin to work with bonds. The coupon rate is the interest rate printed on the bond; this is only used to determine the interest or coupon payments. The yield to maturity (YTM) is an interest rate that is used to discount the bond's future cash flow. The YTM is derived from the marketplace and is based on the riskiness of future cash flows.

As we have seen when pricing bonds, a bond's YTM is the rate of return that the bondholder will receive at the current price if the investor holds the bond to maturity.

Yield to Maturity

As noted above, the market sets this discount rate, or the yield to maturity. The YTM reflects the going rate in the bond market for this type of bond and the bond issuer's perceived ability to make the future payments. Hence, we base the yield on a mutually agreeable price between seller and buyer. The bond market determines the YTM and the available supply of competing financial assets. By competing against other available financial assets, the YTM reflects the risk-free rate and inflation, plus such premiums as maturity and default specific to the issued bond.

The YTM is the expected return rate on the bond held to maturity. How do we determine the bond's YTM? We can use our same three trusty methods: equations, a financial calculator, and Microsoft Excel (as shown at the end of the chapter).

2 Adam Hayes. "What Do Constantly Low Bond Yields Mean for the Stock Market?" *Investopedia*. June 15, 2021. https://www.investopedia.com/ask/answers/061715/how-can-bond-yield-influence-stock-market.asp

Determining Bond Yield Using an Equation

The solution, when solving for discount rates, requires us to revisit the bond pricing formula, which is

$$\text{Bond Price} = \text{Par Value} \times \frac{1}{(1+r)^n} + \text{Coupon Payment Amount} \times \frac{\left[1 - \frac{1}{(1+r)^n}\right]}{r}$$

Of course, with one equation, we can solve for only one unknown, and here the variable of concern is *r*, which is the YTM. Unfortunately, it is difficult to isolate *r* on the left-hand side of the equation. Therefore, we need to use a calculator or spreadsheet to solve for the bond's YTM.

Let's take another bond, the Coca-Cola bond, from Table 10.1 above and again back up our time to March 2021. If the Coca-Cola bond has just been issued in March 2021, then it would be a seven-year, semiannual bond with a coupon rate of 1.0% and an original price of $952.06 at the time of issue (Table 10.5).

Bond Characteristic	Details
Price (% of par)	95.20
Coupon rate	1%
Maturity date	March 15, 2028
Standard & Poor's Rating	A+
Coupon payment frequency	Semiannual
First coupon date	September 1, 2021
Type	Corporate
Callable?	Yes

Table 10.5 Overview of Coca-Cola Bond (as of March 2021) (credit: FINRA-Markets.Morningstar)

Determining Bond Yield Using a Calculator

For the Coca-Cola bond above, what was the bond's YTM at its issue date? This is not an easy problem to solve with a mathematical formula. It is far more practical, not to mention easier, to use a financial calculator or an Excel spreadsheet to solve for bond prices, yields, and maturity periods.

We will cover Excel applications later, but we can jump into some calculator examples right now. So, to calculate the yield on the Coca-Cola bond, we'll start by entering the values we have for this bond into a calculator. The values we know are as follows:

$$\$1{,}000 \text{ par value}$$

$$14 \text{ payments } (n = 7 \text{ years} \times 2 \text{ payments per year})$$

$$\$5.00 \text{ coupon per period } \left(\frac{\$1{,}000 \times 1\%}{2} = \$5.00\right)$$

If the bond's selling price was $952.06 at issue, we have all the information we need to determine the bond's YTM at issue. Table 10.6 shows the steps for using a calculator to come to an answer.

Step	Description	Enter	Display	
1	Clear calculator register	`CE/C`		0.0000
2	Enter present value or price as a negative amount	952.06 `+|-` `PV`	PV =	-952.0600

Table 10.6 Calculator Steps for Bond's Yield to Maturity at Issue

Step	Description	Enter	Display	
3	Enter future or par value	1000 FV	FV =	1,000.0000
4	Enter periods $7 \text{ years} \times 2 = 14 \text{ semiannual periods}$	14 N	N =	14.0000
5	Enter coupon payment $\left(\frac{\$1{,}000 \times 1\%}{2} = \$5.00\right)$	5 PMT	PMT =	5.0000
6	Compute interest rate	CPT I/Y	I/Y =	0.8651

Table 10.6 Calculator Steps for Bond's Yield to Maturity at Issue

The calculated I/Y (interest rate or YTM) of 0.8651 is a semiannual figure because the periods and coupon payments we entered for the calculation are semiannual values. To covert the semiannual value into an annual rate, we will need multiply the calculated I/Y by 2. This gives us an amount of 1.73%.

So, the YTM of the Coca-Cola bond at issue date was 1.73%. It is important to know that unless otherwise indicated, bond yields are expressed in annual percentage terms.

We have just demonstrated how a calculator can be used to determine the YTM or interest rate of a bond. Let's look at a few more examples that cover the most common types of bond problems. These are determining a YTM, calculating a bond's current price (or value), and determining a bond's maturity period.

First, let's work through another example of calculating a YTM, but this time with a bond that has annual interest payments instead of semiannual coupons.

Let's say you are considering buying a bond, but you want to calculate the YTM to determine if it will meet your overall return requirements. Some facts you have on the bond are that it has a $1,000 face value and that it matures in 12 years. Assume that the current price of the bond is $675 and it pays coupons annually at 3.5%. See Table 10.7 for the steps to calculate the YTM.

Step	Description	Enter	Display	
1	Clear calculator register	CE/C		0.0000
2	Enter present value or price as a negative amount	675 +|− PV	PV =	-675.0000
3	Enter future or par value	1000 FV	FV =	1,000.0000
4	Enter periods (12 years)	12 N	N =	12.0000
5	Enter coupon payment $(\$1{,}000 \times 3.5\% = \$35.00)$	35 PMT	PMT =	35.0000
6	Compute interest rate	CPT I/Y	I/Y =	7.7589

Table 10.7 Calculator Steps for Computing Yield to Maturity

By following the steps in the table above, you will arrive at a YTM of 7.76%.

Using a calculator is fast and accurate for finding bond yields. Thus, if you know the bond's current price and all of the future cash flows, you can find the YTM, or the return rate that the bond buyer is receiving on the funds loaned to the bond issuer. As mentioned, Excel spreadsheets are as easy and accurate as a financial calculator for determining bond rates, and we will cover these later in the chapter.

Determining Bond Price or Value Using a Calculator

Let's say a friend recommends a 20-year bond that has a face value of $1,000 and a 6% annual coupon rate. If similar bonds are yielding 4% annually, what would be a fair price for this bond today? Table 10.8 shows the steps to make this determination.

Step	Description	Enter	Display	
1	Clear calculator register	CE/C		0.0000
2	Enter future or par value as a negative amount	1000 +|− FV	FV =	-1,000.0000
3	Enter interest rate (4% annual rate)	4 I/Y	I/Y =	4.0000
4	Enter periods (20 years)	20 N	N =	20.0000
5	Enter coupon payment ($\$1{,}000 \times 6\% = \$60$) as a negative amount	60 +|− PMT	PMT =	-60.0000
6	Compute present value or price	CPT PV	PV =	1,271.8065

Table 10.8 Calculator Steps for Computing Present Value

So, the bond should be priced today at $1,271.81.

Determining Bond Maturity Using a Calculator

Imagine you are considering investing in a bond that is selling for $820, has a face value of $1,000, and has an annual coupon rate of 3%. If the YTM is 10%, how long would it take for the bond to mature? See Table 10.9 for the steps to calculate the time to maturity.

Step	Description	Enter	Display	
1	Clear calculator register	CE/C		0.0000
2	Enter present value or price as a negative amount	820 +|− PV	PV =	-820.0000
3	Enter interest rate (10% annual rate)	10 I/Y	I/Y =	10.0000
4	Enter future or par value	1000 FV	FV =	1,000.0000
5	Enter coupon payment ($\$1{,}000 \times 3\% = \$30.00$)	30 PMT	PMT =	30.0000
6	Compute periods until maturity	CPT N	N =	3.1188

Table 10.9 Calculator Steps for Computing Time to Maturity

So, the bond's time to maturity would be 3.12 years.

THINK IT THROUGH

Using a Calculator

If a $1,000 face value bond is selling for $595, has 20 years until it matures, and has a YTM of 6.5%, what are the coupon rate and the periodic coupon payment of the bond? Follow the steps in Table 10.10.

Step	Description	Enter	Display	
1	Clear calculator register	CE/C		0.0000
2	Enter present value or price as a negative amount	595 +|− PV	PV =	-595.0000
3	Enter periods	20 N	N =	20.0000
4	Enter future or par value	1000 FV	FV =	1,000.0000

Step	Description	Enter	Display	
5	Enter interest rate or YTM	6.5 I/Y	I/Y =	6.5000
6	Compute coupon payment	CPT PMT	PMT =	28.2437

Table 10.10 Calculator Steps for Computing Coupon Payment

Solution:

The annual coupon payment amount is $28.24. This means the coupon rate on the bond is $\frac{28.24}{1{,}000} = 2.824\%$.

The Coupon Rate

The coupon rate is the rate that we use to determine the amount of a bond's coupon payments. The issuer states the rate as an annual rate, even though payments may be made more frequently. Thus, for semiannual bonds, the most common type of corporate and government bond, the coupon payment is the par value of the bond multiplied by the annual coupon rate and then divided by the number of payments per year, 2.

We have already seen the coupon rate. The first bond we reviewed, the 3M Co. bond, was an annual coupon bond with a coupon rate of 2.25%. Using a par value of $1,000, we determined that the annual coupon payments would be $\$1{,}000 \times 0.0225 = \$22.50$.

For the Coca-Cola bond, we note from Table 10.5 that it has a coupon rate of 1% and is paid semiannually. Using a par value of $1,000, we can determine that the coupon payments would be $\frac{\$1{,}000 \times 1\%}{2} = \$5.00$.

The Relationship of Yield to Maturity and Coupon Rate to Bond Prices

The value or price of any bond has a direct relationship with the YTM and the coupon rate.

- When the coupon rate of a bond exceeds the YTM, the bond sells at a premium compared to its par value. That is, market demand will push the price of the bond to an amount greater that than its face or par value. We call this kind of bond a **premium bond**.
- When the coupon rate is less than the YTM, the bond sells at a discounted amount, or less than its par value. We refer to such a bond as a **discount bond**.
- When the coupon rate and YTM are identical, a bond will sell at its par value. Bonds that experience this scenario in the market are referred to as par value bonds.

The interest or coupon payments of a bond are determined by its coupon rate and are calculated by multiplying the face value of the bond by this coupon rate.

The inverse relationship of interest rates and bond prices is an important concept for investors to know. Because interest rates fluctuate and can change significantly over time, it is important to understand how these changes will impact bond values.

10.3 Using the Yield Curve

Learning Outcomes

By the end of this section, you will be able to:

- Use the yield curve to show the term structure of interest rates.
- Describe and define changes in the yield curve shape.
- Explain the importance of the yield curve shape.

Term Structure of Interest Rates

The expected yields of various bonds across different maturity periods are referred to as the *term structure of interest rates*. This is because they represent interest rates for different periods of time, maturities, or terms.

When interest rate yields are plotted against their respective maturity periods and these plotted points are connected, the resulting line is called a **yield curve**. Essentially, the yield curve is a result of this plotting process and becomes a graphical representation of the term structure of interest rates. A yield curve will always be constructed by showing the value of yields (rates) on the *y*-axis and maturities or time periods on the *x*-axis (see Figure 10.5).

To create a useful graph of the yield curve, interest rate yields should be computed for all government bonds at all remaining times to maturity. For example, the yields on all government bonds with a single year remaining until maturity should be calculated. This value is then plotted on the *y*-axis against the one-year term on the *x*-axis. Similarly, yields on government bonds with two years remaining until maturity are calculated and plotted on the *y*-axis against two years on the *x*-axis, and so on, until a point of critical mass of information is reached and the resulting graph displays useful information.

The yield curve for government bonds is also known as the *risk-free yield curve* because these securities are thought of as safe investments that are not expected to fail or default and will in all likelihood repay or otherwise meet all financial obligations made through the bond issuance.

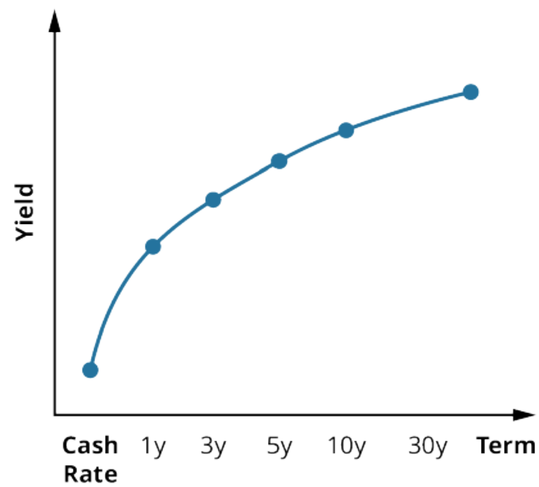

Figure 10.5 A Normal Yield Curve: Long-Term Rates Are Higher Than Short-Term Rates

A normal yield curve slopes upward, with yield increasing as the term increases. This is because yields on fixed-income investments such as bonds will rise as maturity periods increase and produce greater levels of risk.

Corporate issuers of bonds will usually offer bond issues at higher yields that the government, which is understandable because they are potentially riskier for investors. Government securities are guaranteed by governments and have little to no chance of default or nonpayment. This is not the case for corporate bonds, where there is always a chance of default, though the likelihood of this occurring will vary by individual company or issuer as well as by bond type and term. We will discuss bond default and default risk next.

LINK TO LEARNING

The Yield Curve

Review this video (https://openstax.org/r/introduction-to-the-yield-curve) that introduces the concept of the yield curve.

Different Shapes of the Yield Curve

There are two important elements to any yield curve that will define its shape: its level and its slope. The level of a yield curve directly relates to the yield rates depicted on the *y*-axis of the graph (see Figure 10.6). The slope of the yield curve indicates the difference between yields on short-term and longer-term investments. The difference in yields is primarily due to investors' expectations of the direction of interest rates in the economy and how the federal funds rate (referred to as **cash rate** in many countries) is uncertain and may differ significantly over time. As an example, yields on three-year bonds incorporate the expectations of investors on how bank rates might move over the next three years, combined with the uncertainty of those rates over the three-year period.

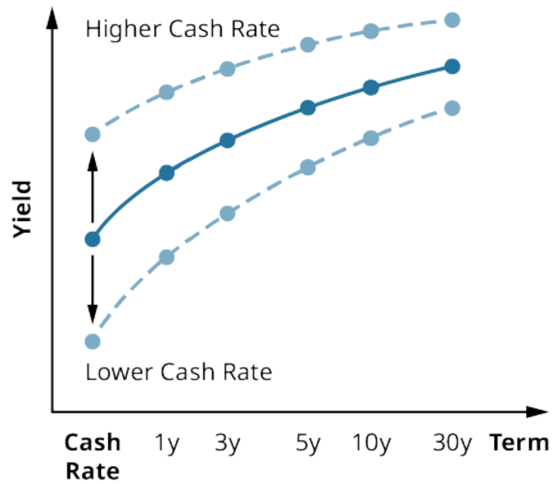

Figure 10.6 Changes in Yield Curve Depending on Cash Rate

As we briefly discussed above, a positive or normal yield curve is indicative of the investment community's requirements for higher rates of return as financial consideration for assuming the risk of entering into fixed-income investments, such as the purchase of bond issues. Typically, as a bond term increases, so will the potential interest rate risk to the bondholder. Therefore, bonds with longer terms will usually carry higher coupon rates to make returns greater for investors. Additionally, economists have come to believe that a steep positive yield curve is a sign that investors anticipate relatively high inflation in the future and thus higher interest rates accompanied by higher investment yields over shorter (inflationary) periods of time.

Normal yield curves are generally observed during periods of economic expansion, when growth and inflation are increasing. In any expansionary economy, there is a greater likelihood that future interest rates will be higher than current rates. This tends to occur because investors will anticipate the Fed or the central bank raising its short-term rates in response to higher inflation rates within the economy.

CONCEPTS IN PRACTICE

How COVID-19 Impacted the Yield Curve

Figure 10.7 shows the relatively normal-shaped yield curve effective in February 2021.

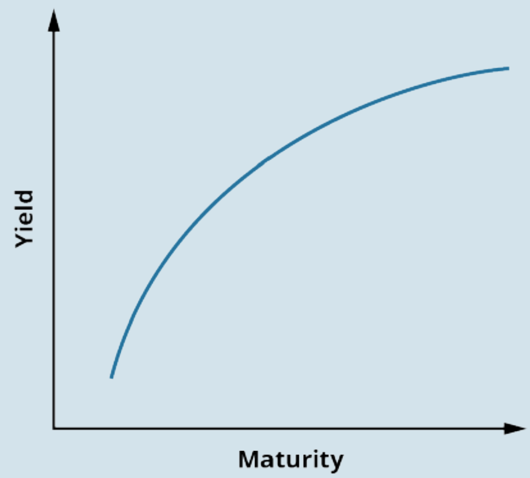

Figure 10.7 Yield Curve in February 2021

A yield curve with an inverted (downward-sloping) shape is considered unusual and will occur when long-term rates are lower than short-term rates. This causes the yield curve to assume an inverted shape with a negative slope. An inverted yield curve has historically been observed as a prelude to a general decline in economic activity and interest rate levels. In some countries, such as the United States, an inverted yield curve has been associated with upcoming recession and economic contraction.

This may occur because central banks, such as the Federal Reserve in the United States, will often attempt to stimulate a stagnant economy by reducing interest rates. Essentially, the potential actions of the central bank to improve the economy have the effect of lowering overall money rates with the economy, which is exactly what investors anticipated would happen and why the yield curve was inverted to begin with.

The yield curve was considered normal with an upward slope in August 2018, as shown in Figure 10.8, but the curve inverted in March 2019 as yields on short-term bonds exceeded those of longer-term bonds, resulting in concerns surrounding impending recession and other economic problems. This inverted shape to the yield curve continued into 2020, as evidenced in Figure 10.9.

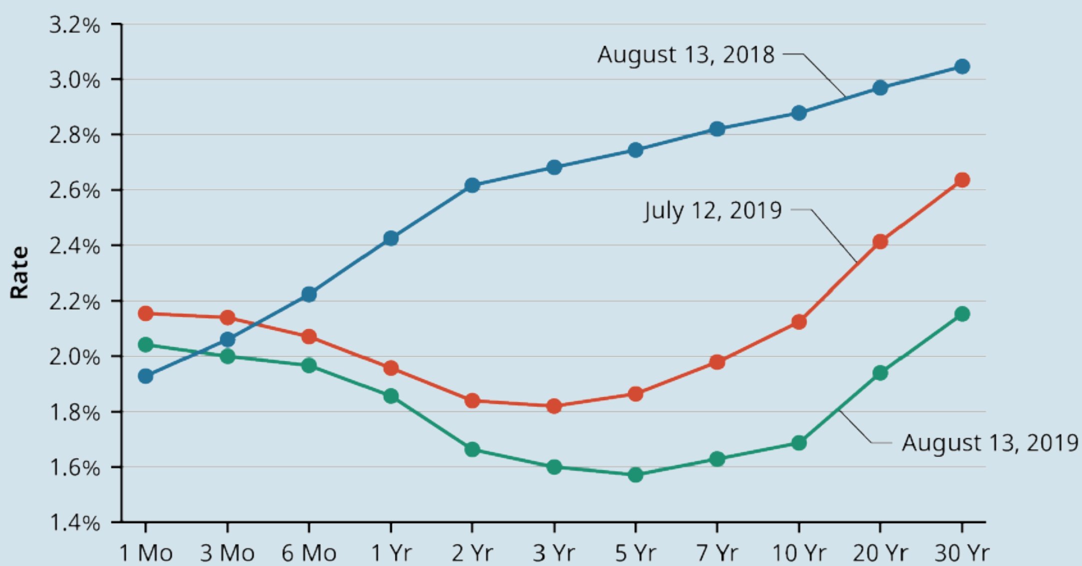

Figure 10.8 The Economy Shifts to an Inverted Yield Curve (data source: US Department of the Treasury, Resource Center, Daily Treasury Yield Curve Rates)

Yield curves constructed on different days in early 2020 appeared similar to the examples below. Again, these are obviously not normal yield structures. As a specific example, note on the February 21, 2020, curve that rates on five-year securities are lower than those of one-year and even three-month securities.

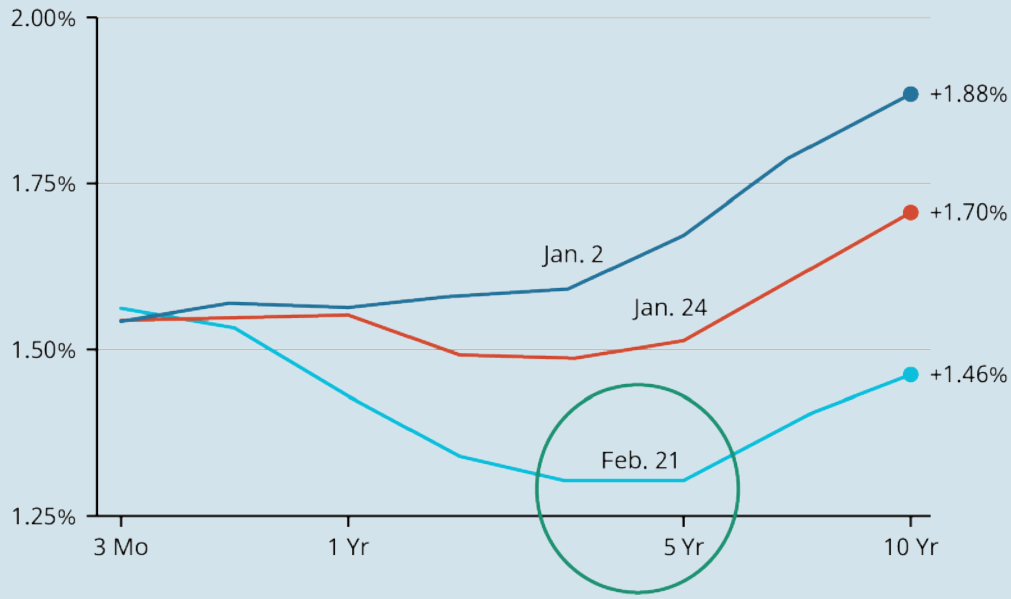

Figure 10.9 Elements of Inversion in Recent Yield Curves (data source: US Department of the Treasury, Resource Center, Daily Treasury Yield Curve Rates)

This inverted yield curve signaled the beginning of a recessionary period in the United States, which was compounded by the COVID-19 pandemic and the closing of many restaurants and businesses.

In March and April 2020, the US economy experienced a significant decline. Most economic indicators dropped so badly that the National Bureau of Economic Research's **Business Cycle Dating Committee**, the US agency that officially declares recessions, was required to intervene.[3]

The recession declaration process by the committee is completed over the course of four months, but in this instance, it only took a total of 15 weeks for the committee to make its declaration. This remains the fastest declaration by the committee on record since the founding of the National Bureau of Economic Research (NBER) in 1978.[4]

In July 2021, the committee declared that the economy had reached a trough in April 2020, marking the end of the recession of the early 2020s and making it the shortest US recession on record as well as the most quickly identified one.[5]

(sources: www.nytimes.com/2019/11/08/business/yield-curve-recession-indicator.html; www.nber.org/news/business-cycle-dating-committee-announcement-june-8-2020; fredblog.stlouisfed.org/2020/11/are-we-still-in-a-recession/)

A flat shape for the yield curve occurs when there is not a great deal of difference between short-term and long-term yields (see Figure 10.10). A flat curve is usually not long lasting and is often observed when the curve is transitioning between a normal and an inverted shape, or vice versa.

A flat yield curve has also been observed as a result of low interest rate levels or some types of unconventional monetary policy.

3 National Bureau of Economic Research. "Business Cycle Dating Committee Announcement June 8, 2020." *NBER News*.
4 Jeffrey Frankel. "The US Is Officially in Recession Thanks to the Corona Virus Crisis." *The Belfer Center for Science and International Affairs*. Harvard Kennedy School, June 16, 2020. https://www.belfercenter.org/publication/us-officially-recession-thanks-corona-virus-crisis
5 National Bureau of Economic Research. "Business Cycle Dating Committee Announcement July 19, 2021." *NBER News*. July 19, 2021. https://www.nber.org/news/business-cycle-dating-committee-announcement-july-19-2021

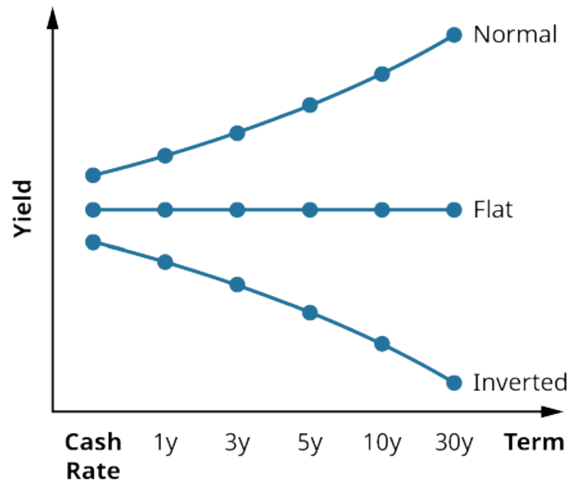

Figure 10.10 Graph Depicting Normal, Flat, and Inverted Yield Curves

Why Is the Yield Curve Important?

Market technicians, brokers, and investment analysts will study the yield curve in great detail by keeping track of its many changes and movements. This is because of the overall importance of the yield curve as an economic indicator and how it can be representative of the ideas, attitudes, and bond market expectations of individuals as well as large institutional investors that exert significant influence on investment markets and the economy as a whole.

10.4 Risks of Interest Rates and Default

Learning Outcomes

By the end of this section, you will be able to:

- Define interest rate, default, and other common forms of bond risk.
- Calculate the primary indicator of interest rate risk.
- Determine factors impacting default risk.
- Understand bond laddering as an investment strategy.
- List major rating agencies and their indications of default.
- Define and calculate the yield to maturity (YTM) on a bond.

Bond Risks

As we touched on earlier, bonds are fixed-income investments, and because of this, they are subject to a number of risks that could have negative effects on their market value. The most common and best-known risks are **interest rate risk** and **default risk**, but other risks exist that should be understood. Among these risks are the following:

- **Credit risk**. If investors believe that a bond issuer is unlikely to meet its payment commitments, they may demand a higher yield to purchase the bond issue in the first place. Due to the relative stability of governments compared to corporations, government bonds are considered to have low credit risk.
- **Liquidity risk**. If investors believe that a bond may be difficult to sell, it will likely have a higher yield. This has the effect of compensating the bondholder for the lack of liquidity (the ability to cash out of the bond). Government bonds usually have the lowest yields of all investments available and are typically among the most liquid in any country where they are traded. Government securities will only face significant liquidity risk in times of great economic distress.
- **Duration risk**. Duration risk is the risk associated with the sensitivity of a bond's price to a single 1% change in interest rates. A bond's **duration** is expressed in numerical measurements. The higher the duration number, the more sensitive a bond investment will be to changes in interest rates.

- **Call risk and reinvestment risk. Call risk** is the risk of bonds being redeemed or called by the issuing firm before their maturity dates. Corporations may elect to call a bond issue (provided the bond issue has a call feature) when interest rates drop and companies are in a position to save a great deal of money by issuing new bonds with lower coupon rates. To investors, this is a risk in and of itself, but call risk also has the effect of potentially causing reinvestment risk. **Reinvestment risk** is defined as the risk to investors when they find themselves facing unfavorable alternatives for investing the proceeds from their called bonds in new, lower-paying investments. This can potentially lead to substantial financial loss for the original bond investors.
- **Term risk**. Investors will generally demand higher returns for lending funds at fixed interest rates. This is because doing so exposes them to the risks presented by rising interest rates and the negative impact of these higher rates on their bond holdings. In a scenario of rising interest rates, investors will find that their return from lending money through a bond purchase just once, at a fixed interest rate, will be lower than the return they might have realized from making several different investments for much shorter periods of time. Term risk is usually measured by a special indicator referred to as the *term premium*.

As mentioned above, however, the most common forms of bond risk are interest rate risk and default risk.

Interest Rate Risk

As we have discussed, when interest rates rise, bond values will fall. This is the general concept behind interest rate risk. Any investor in **fixed-income securities** (such as bonds) will have to contend with interest rate risk at one time or another. Interest rate risk is also referred to as *market risk* and usually increases the longer an investor maintains a bond investment.

Default Risk

Any time a bond is purchased, the investor is taking a risk that the bond issuer may be late in making scheduled payments on a bond issue—or, in the worst case, may not be able to make payments at all. This is the underlying idea behind the concept of default risk.

Because US Treasury securities have the full backing of the government, they are generally considered free of default risk. However, most corporate bonds will face some possibility of default. Obviously, some bonds and their issuing companies are riskier in this respect than others.

To assist potential bond investors in understanding some of these risks, **bond ratings** are regularly published by a number of organizations to express their assessment of the risk quality of various bond issues. We will discuss these bond ratings and the companies that issue them next.

Bond Ratings and Rating Providers

It is important for investors to know the risks they are assuming when investing in bonds. Many investors will take advantage of information provided by bond rating services to assess the likelihood of borrowers (bond issuers) defaulting on the financial obligations of their bond issues.

To help investors evaluate the default risks of bonds, **rating agencies (bond rating services)** were established to evaluate bonds and other fixed-income investments, taking into consideration and then analyzing any information that has been published or otherwise made available to the investing public. These services then apply a rating system that has been developed for measuring the quality of bonds and assign individual grades to each bond and its issuing company.

The three largest and best-known bond rating providers are Fitch Ratings, Moody's Investors Service, and Standard & Poor's (S&P) Global Ratings. The rating system used by these services identifies the very highest-quality bonds (the least likely to default) as triple-A (AAA or Aaa), followed next in quality level by double-A bonds (AA or Aa), and so on. Any bond that is rated BBB (S&P, Fitch) / Baa (Moody's) or higher is referred to as **investment grade** and is considered strong and stable by the investment community (see Table 10.11).

It is important to note that investment-grade bonds are among the most popular due to the fact that many commercial banks, as well as several pension funds, are only allowed to trade bonds that are investment grade.

Any bond that is below investment grade, or rated lower than BBB (S&P, Fitch) or Baa (Moody's), is referred to as a high-yield bond or a junk bond. Junk bonds have had mixed levels of success for companies wishing to issue them to raise capital. In the early 1990s, the market for junk bonds collapsed, due in part to a political movement involving influential people who had been dominating corporate debt markets. This movement, combined with illegal insider trading activities conducted by investments banks, ultimately resulted in the bankruptcy of former financial giant Drexel Burnham Lambert.[6]

S&P / Fitch	Moody's	Grade	Meaning
AAA	Aaa	Investment	Risk almost zero
AA	Aa	Investment	Low risk
A	A	Investment	Risky if economy declines
BBB	Baa	Investment	Some risk; more if economy declines
BB	Ba	Speculative	Risky
B	B	Speculative	Risky; expected to get worse
CCC	Caa	Speculative	Probably bankruptcy
CC	Ca	Speculative	Probably bankruptcy
C	C	Speculative	In bankruptcy or default
D		Speculative	In bankruptcy or default

Table 10.11 **Bond Ratings** (sources: S&P Global Ratings; Moody's)

The market for junk bonds enjoyed a brief resurgence in popularity when the economy improved later in the 1990s. However, in 2001, the junk bond market shrank once again, resulting in 11% of US junk bond issues defaulting.

In general, it is important to understand that bond ratings are only judgments on corporations' future ability to repay debt obligation and their growth prospects. There is no fixed methodology or basis for calculating a bond rating. However, some financial analysts can get a strong indication of how a bond will be rated by examining certain financial ratios of the issuing firm, such as company debt ratio, earnings-to-interest ratio, and their return on assets.

CONCEPTS IN PRACTICE

The Collapse of Enron: Bond and Credit Ratings and How They Change

The bond rating system is not infallible. A perfect example of this is when energy giant Enron failed in 2001. After the collapse, investors correctly pointed out that a mere two months before this occurred, the company's bonds were rated as investment grade and considered relatively safe, having little risk for investors.

Background on Enron

From its formation in 1985 through the late 1990s, Enron grew to become an energy mega-conglomerate,

6 Lawrence Delevingne. "The Drexel Collapse, 25 Years Later." *CNBC*. February 13, 2015. https://www.cnbc.com/2015/02/13/the-drexel-collpase-25-years-later.html

expanding into areas such as trading of futures contracts, paper products, electricity, water, pipelines, and broadband services. Reported revenues grew at an exceptional pace, Enron's stock price continued to rise, and business was proceeding exceptionally well.

However, things were not as they appeared on the surface. Enron's financial statements were often very confusing to shareholders and analysts. Additionally, Enron's unscrupulous business practices included revenue misstatements and other questionable accounting practices to indicate favorable financial performance. On top of this, some of Enron's speculative business ventures proved to be disastrous, resulting in substantial financial losses.

Initial allegations against Enron also focused on the role of their public accountants, Arthur Andersen. Andersen was one of the Big Five accounting firms in the United States at that time and had served as Enron's auditing firm for over 16 years. According to court documents, Enron and Arthur Andersen had improperly categorized hundreds of millions of dollars of transactions as increases to the company's shareholder equity. It was also later discovered that Andersen failed to follow generally accepted accounting principles (GAAP) when considering Enron's dealings with related partnerships. As a result, Enron was able to conceal some of its losses from the investing public. After investigation by the United States Justice Department, the firm was indicted on obstruction of justice charges in March 2002. The combination of all of these irregularities and issues resulted in the December 2, 2001, bankruptcy of the corporation.[7] It was later determined that the majority of these unethical issues had been perpetuated with the indirect knowledge or even, in some cases, by the direct actions of the board of directors or senior operational management of the company.

Specifics and Enron's Bond Ratings

On October 27, 2001, the company began buying back all its commercial paper, valued at around $3.3 billion, in an effort to calm investor fears about Enron's supply of cash. On November 8, Enron announced that restatements to its financial statements for the years 1997–2000 were necessary to correct several accounting violations. However, by November 28, 2001, credit rating agencies had reduced Enron's bond rating to junk status.[8]

Other Examples of Significant Bond Ratings Downgrades

Some companies that have recently experienced downgrades (or potential downgrades) to their credit and bond ratings include Delta Airlines, Ford, Occidental Petroleum, Carnival Cruises, and T-Mobil. Some of these businesses, such as Delta and Carnival, are suffering the effects of the COVID-19 pandemic, but the hope is that they don't experience the same disastrous fate as Enron.

(sources: www.britannica.com/event/Enron-scandal; www.journalofaccountancy.com/issues/2002/apr/theriseandfallofenron.html; corporatefinanceinstitute.com/resources/knowledge/other/enron-scandal/; www.wsj.com/articles/corporate-bond-downgrades-grow-as-coronavirus-spreads-11585849497)

Concepts of Bond Returns

Bond investors earn profits through two different means: collecting interest income and generating **capital gains**. These are important concepts for any investor who considers putting their money in fixed-income securities such as bonds.

7 Douglas O. Linder. "Enron (Lay & Skilling) Trial (2006)." *Famous Trials*. Accessed November 24, 2021. https://famous-trials.com/enron

8 Paul M. Healy and Krishna G. Palepu. "The Fall of Enron." *Journal of Economic Perspectives* 17, no. 2 (Spring 2003): 3–26. https://doi.org/10.1257/089533003765888403

Collecting Interest Income

As we have covered, when investors buy bonds, they are lending money to bond issuers. The coupon rate of a bond is determined by the issuer and is generally tied to the overall level of interest rates in the economy at the time of issue as well as the maturity period of the bond and the credit rating of the issuer. The established coupon rate then governs how much periodic interest is paid to bondholders. For example, if an investor purchases a 5%, $1,000 bond with a 20-year maturity and annual coupon payments, that investor will receive 20 coupon payments equal to $\$1{,}000 \times 5\%$ or $20 \times \$50$ for a total of $1,000.

Depending on interest and inflation rates over the 20-year period, this could be a very favorable situation resulting in significant **realized return** for the investor. However, if interest rates and inflation over the investment period are at high levels, the investment is not nearly as attractive.

Generating Capital Gains

Many bonds are not held until their maturity dates. Should an investor require funds before maturity, they have the option to sell them through a broker in the secondary market. When this situation occurs, the investor may earn a capital gain or experience a capital loss, depending on whether the bond ends up being sold at a premium (above face value) or at a discount (below face value).

For example, if an investor bought a corporate bond yielding 7% and then the economy changed so that comparable bonds yielded 10%, the investor would have to lower their price on the original 7% bond until it also yielded the 10% market rate. Potential investors would not be very likely to buy the bond if they could simply buy a newly issued bond from an alternate issuer and receive a higher coupon rate.

It is equally possible that prevailing bond rates could fall and an investor could end up selling their bond at a higher price, thus earning a capital gain.

Bond Laddering as an Investment Strategy

There are several successful strategies for successful bond investments, but perhaps one of the most common yet ingenious of these strategies is called *bond laddering*. Bond ladders help investors achieve diversity in their portfolios and reduce risk while helping maintain regular cash inflows in the form of coupon payments or interest. In a bond ladder, an investor will divide their total investment dollars among various bonds that mature at regular intervals, thereby balancing risk and return. An example of a bond ladder would be to purchase 10 different bonds that have maturities of one year, two years, three years, and so on, all the way through to 10 years.

When the first bond matures, the investor will purchase a new bond that matures in 10 years to take its place in the ladder and continue the overall laddering strategy.

This strategy has several benefits. First, the shorter-term bonds in the ladder provide stability because they are less sensitive to risk than longer-term bonds. The longer-term bonds within the ladder will generally provide higher returns but with higher risk due to such factors as rising interest rates. So, by investing in bonds with different maturities and creating a bond ladder, investors can realize superior financial returns to what they would earn by only investing in short-term bonds. Also, the general level of risk from a bond ladder is reduced by the shorter-term component of the investment mix, making the bond ladder less risky than an investment that only included long-term bonds.

It is easy to see why bond laddering has become such a highly adopted bond investment strategy with investors ranging from novice to the most well-seasoned and experienced.

Interest Rate Movements and Bond Prices

We now know that when investors buy bonds, either directly or through mutual funds, they are lending money to bond-issuing firms or governments. In turn, issuers promise to pay back the principal (par or face value) when the loan is due at the bond’s maturity date.

Issuers also promise to pay bondholders periodic interest or coupon payments to compensate them for the use of their money over the term of the bond. The rate at which issuers pay investors, or the bond's stated coupon rate, is typically fixed at the time of issuance.

We have also covered the concept that bond values have an inverse relationship with interest rates. As interest rates rise, bond prices fall, and when interest rates fall, bond values increase. Movement of interest rates can have a dramatic effect on a bond's value and presents the typical bondholder with a number of different financial risks that we have described in detail.

Also in this chapter, we have discussed how bond values can be estimated through the use of several different factors. Prevailing interest rates are among the most critical of these, but also important are factors such as maturity periods, the taxability of bond interest, the credit standing of bond issuers, and the likelihood of **bond call**, or issuers paying off their debt early.

When considering purchasing bonds or any such fixed-income investment, investors should remain aware that interest rates are always in a state of flux and can change at any time. The movements of bond values and bond yields will be significantly affected by these changes and can be favorable or unfavorable for any investor.

10.5 Using Spreadsheets to Solve Bond Problems

Learning Outcomes

By the end of this section, you will be able to:

- Demonstrate bond valuations using Excel.
- Demonstrate bond yield calculations using Excel.

Calculating the Price (Present Value) of a Bond

The following examples illustrate how Microsoft Excel can be used to calculate common bond problems. Please be sure to refer to the chapters on the time value of money for examples of using spreadsheets to solve present value problems, as these same concepts are also used in solving bond problems.

You can use the following steps in Excel to determine the price or present value of a coupon bond. Suppose that a bond has a par or face value of $1,000, pays coupons semiannually at a 4% annual rate, and matures in 15 years. We can assume a YTM rate of 5%.

1. First, select Formulas from the Excel upper menu bar, and from the dialog box, select PV (see Figure 10.11).

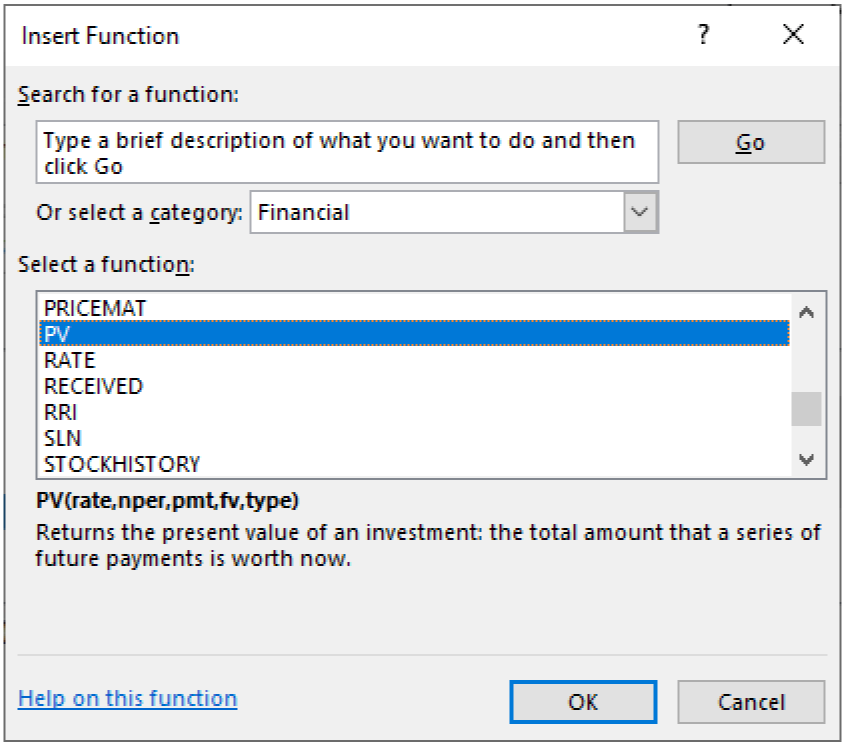

Figure 10.11 Using Excel to Enter a PV (Present Value) Function

2. When the PV function is selected, another dialog box will appear (see Figure 10.12). It is here that the function variables, or arguments, will be entered. It is preferable to use cell addresses to refer to these arguments so that the spreadsheet can be easily used again if inputs/arguments change.

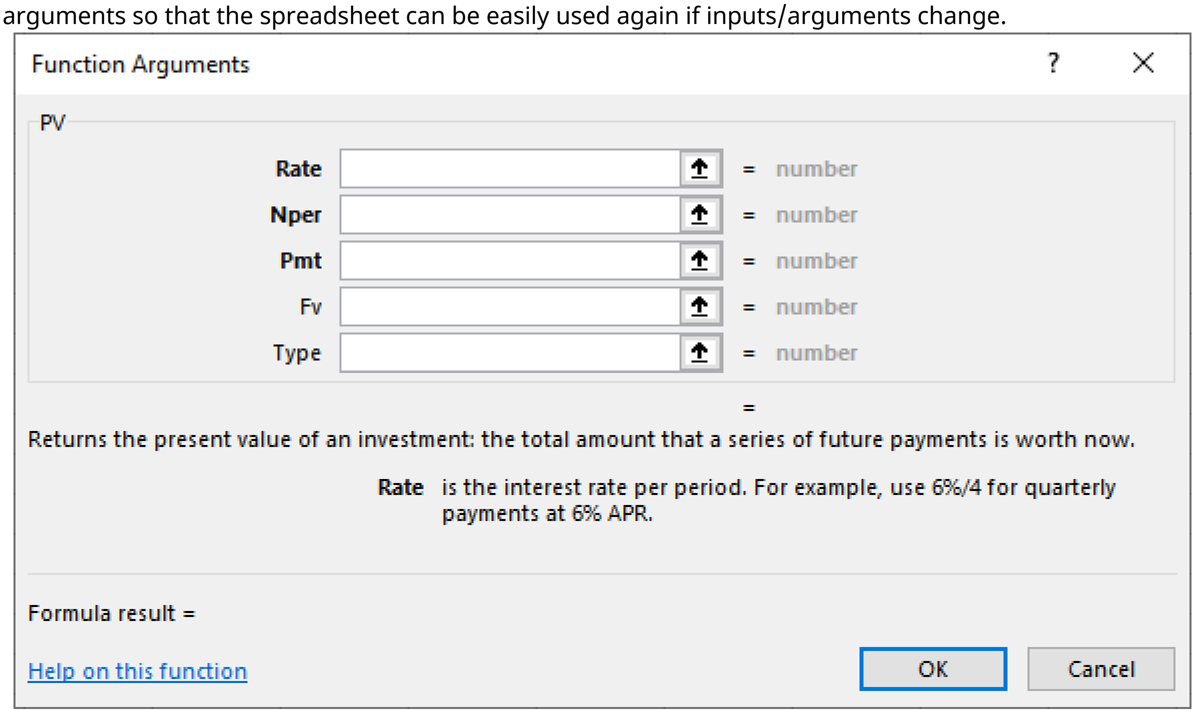

Figure 10.12 Function Arguments Dialog Box

3. Enter the function inputs or arguments (see Figure 10.13). We refer to the cell addresses as per our example spreadsheet.

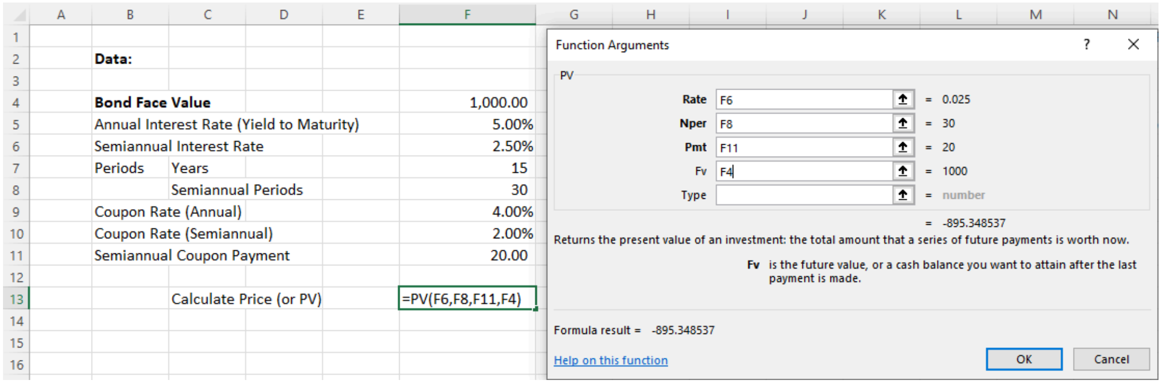

Figure 10.13 Completed Data Entry Menu

Note that the result, the price or present value, will appear in the bottom left section of the Function Arguments box once the arguments are entered. It will appear as a negative value because of the sign convention and because the bond face value in cell F4 was entered as a positive value.

Calculating the Yield to Maturity (Interest Rate) of a Bond

Use the following steps in Excel to determine the YTM (interest rate) of a bond. Assume that you want to find the YTM of a $1,000, 3.5% bond with annual coupon payments that is selling for $675.00 and will mature in 12 years.

1. First, select Formulas from the Excel upper menu bar, and from the dialog box, select Rate (see Figure 10.14).

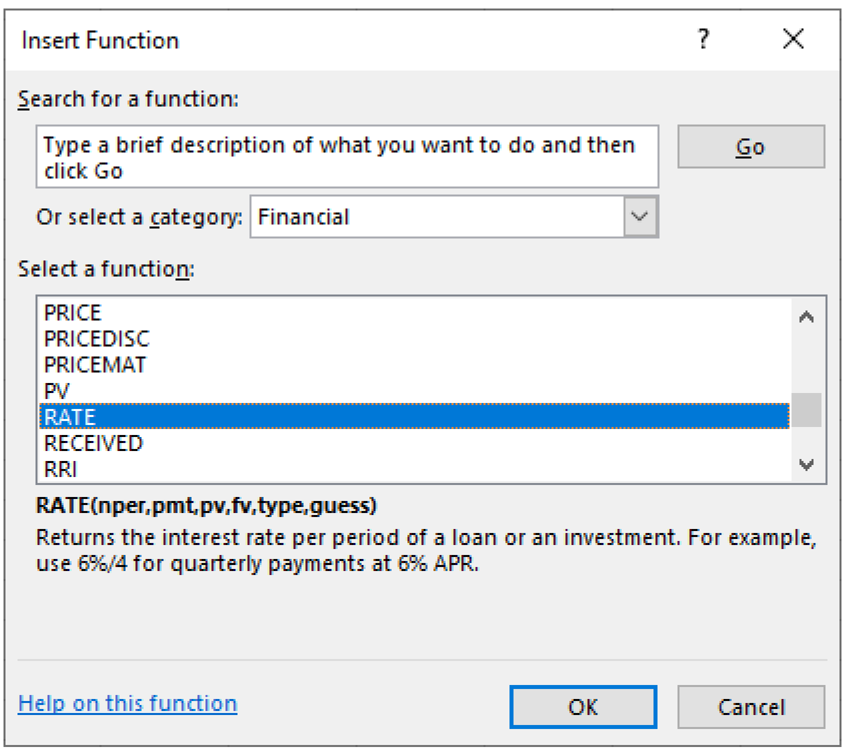

Figure 10.14 Using Excel to Enter a Rate Function

2. After the dialog box appears, enter the variables or arguments. As with our earlier example, we will use the preferred method of identifying the arguments with cell addresses (see Figure 10.15).

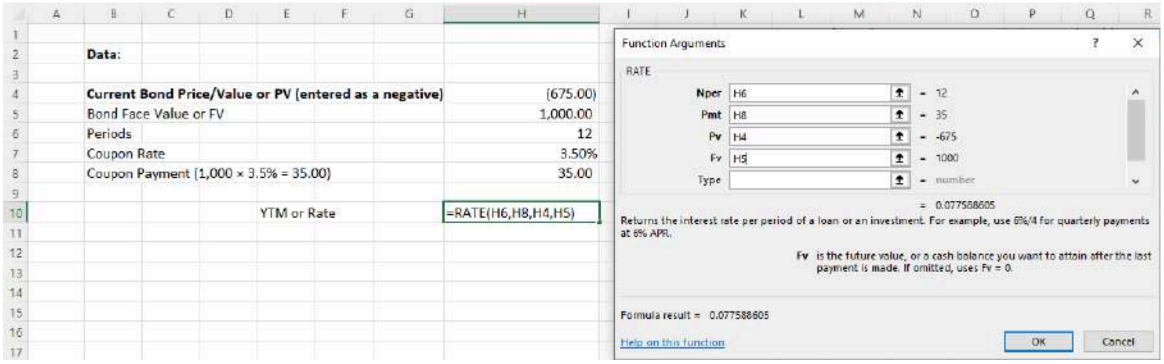

Figure 10.15 Completed Data Entry Menu

3. Again, after all arguments are entered through their correct cell references, the answer will appear in the lower left corner of the box. Once satisfied with the result, you can hit Enter to insert this final calculated value in your spreadsheet. This has been set up in this sheet in cell H10.

THINK IT THROUGH

Calculating a Coca-Cola Bond to Maturity

Earlier, we covered how a financial calculator could be used to determine the YTM of our Coca-Cola bond example. If we wanted to use an Excel spreadsheet to perform this calculation instead of a calculator, we would set up our spreadsheet as shown in the steps below. The current bond price, entered as a negative, is ($952.06). The bond face value of FV is $1,000; the time period is $7 \text{ years} \times 2$, or 14 semiannual periods; the coupon rate is $\frac{1\%}{2}$, or 0.05%; and the coupon payment is $5.00.

1. First, select Formulas from the Excel upper menu bar, and from the dialog box, select Rate (see Figure 10.16).

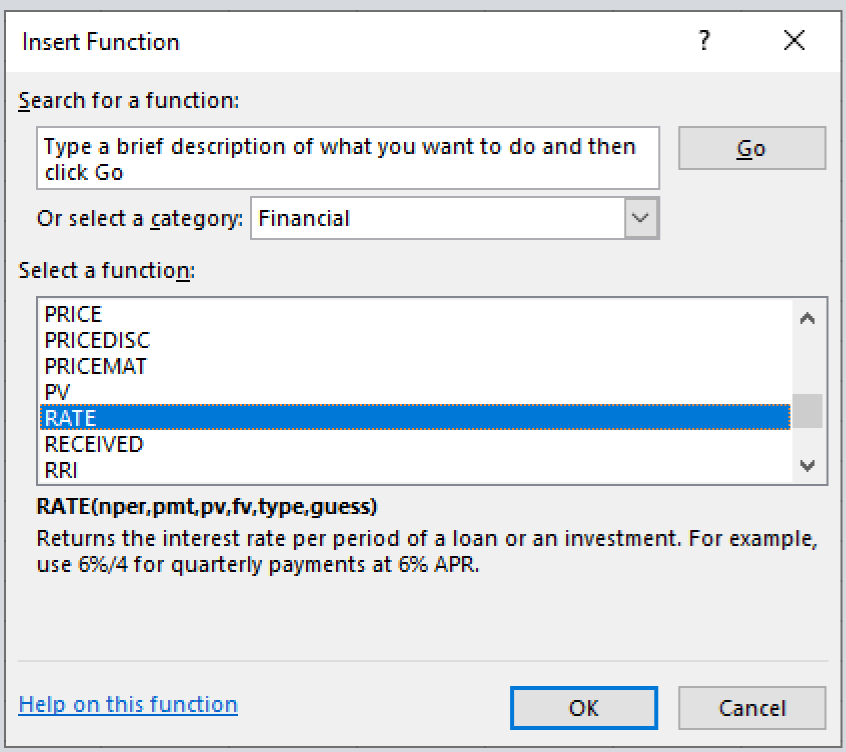

Figure 10.16 Using Excel to Enter a Rate Function

2. After the dialog box appears, enter the variables or arguments. As with our earlier examples, we will use the preferred method of identifying arguments with cell addresses (see Figure 10.17).

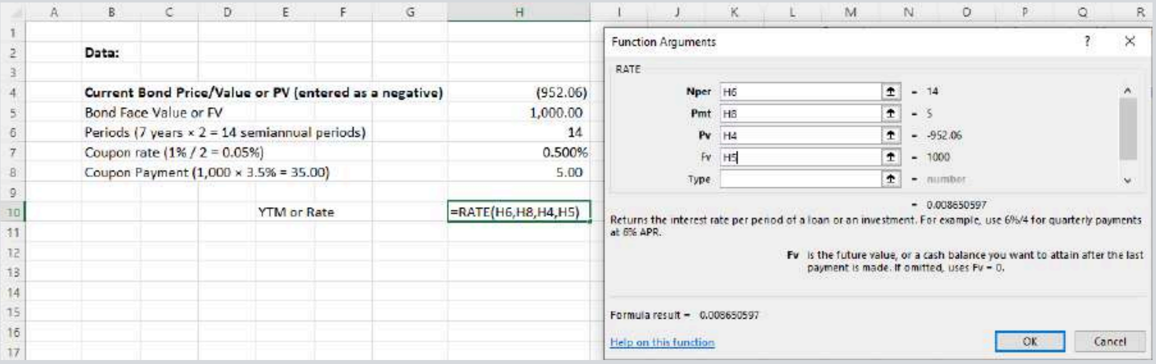

Figure 10.17 Completed Data Entry Menu

3. Again, after all arguments are entered through their correct cell references, the answer will appear in the lower left corner of the box. Once satisfied with the result, you can hit Enter to insert this final calculated value into your spreadsheet. This has been set up in this sheet in cell H10.

As noted above, remember that this is a semiannual rate because it was calculated using semiannual coupon payments and periods. To express it as an annual YTM rate, you must multiply it by 2.

Calculating the Maturity Period (Term) of a Bond

You can use the following steps in Excel to determine the maturity period or term of a bond. Assume that you are considering investing in a bond that is selling for $820.00, has a face value of $1,000, and has an annual coupon rate of 3%. If the YTM is 10%, how long will it be until the bond matures?

1. First, select Formulas from the Excel upper menu bar, and from the dialog box, select Nper (see Figure 10.18).

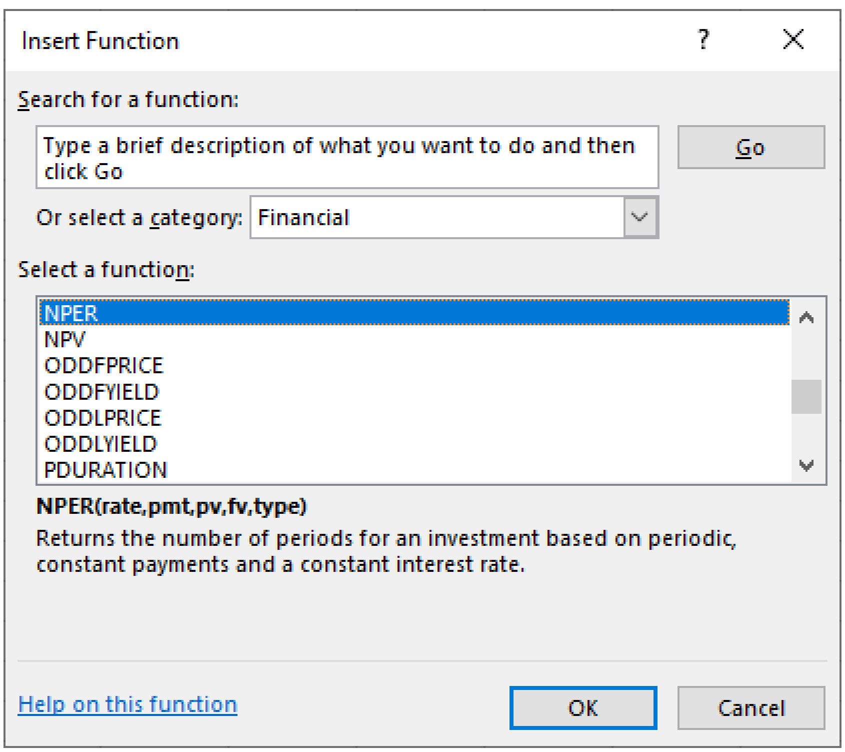

Figure 10.18 Using Excel to Calculate Bond Time to Maturity

2. When the dialog box appears, enter function arguments (see Figure 10.19). Once again, we will use the preferred method of using cell addresses as reference points.

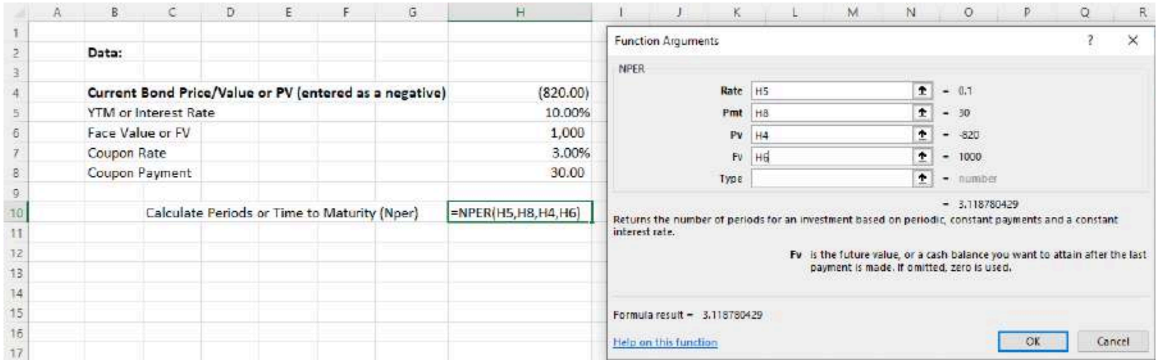

Figure 10.19 Completed Data Entry Menu

3. When arguments have all been entered, the answer will appear in the lower left of the Function Arguments box, as per the above. We arrive at a final answer of 3.12 years until this bond matures.

Calculating Coupon Rate and Interest (Coupon) Payments

Here is how you would determine the coupon or interest rate and coupon payment using Excel. Assume a $1,000 face value bond is selling for $595, has 20 years until it matures, and has a YTM of 6.5%. What are the coupon rate and the periodic coupon payment amount of the bond?

1. First, select Formulas from the Excel upper menu bar, and from the dialog box, select PMT (see Figure 10.20).

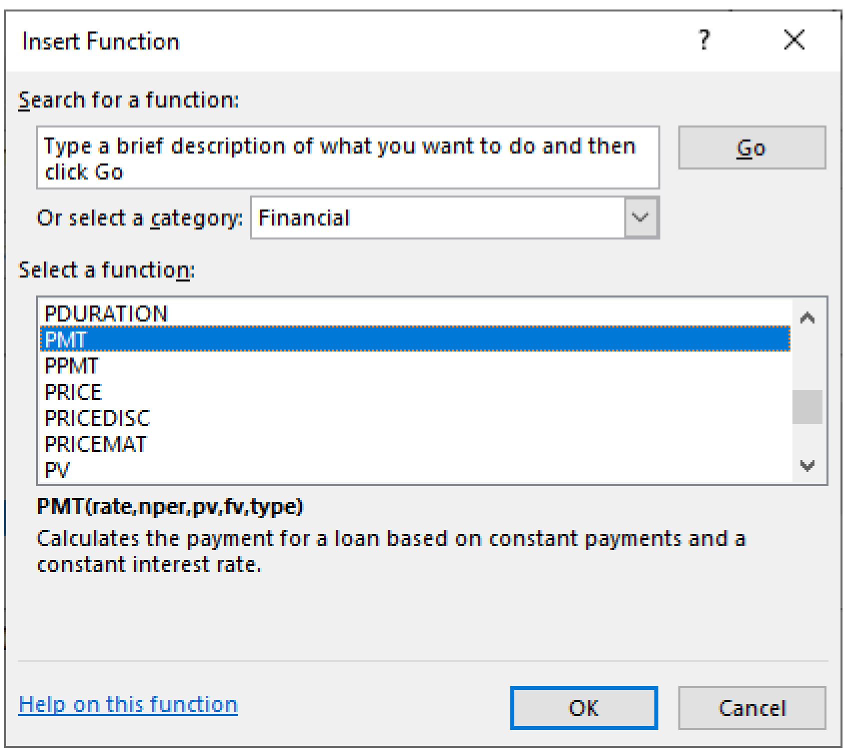

Figure 10.20 Using Excel to Enter a PMT or Payment Function

2. When the dialog box appears, enter function arguments. Once again, we will use the preferred method of using cell addresses as reference points (see Figure 10.21).

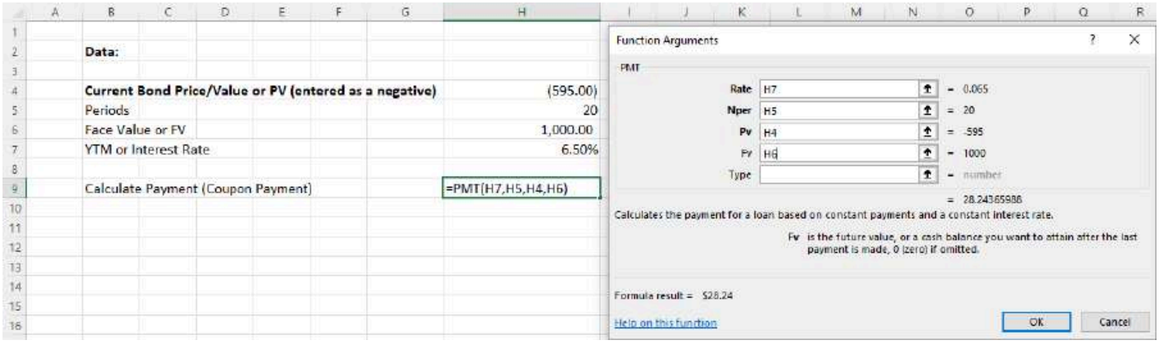

Figure 10.21 Completed Data Entry Menu

3. When arguments have all been entered, the answer will appear in the lower left of the Function Arguments box, as per the above. We arrive at a final answer of $28.24 as the coupon payment.

The coupon rate can be calculated by taking this coupon payment amount and dividing it by the face value:

$$\frac{\$28.24}{\$1{,}000} = 2.824\%$$

So, the coupon rate is 2.824%.

Summary

10.1 Characteristics of Bonds

Bonds are typically a basic form of investment that entails a straightforward financial agreement between issuer and purchaser. There are three primary categories of bonds: government bonds, corporate bonds, and convertible bonds. These different types of bond vary depending on their issuer, length until maturity, interest rate, and risk.

10.2 Bond Valuation

It is important to ascertain what a given bond is worth to a willing buyer and a willing seller. We can price a bond using an equation, a calculator, or a spreadsheet. The essential steps are (1) identify the amount and timing of the future cash flow; (2) determine the discount rate; (3) find the present values of the lump sum principal and the annuity stream of coupons; and (4) add the present value of the lump sum principal and the present value of the coupons.

10.3 Using the Yield Curve

When interest rate yields are plotted against their respective maturity periods and these plotted points are connected, the resulting line is called the yield curve. The yield curve is a graphical representation of the term structure of interest rates. A yield curve always shows the value of yields (rates) on the *y*-axis and maturities or time periods on the *x*-axis.

10.4 Risks of Interest Rates and Default

Because bonds are fixed-income investments, they are subject to a number of risks that could have negative effects on their market value. The most common and best-known risks are interest rate risk and default risk, but there are some others risks that should be understood, such as credit risk, liquidity risk, duration risk, call risk, investment risk, and term risk. To assist potential bond investors in understanding some of these risks, bond ratings have been developed and are regularly published by a number of organizations to express their assessment of the risk quality of various bond issues.

10.5 Using Spreadsheets to Solve Bond Problems

Microsoft Excel can be used to solve common bond problems. It can be used to calculate the value of a coupon bond, the yield to maturity (interest rate) of a bond, the maturity period of a bond, and the coupon rate and interest (coupon) payments of a bond.

Key Terms

bond call a feature of certain bonds or other fixed-income instruments that allows the issuer to repurchase and retire these instruments before maturity

bond price the present, discounted value of the future cash stream generated by a bond; the sum of the present values of all likely coupon payments and the present value of the par value at maturity

bond ratings grades assigned to bonds by rating services that indicate their overall credit quality

Business Cycle Dating Committee a subdivision of the National Bureau of Economic Research (NBER), the US government agency that maintains a chronology of US business cycles

call risk the risk that a bond issuer will redeem a callable bond prior to maturity

capital gains the increase in a capital asset’s value that is realized when the asset is sold

cash rate the interest rate that a central bank, such as the Reserve Bank of Australia or the US Federal Reserve System, will charge commercial banks for loans; also known as the bank rate or the base interest rate

convertible bonds fixed-income corporate debt securities that yield interest payments but can be converted into a predetermined number of common stock or equity shares

coupon payment the periodic dollar value of interest that is paid to a bondholder by the bond issuer
coupon rate the amount of annual interest paid by the bond issuer; is multiplied by the face value of a bond to determine annual interest or coupon payment amounts
credit risk the risk taken by a bond investor that the bond issuer will default by failing to pay interest and repay the principal on schedule
deep discount bonds bonds that sell at significantly lower values than their par values
default when an issuer fails to make scheduled interest or principal payments on its bonds
default risk the risk taken by investors that payments will be delayed or will not occur
discount bond a bond currently trading for less than its par value in the secondary market; offers a coupon rate that is lower than prevailing interest rates
duration a measure of how much bond prices are likely to change if and when interest rates move
duration risk the risk associated with the sensitivity of a bond's price to a 1% change in interest rates
Federal Reserve funds rate (federal funds rate) the target interest rate, set by the Federal Reserve, at which commercial banks borrow and lend their excess reserves to each other
Federal Reserve System (the Fed) the central banking system of the United States, responsible for administering fiscal policy for the country
fixed-income securities investments that provide a return in the form of fixed, periodic interest payments and the eventual return of principal at maturity; the most common forms are bonds
floating-rate bonds bonds with variable interest rates that allow investors to benefit from rising interest rates
interest income annual interest amounts paid, or coupon payments made, on a bond between its issue date and the date of maturity
interest rate risk the risk of investment losses that result from changes in interest rates
investment grade describes a municipal or corporate bond with a rating that indicates it presents a low risk of default
junk bonds bonds that have been given a low credit rating, below investment grade; riskier than other bonds due to a greater chance that the issuer will default or experience a credit event
liquidity risk risk that stems from the lack of marketability of an investment, meaning that it cannot be bought or sold quickly enough to prevent or minimize a loss
London Interbank Offered Rate (LIBOR) a benchmark interest rate at which major global banks lend to one another in the international interbank market for short-term loans
maturity date the date on which a bondholder ceases to receive interest payments on a bond investment and instead is repaid its par, or face, value
municipal bonds ("munis") debt securities issued by state and local governments; can be thought of as loans that investors make to local governments to fund infrastructure
par value also called the face amount or face value; the value written on the front of the bond, which is the amount of money that bond issuers promise to be paid at maturity
premium bond a bond that is trading above its par value in the secondary market; offers a coupon rate that is higher than the current prevailing interest rates being offered
prime rate the interest rate that banks charge creditworthy corporate customers; among the most widely used benchmarks for setting home equity lines of credit and credit card rates, based on the federal funds rate set by the Federal Reserve
rating agencies (bond rating services) independent service agencies, such as Fitch, Moody's, or Standard & Poor's, that perform the isolated function of credit risk evaluation
realized return the actual return that an investor earns over a given time period through the buying and selling of a security
reinvestment risk the risk that an investor will be unable to reinvest cash flows received from an investment (e.g., coupon payments or interest) at a rate comparable to their current rate of return
savings bonds debt securities purchased by investors, as a personal investments or as gifts, that the US government issues to pay for certain public or government programs

term risk the risk of potentially earning lower returns on longer-term bond holdings compared to those potentially available when making several shorter-term investments over the same period of time

US Treasury bills (T-bills) short-term US government debt obligations backed by the Treasury Department with a maturity of one year or less

US Treasury note rate the interest rate that the US government pays to borrow money for different lengths of time; notes are issued in terms of two, three, five, seven, and 10 years

yield curve a line that plots yields (interest rates) of bonds having equal credit quality but differing maturity dates; gives an idea of future interest rate changes and economic activity

yield to maturity (YTM) the total return anticipated on a bond if the investment is held until maturity

zero-coupon bonds bonds that are issued at a deep discount from face value and offer no interest or coupon payments

CFA Institute

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Multiple Choice

1. When solving bond problems relating to a bond that pays interest on a quarterly basis, the _______ before being applied.
   a. quoted annual yield to maturity should be multiplied by 4
   b. quoted number of years until maturity should be divided by 4
   c. quoted annual coupon payments should be divided by 4
   d. stated face value should be divided by 4

2. Which of the following is NOT an adjustment that must be made when interest is paid semiannually instead of annually?
   a. Dividing the annual coupon payment by 2
   b. Dividing the annual interest rate by 2
   c. Dividing the total number of years by 2
   d. Dividing the annual yield to maturity by 2

3. Which of the following is NOT considered a factor that influences a bondholder’s required rate of return?
   a. Financial risk
   b. Other investments by the bondholder
   c. Risk premium
   d. Business risk

4. How might an investment in a bond fund be affected by a decline in interest rates?
   a. The fund investment would not be affected.
   b. The fund investment would likely decrease in value.
   c. The fund investment would likely increase in value.
   d. Coupon payments from bonds in the fund would decline.

5. Interest rates and bond prices _______.
   a. are unrelated
   b. have an inverse relationship
   c. have a direct relationship
   d. are both economic factors set by central banks

6. The coupon rate of a bond is typically _______.
a. fixed at the time of bond issuance
b. subject to change based on the federal funds rate
c. zero in the case of zero-coupon bonds
d. Both A and C

7. A zero-coupon bond is a bond that _______.
a. has no value
b. has no periodic coupon payments
c. has been rated below investment grade
d. Both A and C

8. A bond that has a coupon rate less than prevailing interest rates will _______.
a. sell at par value
b. sell at a discount
c. sell at a premium
d. be overpriced

9. Determining bond prices often involves using which two TVM (time value of money) equations?
a. The future value of a lump sum and the present value of a lump sum
b. The present value of an annuity and the future value of a lump sum
c. The future value of an annuity and the present value of a lump sum
d. None of the above

10. A normal yield curve will _______.
a. slope downward as it moves along its *x*-axis (term).
b. slope upward as it moves along its *x*-axis (yield).
c. fluctuate depending on the federal funds rate
d. slope upward as it moves along its *x*-axis (term).

11. An inverted yield curve is an indication that _______.
a. long-term yields and interest rates are higher than short-term rates
b. the economy is in the process of a significant recovery
c. short-term yields and interest rates are higher than long-term rates
d. the yields to maturity on all bonds are less than market interest rates

12. Bond laddering is _______.
a. a risky bond investment strategy that may yield tremendous returns
b. a strategy in which bonds with several different maturity periods are added to a portfolio
c. a strategy that involves replacing equity investments with bonds in a portfolio
d. a bond strategy that sacrifices diversity for potential capital gains

13. A call feature _______.
a. is desirable to an investor
b. may cause additional risk for the bond issuer
c. may cause additional risk for an investor
d. Both A and B

14. The duration of a bond is _______.
a. a measurement of the bond's overall risk

b. synonymous with the bond’s term
c. a measurement of how long an investor holds the bond
d. a measurement of the bond’s sensitivity to interest rate changes

Review Questions

1. What is a junk bond?
2. Briefly describe interest income within the context of bond investments.
3. Briefly describe the two types of cash flow that a bondholder will receive from the issuer.
4. What is an inverted yield curve, and what is its significance?
5. Describe reinvestment risk for a bondholder.

Problems

1. A $1,000 Expo Corp. bond has a coupon rate of 5%, pays interest semiannually, and matures in six years. If the yield to maturity is 7%, what is the bond’s value today?
2. A $1,000 Omega Corp. bond has an 8% coupon rate that is paid semiannually. The bond matures in three years. If the current price of the bond is $1,125, what is the yield to maturity?
3. You are considering buying a bond that is currently priced at $830, has a face value of $1,000, and matures in seven years. If interest is paid semiannually and the bond has a yield to maturity of 6%, what is the bond’s annual coupon rate?
4. A $1,000 Noah Corp. bond has a coupon rate of 5% with semiannual payments, matures in 10 years, and has a yield to maturity of 6.5%. What is the bond’s current price?
5. Chronowerx Inc. has issued a bond that has a face value of $1,000, a 3% coupon rate (with semiannual interest), and a maturity date four years from now. If the bond’s current price is $895, what is its yield to maturity?
6. You are considering adding a $1,000, 25-year bond to your portfolio. It has a coupon rate of 8%, which is paid annually, and your required return is 10%. What is the current price of the investment?
7. A Cameron Corp. bond has a $1,000 par value, a 5 percent coupon rate paid semiannually, and nine years until maturity. If similar investments yield 6%, what is the current value of Cameron Corp. bonds?
8. McLaren Motors just issued a series of $1,000.00 bonds with a 10-year maturity and an 8% coupon rate, paid quarterly. If you purchase a McLaren bond at a price of $920.00, what is your required rate of return?
9. Three years ago, Petty Partners Inc. issued 15-year, $1,000 bonds that are currently priced at $911.37. If the prevailing rate of return on similar investments is 5%, what is the coupon rate on Petty Partners bonds, and what is the annual interest payment?
10. A $1,000 Riker Corp. bond has a 20-year maturity and a 6% coupon rate, with interest paid annually. If similar bonds from Riker Corp. are yielding 4%, what is the current market value of the Riker issue?
11. A $1,000 bond that matures in eight years, has quarterly coupon payments of $25, and is currently priced at $962.00 will have a yield to maturity of ________.

Video Activity

Using TI BA II+ to Price a Bond

Click to view content (https://openstax.org/r/ti-ba-pricing-bond)

1. If you are provided with annual information in a bond problem, which bond variables must be adjusted to accommodate semiannual compounding periods, and how must they be adjusted? Review the video to follow along as this information is provided.

2. Following the instructions laid out in the video, practice using a calculator to find the price of a bond under two scenarios. The first scenario should be when compounding periods are annual, or once a year, and the second scenario should be when compounding periods are semiannual, or once every six months.

   Start out this exercise with the bond factor input variables that are used in the video: par value of $1,000, annual coupon rate of 4%, time to maturity of 10 years, and yield to maturity of 8%. Calculate the current value or price of the bond under both of the different compounding period scenarios.

   Once you have arrived at the same results demonstrated in the video, practice calculating prices using different bond factor variables for inputs, changing time or years to maturity, coupon rate (and coupon payments), and yield to maturity until you are completely confident using a financial calculator to find the price or value of any bond.

Bond Pricing, Valuation, Formulas, and Functions in Excel

Click to view content (https://openstax.org/r/bond-pricing-valuation)

Review the examples included in this video, and practice setting up spreadsheets that solve for each of the five primary bond variables using the values in the videos (maturity 10 years, coupon rate 10%, coupon payment $100, yield to maturity 8%, and par value $1,000). Parallel the spreadsheets that are set up in the video, ensuring that you arrive at the same results for each bond variable amount.

3. Name and describe the five primary bond variables that can be solved using Excel spreadsheets.

4. What are the Excel functions that allow you to perform these calculations, and where in the standard Excel spreadsheet are they located?

11 Stocks and Stock Valuation

Figure 11.1 In addition to bonds, corporations will often issue common stock as a means of raising necessary capital to finance future operations. (credit: modification of “New York Stock Exchange Huge US Flag Photo i018” by Grant Wickes/flickr, CC BY 2.0)

Chapter Outline

Why It Matters

Similar to bonds, shares of **common stock** entitle investor owners to a portion of a company’s future earnings and cash flows. However, stocks differ significantly from bonds in how they are issued and managed by companies, the methodology used to calculate their values in public markets, and how they can generate income and eventual value for individual investors.

With common stock, there is no specific promise of how much cash investors will receive or when they will receive it. This differs from bond investments, which are valued entirely on the basis of their guaranteed timing of future cash flows to bondholders.

This means that with stocks, there are no maturity dates, face values, or coupon payment guarantees. It also means that stocks do not promise any specified cash flows in the form of coupons or a face value payment at some point in the future. Instead, stocks (only some, not all) may pay dividends. These dividends are declared after shares of stock have been issued by a company and then purchased by the investing public. Following a dividend declaration, the designated per-share amounts are paid to shareholders of record on a specified date, also determined by a company’s board.

Because stock investments carry no guarantee of payments to investors, they are far riskier than bonds and other forms of fixed-income investments.

While there are many reasons for an investor to choose to purchase common stock, three of the most common reasons are

- to use stocks as instruments or repositories for maintaining value;
- to accumulate wealth over the term of the stock investment; and
- to earn income through capital gains and dividend payments.

As with any financial instrument, common stock purchases offer advantages and disadvantages to investors. Important advantages include the following:

- Returns through dividends and price appreciation of shares can be substantial.
- Stocks are a liquid form of investment and can be bought or sold within **secondary markets** relatively easily.
- Information about companies, markets, and important trends are widely published and readily available to the investing public.

These advantages are significant and lead many individuals to move into stock investments. Yet it is important to realize that stock has some significant disadvantages, which can include the following:

- General risk levels are greater than with bonds or other fixed-income investments.
- Timing the buy-and-sell transactions of stock can be tricky and may lead to losses or not taking full advantage of share price opportunities.
- Dividends (provided that the stock does indeed pay them, as not all do) are uncertain and subject to change based on decisions of company management.

We will discuss these topics in this chapter and cover many of the details regarding why corporations issue common stock and why investors purchase that stock.

11.1 Multiple Approaches to Stock Valuation

Learning Outcomes

By the end of this section, you will be able to:

- Define and calculate a P/E (price-to-earnings) ratio given company data.
- Determine relative under- or overvaluation indicated by a P/E (price-to-earnings) ratio.
- Define and calculate a P/B (price-to-book) ratio given company data.
- Determine relative under- or overvaluation indicated by a P/B (price-to-book) ratio.
- Define and detail alternative valuation multipliers, including P/S (price-to-sales) ratio, P/CF (price-to-cash-flow) ratio, and dividend yield.

The Price-to Earnings (P/E) Ratio

Experienced investors use a number of different methods to evaluate information on companies and their common stock before deciding on any potential purchase. One of the most popular techniques used by investors and analysts is to study a company’s financial statements in order to uncover basic fundamental information on the company. This involves calculating a number of financial ratios that help identify trends, bringing elements of operational performance to light and allowing for clearer analysis and evaluation.

A well-proven analytical approach for investors to use in evaluating common stock is to review the overall market value of the company that issues a stock. One of the most consistently used calculations in this analysis, which has important applications in company and common stock evaluation, is the **price-to-earnings (P/E) ratio**.

The P/E ratio is computed using the following formula:

$$\text{P/E Ratio} = \frac{\text{Price per Share}}{\text{Earnings per Share}}$$

The P/E ratio is extremely useful to analysts in that it shows the expectations of the market. Essentially, the P/E ratio is representative of the price an investor must pay for every unit of current (or future) corporate earnings.

Bottom-line earnings are a critical factor in valuing common stock. Investors will always want to know how profitable a company is now as well as how profitable it will be in the future. When a company's bottom line remains relatively flat over a period of time, leaving **earnings per share (EPS)** relatively unchanged, the P/E ratio can be interpreted as the payback period for the original amount paid for each share of common stock.

For example, the common stock price of Cameo Corp. is currently at $24.00 a share, and its EPS for the year is $4.00. Cameo's P/E ratio is calculated as

$$\text{P/E}_{\text{Cameo}} = \frac{\$24.00}{\$4.00} = 6$$

This ratio would typically be expressed in the form $6\times$. Essentially, this means that investors are willing to pay up to six dollars for every one dollar of earnings. It can also be stated that Cameo stock is currently trading at a multiple of six.

The P/E ratio is typically expressed in two primary ways. The first is as a metric listed by most finance websites and often carries the notation *P/E (ttm)*. This refers to the Wall Street acronym for "trailing 12 months" and signals the company's operating performance over the past 12 months.

Another form of the P/E ratio is known as the forward (or leading) P/E. This uses future earnings projections rather than actual trailing amounts. The leading P/E, sometimes called the *estimated price to earnings*, is useful for comparing current earnings to future earnings and helps provide a clearer picture of what earnings may look like, assuming there are no major changes in the company's operations or accounting treatments.

Referring back to our calculation for Cameo Corp. above, because the current EPS was used in the calculation, this ratio would be classified as a trailing P/E ratio. If we had used an estimated or projected EPS as the denominator in the calculation, it would then be considered a leading P/E ratio.

Analyzing a company's P/E ratio alone or within a vacuum will actually tell an analyst very little. It is only when a company's P/E is compared to historical P/E ratios or the P/E ratios of other companies in the same industry that it becomes a useful tool for analysis. One of the most important benefits of using comparative P/E ratios is that they can standardize stocks with different prices and various earnings levels.

Generally speaking, it is very difficult to make any conclusions about a stand-alone **stock value**, such as whether a stock that has a ratio of $8\times$ is a good buy at its current price or if a stock with a P/E ratio of $35\times$ is too expensive, without performing any relevant comparisons or further analysis.

Analysts have many different ways to interpret P/E ratio data. One of the most common interpretations is that firms with high P/E ratios should be growth companies. Also, a high P/E ratio could mean that a stock's price is high relative to earnings and possibly overvalued. This could signal a possible undesired downward adjustment in market price in the future.

We can extrapolate from the argument above to put forward the idea that stocks with low P/E ratios should be stabler, more mature organizations. A low P/E might indicate that the current stock price is low relative to earnings and that there may be an opportunity to take advantage of upward price movements and potential investment gains through stock price appreciation.

While this information is often very useful for evaluating stocks and making investment decisions, caution must always be used, as a current stock price may simply be out of line with the company's earning potential, which would mean that price adjustments are likely to occur in the short term. This is why experienced analysts and investors will use multiple evaluation techniques when conducting stock analysis and evaluation and not rely solely on insights provided by a single set of facts or one form of statistical measurement.

The Price-to-Book (P/B) Ratio

Another financial ratio commonly used by investors and analysts is the **price-to-book (P/B) ratio**, also called the market-to-book (M/B) ratio. This is a financial metric used to evaluate a company's current market value relative to its book value.

The market value, or **market capitalization**, of a company is defined as the current price of all its outstanding shares of common stock. This is essentially equal to the total value of the company as perceived by the market. For all intents and purposes, the book value is representative of the residual of a company after it has liquidated all assets and paid off all of its liabilities.

Book value can be determined by performing some financial analysis on a company's balance sheet. Essentially, analysts will use the P/B ratio to compare a business's available net assets relative to the current sales price of its stock. The price-to-book-value ratio formula is

$$\text{P/B Ratio} = \frac{\text{Market Price per Share}}{\text{Book Value per Share}}$$

One of the primary uses of the P/B ratio is to understand market perceptions of a particular stock's value. It is often the metric of choice for evaluating financial services firms such as real estate firms, insurance companies, and investment trusts. The P/B ratio has a notable shortcoming, however, in that it does not evaluate companies that have a high level of **intangible assets** such as patents, trademarks, and copyrights.

Ultimately, this ratio will tell an analyst exactly how much potential investors are willing to pay for each dollar of asset value. The PB(M/B) ratio is computed by dividing the current closing price of the stock by the company's current book value per share, which is calculated by either of the following two equations:

$$\text{P/B Ratio} = \frac{\text{Market Capitalization}}{\text{Net Book Value}}$$
$$\text{P/B Ratio} = \frac{\text{Price per Share}}{\text{Net Book Value per Share}}$$

Net book value is equal to net assets, or the total assets minus the total liabilities of the company.

Analysts often consider a low P/B ratio (less than 1) to indicate that a stock is undervalued and a higher ratio (greater than 1) to mean that a stock is overvalued. A low ratio may be an indication that something is wrong with the company or that an investor may be paying too much for any residual value should the company be liquidated.

However, many market experts will argue the exact opposite of the above interpretations. Because of these discrepancies in interpretation and overall variance of opinion, the use of alternate stock valuation metrics, either in addition to or in place of the P/B ratio, is always worth exploring.

In conclusion, the P/B ratio can help a company understand if its net assets are comparable to the market price of its stock. However, as with the P/E ratio, it is always a good idea to compare P/B ratios of companies within the same industry and use them in conjunction with other metrics and analytical methodologies.

LINK TO LEARNING

Price-to-Earnings Ratio and Price-to-Book Ratio

Two videos cover the price-to-earnings (P/E) ratio (https://openstax.org/r/price-to-earnings) and the price-to-book (P/B) ratio (https://openstax.org/r/price-to-book_ratio). These are excellent introductory videos that will provide you with helpful information on what these ratios represent and how they can be used in stock valuation.

Alternative Multipliers

There are two main types of valuation metrics multiples used to value common stock. These are **equity multiples** and **enterprise value (EV) multiples**. Additionally, there are two primary methods by which to perform analysis using these multiples. These methods are **comparable company analysis (comps)** and **precedent transaction analysis (precedents)**.

Experienced financial analysts advocate the use of multiples in valuation analysis for a number of reasons, the most important being that they help generate realistic and sound judgments of enterprise values (total company values), they are relatively easy to use and interpret, and they can provide helpful information on a company's overall financial condition when used appropriately.

However, it should be noted that simplicity may have some important disadvantages. When such complex information is reduced to a single equation or final value, it can easily be misunderstood, and the influence of important factors may be masked or lost in the evaluation process.

What's more, the calculation of multiples represents a snapshot in time for a firm and cannot easily show how a company grows or progresses. Thus, these calculations are only applicable to short-term analysis, not to long-term scenarios.

Equity Multiples

Equity multiples are especially useful for investment decisions when an investor aspires to minority positions in companies. Below are some common equity multiples used in valuation analyses.

The price-to-earnings (P/E) ratio, which we discussed earlier, is probably the most common equity multiple used in stock valuation because it is relatively simple to calculate and all necessary data are easily accessible by analysts and investors. The market-to-book (M/B), or price-to-book (P/B), ratio is also useful if assets primarily drive a company's earnings. Again, it is computed as the proportion of share price to book value per share.

Dividend yield is another form of equity multiple and is primarily used when conducting comparisons between cash returns and investment types. Dividend yield is computed as the proportion of **dividend** per share to share price. The **price-to-sales (P/S) ratio** is an additional metric used for firms that are experiencing financial losses. The P/S ratio is often used for quick estimates and is computed as the proportion of share price to sales (or revenue) per share.

Another useful metric is the **price-to-cash-flow (P/CF) ratio**. The P/CF ratio is used to compare a company's market value to its operating cash flow (or the company's stock price per share to its operating cash flow per share). This measurement is suitable only in certain cases, such as when a company has substantial noncash expenses (e.g., **depreciation** or **amortization**). In some situations, companies may have positive cash flows but still show a bottom-line loss due to large noncash expenses. The P/CF ratio is helpful for arriving at a less distorted view of such a company's value.

While these various metrics are important, a financial analyst must always consider that companies often operate under their own unique sets of circumstances that ultimately will influence many of these equity multiples.

Enterprise Value (EV) Multiples

The following are some common EV multiples used in valuation analyses:

Gordon growth model is as follows

$$\frac{\text{Enterprise Value}}{\text{Revenue}}$$

$$\frac{\text{Enterprise Value}}{\text{EBIT}}$$

$$\frac{\text{Enterprise Value}}{\text{EBITDA}}$$
$$\frac{\text{Enterprise Value}}{\text{EBITDAR}}$$

EV multiples take an increasingly important role when value decisions surround recent mergers and acquisitions. **Enterprise value (EV)** is a measurement of the total value of a company. Companies often believe that EV offers a more accurate representation of a firm’s total value than a basic market capitalization method. Generally, EV is perceived to offer an aggregate value of the firm as an enterprise, which is a more comprehensive measurement (see Figure 11.2).

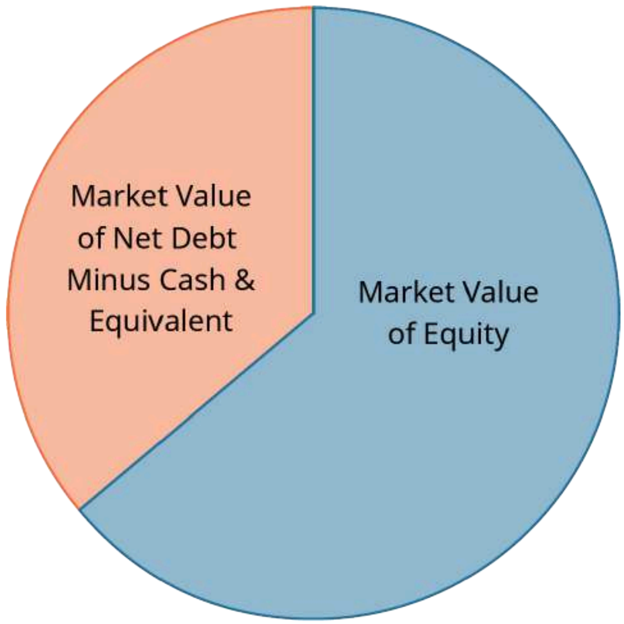

Figure 11.2 Enterprise Value: The Complete Picture

Following are two of the most common enterprise values metrics used in valuing companies and their common stock:

EV/Revenue (EV/R). Also called EV/Sales, EV/R is a valuation metric used to understand a company’s total valuation compared to its annual sales levels. EV/R can help provide an analyst with an idea of exactly how much investors pay for every dollar of a company’s sales revenue.

EV/R is considered a relatively crude metric but can be useful when analyzing companies that have different methods of revenue recognition. P/E ratios, for example, can be significantly affected by changes in the accounting policies of companies being evaluated. This is another reason why multiple metrics should be used in valuations.

Additionally, EV/R is a useful measure for companies that are consuming cash or experiencing financial losses. Such companies may be start-ups or emerging technology firms that have not fully matured and are still in a growth stage of development.

EV/EBIT. A firm’s earnings before interest and taxes (**EBIT**) is an indicator of its profitability before the effects of interest or taxes. EBIT is also referred to as operating earnings, operating profit, and profit before interest and tax.

- **EV/EBITDA.** EV/EBITDA is a ratio that compares a company’s enterprise value (EV) to its earnings before interest, taxes, depreciation, and amortization (EBITDA). EBITDA is often used by analysts as a substitute for cash flow and can be applied to capital analysis using tools such as net present value and internal rate of return. It is relatively easy to calculate, as all information required to compete the calculation is available from any publicly traded company's financial statements. Because of this, the EV/EBITDA ratio is a commonly used metric to compare the relative values of different businesses.

- **EV/EBITDAR.** Another form of valuation based on enterprise value is EV/EBITDAR. This metric divides enterprise value by earnings before interest, tax, depreciation, amortization, and rental costs (EBITDAR). This multiple is used in businesses that have substantial rental and lease expenses, such as hotel chains and airlines. Capital investment can differ significantly for these firms, and when assets are leased, these companies tend to have artificially lower debt and operating income compared to firms that actually own their assets.

EV/Capital Employed. The EV-to-**capital employed** ratio is a measure of enterprise value compared to the level of capital used by a business. For example, a business with a large capital basis is bound to carry a large enterprise value simply due to its large capital holdings.

Final Thoughts on Valuation Ratios and Multiples

There are many equity and enterprise value multiples used in company valuation, but the discussions above cover those that are most commonly used. In any case, gaining a thorough understanding of each multiple and its related concepts can help analysts make better use of these metrics in their stock analysis and valuation efforts. Also, as discussed, it is important that analysts and technicians use multiple ratios and alternate measures for any evaluation of a company and its common stock. Not doing so will limit the ultimate interpretation of the results, can lead to incorrect conclusions, and may cause fundamental mistakes in overall investment strategy.

LINK TO LEARNING

Graph of Historical P/E for S&P 500

Look at the 90-year historical average P/E ratio of the S&P 500 (https://openstax.org/r/90-year_historical_average_P/E). When viewing this information on historical P/E ratios, think about the following:

- Note that the general trend for historical P/E ratios has been one of growth.
- Note that in May 2009, the P/E ratio reached a staggering $123.73\times$, the highest ratio in US history. This was primarily due to depressed earnings during the Great Recession.

11.2 Dividend Discount Models (DDMs)

Learning Outcomes

By the end of this section, you will be able to:

- Identify and use DDMs (dividend discount models).
- Define the constant growth DDM.
- List the assumptions and limitations of the Gordon growth model.
- Understand and be able to use the various forms of DDM.
- Explain the advantages and limitations of DDMs.

The **dividend discount model (DDM)** is a method used to value a stock based on the concept that its worth is the present value of all of its future dividends. Using the stock's price, a required rate of return, and the value of the next year's dividend, investors can determine a stock's value based on the total present value of future dividends.

This means that if an investor is buying a stock primarily based on its dividend, the DDM can be a useful tool to determine exactly how much of the stock's price is supported by future dividends. However, it is important to understand that the DDM is not without flaws and that using it requires assumptions to be made that, in the end, may not prove to be true.

The Gordon Growth Model

The most common DDM is the **Gordon growth model**, which uses the dividend for the next year (D_1), the **required return** (r), and the estimated future dividend **growth rate** (g) to arrive at a final price or value of the stock. The formula for the Gordon growth model is as follows:

$$\text{Stock Value} = \frac{D_1}{r - g}$$

This calculation values the stock entirely on expected future dividends. You can then compare the calculated price to the actual market price in order to determine whether purchasing the stock at market will meet your requirements.

LINK TO LEARNING

Dividend Discount Model

Watch this short video on the dividend discount model (https://openstax.org/r/short_video_on_the_dividend) and how it is used it in stock valuation and analysis.

The Gordon growth model equation is presented and then applied to a sample problem to demonstrate how the DDM yields an estimated share price for the stock of any company.

Now that we have been introduced to the basic idea behind the dividend discount model, we can move on to cover other forms of DDM.

Zero Growth Dividend Discount Model

The zero growth DDM assumes that all future dividends of a stock will be fixed at essentially the same dollar value forever, or at least for as long as an individual investor holds the shares of stock. In such a case, the stock's **intrinsic value** is determined by dividing the annual dividend amount by the required rate of return:

$$\text{Stock Value} = \frac{\text{Annual Dividends}}{\text{Required Rate of Return}}$$

When examined closely, it can be seen that this is the exact same formula that is used to calculate the present value of a perpetuity, which is

$$\text{Present Value} = \frac{\text{Dividend}}{\text{Discount Rate}}$$

For the purpose of using this formula in stock valuation, we can express this as

$$\text{PV} = \frac{D}{r}$$

where PV is equal to the price or value of the stock, D represents the dividend payment, and r represents the required rate of return.

This makes perfect sense because a stock that pays the exact same dividend amount forever is no different from a **perpetuity**—a continuous, never-ending annuity—and for this reason, the same formula can be used to price preferred stock. The only factor that might alter the value of a stock based on the zero-growth model would be a change in the required rate of return due to fluctuations in perceived risk levels.

Example:

What is the intrinsic value of a stock that pays $2.00 in dividends every year if the required rate of return on similar investments in the market is 6%?

Solution:

We can apply the zero growth DDM formula to get

$$\text{Stock Value} = \frac{\$2.00}{0.6} = \$33.33$$

While this model is relatively easy to understand and to calculate, it has one significant flaw: it is highly unlikely that a firm's stock would pay the exact same dollar amount in dividends forever, or even for an extended period of time. As companies change and grow, dividend policies will change, and it naturally follows that the payout of dividends will also change. This is why it is important to become familiar with other DDMs that may be more practical in their use.

Constant Growth Dividend Discount Model

As indicated by its name, the constant growth DDM assumes that a stock's dividend payments will grow at a fixed annual percentage that will remain the same throughout the period of time they are held by an investor. While the constant growth DDM may be more realistic than the zero growth DDM in allowing for dividend growth, it assumes that dividends grow by the same specific percentage each year. This is also an unrealistic assumption that can present problems when attempting to evaluate companies such as Amazon, Facebook, Google, or other organizations that do not pay dividends. Constant growth models are most often used to value mature companies whose dividend payments have steadily increased over a significant period of time. When applied, the constant growth DDM will generate the present value of an infinite stream of dividends that are growing at a constant rate.

The constant growth DDM formula is

$$\text{Stock Value} = \frac{D_0(1 + g)}{r - g} = \frac{D_1}{r - g}$$

where D_0 is the value of the dividend received this year, D_1 is the value of the dividend to be received next year, g is the growth rate of the dividend, and r is the required rate of return.

As can be seen above, after simplification, the constant growth DDM formula becomes the Gordon growth model formula and works in the same way. Let's look at some examples.

THINK IT THROUGH

Constant Growth DDM: Example 1

If a stock is paying a dividend of $5.00 this year and the dividend has been steadily growing at 4% annually, what is the intrinsic value of the stock, assuming an investor's required rate of return of 8%?

Solution:

Apply the constant growth DDM formula:

$$\text{Stock Value} = \frac{D_0\ (1 + g)}{r - g} = \frac{\$5.00(1 + 0.04)}{0.08 - 0.04}$$

Simplify to the Gordon growth model:

$$D_1 = D_0(1 + g) = \$5.00 \times 1.04 = \$5.20$$

$$\text{Stock Value} = \frac{D_1}{r - g} = \frac{\$5.20}{0.08 - 0.04} = \$130.00$$

THINK IT THROUGH

Constant Growth DDM: Example 2

If a stock is selling at $250 with a current dividend of $10, what would be the dividend growth rate of this stock, assuming a required rate of return of 12%?

Solution:

Apply the constant growth DDM formula:

$$\$250 = \frac{\$10 \times (1 + g)}{0.12 - g}$$

Simplify and continue the calculation:

$$\begin{aligned} 30 - 250g &= 10 + 10g \\ 0 &= 10 + 260g \\ 20 &= 260g \\ 7.69\% &= g \end{aligned}$$

So, the growth rate is 7.69%.

LINK TO LEARNING

Dividend Discount Model: A Complete Animated Guide

In this video for the Investing for Beginners course and podcast, Andrew Sather introduces the DDM, (https://openstax.org/r/Andrew_Sather_introduces_the_DDM) demonstrating both the constant growth DDM (Gordon growth model) and the two-stage DDM.

Variable or Nonconstant Growth Dividend Discount Model

Many experienced analysts prefer to use the variable (nonconstant) growth DDM because it is a much closer approximation of businesses' actual dividend payment policies, making it much closer to reality than other forms of DDM. The variable growth model is based on the real-life assumption that a company and its stock value will progress through different stages of growth.

The variable growth model is estimated by extending the constant growth model to include a separate calculation for each growth period. Determine present values for each of these periods, and then add them all together to arrive at the intrinsic value of the stock. The variable growth model is more involved than other DDM methods, but it is not overly complex and will often provide a more realistic and accurate picture of a stock's true value.

As an example of the variable growth model, let's say that Maddox Inc. paid $2.00 per share in common stock dividends last year. The company's policy is to increase its dividends at a rate of 5% for four years, and then the growth rate will change to 3% per year from the fifth year forward. What is the present value of the stock if the required rate of return is 8%? The calculation is shown in Table 11.1.

Year	Growth %	Dividend ($)	Value after Year 4 ($)	PV Discount Factor at 8%	Present Value of Dividend ($)
0	5%	2.00			
1	5%	2.10		1.0800	1.9444
2	5%	2.21		1.1664	1.8904
3	5%	2.32		1.2597	1.8379
4	5%	2.43		1.3605	1.7869
5	3%	2.50	50.07886	1.4693	35.7870
					Total: $43.2466

Table 11.1 Value of Stock with 8% Required Rate of Return

Note:

$$\text{Value after Year 4} = \frac{2.4310125 \times 1.03}{0.08 - 0.03} = 50.078858$$

The value of Maddox stock in this example would be $43.25 per share.

Two-Stage Dividend Discount Model

The two-stage DDM is a methodology used to value a dividend-paying stock and is based on the assumption of two primary stages of dividend growth: an initial period of higher growth and a subsequent period of lower, more stable growth.

The two-stage DDM is often used with mature companies that have an established track record of making residual cash dividend payments while experiencing moderate rates of growth. Many analysts like to use the two-stage model because it is reasonably grounded in reality. For example, it is probably a more reasonable assumption that a firm that had an initial growth rate of 10% might see its growth drop to a more modest level of, say, 5% as the company becomes more established and mature, rather than assuming that the firm will maintain the initial growth rate of 10%. Experts tend to agree that firms that have higher payout ratios of dividends may be well suited to the two-stage DDM.

As we have seen, the assumptions of the two-stage model are as follows:

- The first period analyzed will be one of high initial growth.
- This stage of higher growth will eventually transition into a period of more mature, stable, and sustainable growth at a lower rate than the initial high-growth period.
- The dividend payout ratio will be based on company performance and the expected growth rate of its operations.

Let's use an example. Lore Ltd. estimates that its dividend growth will be 13% per year for the next five years. It will then settle to a sustainable, constant, and continuing rate of 5%. Let's say that the current year's dividend is $14 and the required rate of return (or discount rate) is 12%. What is the current value of Lore Ltd. stock?

Step 1:

First, we will need to calculate the dividends for each year until the second, stable growth rate phase is reached. Based on the current dividend value of $14 and the anticipated growth rate of 13%, the values of dividends (D_1, D_2, D_3, D_4, D_5) can be determined for each year of the first phase. Because the stable growth rate is achieved in the second phase, after five years have passed, if we assume that the current year is 2021, we can lay out the profile for this stock's dividends through the year 2026, as per Figure 11.3.

	A	B	C	D	E	F	G
1	Step 1						
2		Current					
3		2021	2022	2023	2024	2025	2026
4							
5	Dividend at 13% Growth	14.00	15.82	17.88	20.20	22.83	25.79
6							
7	Growth Rate of Dividends	N/A	13%	13%	13%	13%	13%

Figure 11.3 Profile of Stock Dividend through 2026

Step 2:

Next, we apply the DDM to determine the terminal value, or the value of the stock at the end of the five-year high-growth phase and the beginning of the second, lower growth-phase.

We can apply the DDM formula at any point in time, but in this example, we are working with a stock that has constant growth in dividends for five years and then decreases to a lower growth rate in its secondary phase. Because of this timing and dividend structure, we calculate the value of the stock five years from now, or the terminal value. Again, this is calculated at the end of the high-growth phase, in 2026. By applying the constant growth DDM formula, we arrive at the following:

$$\text{Stock Value}_N = \frac{D_N(1 + g)}{r - g} = \frac{D_{N+1}}{r - g}$$

The terminal value can be calculated by applying the DDM formula in Excel, as seen in Figure 11.4 and Figure 11.5. The terminal value, or the value at the end of 2026, is $386.91.

	A	B	C	D	E	F	G	H
9	Step 2A							
10		Current						
11		2021	2022	2023	2024	2025	2026	2027
12								
13	Dividend at 13% Growth	14.00	15.82	17.88	20.20	22.83	25.79	**27.08**
14								
15	Growth Rate of Dividends	N/A	13%	13%	13%	13%	13%	5%
16	Terminal Value						**=H13/(B17-H15)**	
17	Required Rate of Return	**0.12**						

Figure 11.4 Terminal Value at the End of 2026 (Showing Formula)

	A	B	C	D	E	F	G	H
19	Step 2B							
20		Current						
21		2021	2022	2023	2024	2025	2026	2027
22								
23	Dividend at 13% Growth	14.00	15.82	17.88	20.20	22.83	25.79	27.08
24								
25	Growth Rate of Dividends	N/A	13%	13%	13%	13%	13%	5%
26	**Terminal Value**						**386.91**	
27	**Required Rate of Return**	**0.12**						

Figure 11.5 Terminal Value at the End of 2026

Step 3:

Next, we find the PV of all paid dividends that occur during the high-growth period of 2022–2026. This is shown in Figure 11.6. Our required rate of return (discount rate) is 12%.

	A	B	C	D	E	F	G	H
29	Step 3							
30		Current						
31		2021	2022	2023	2024	2025	2026	2027
32								
33	Dividend at 13% Growth	14.00	15.82	17.88	20.20	22.83	25.79	27.08
34								
35	Growth Rate of Dividends	N/A	13%	13%	13%	13%	13%	5%
36	Terminal Value						386.91	
37	Required Rate of Return	0.12						
38								
39	**Present Value of Dividends**	**N/A**	**14.13**	**14.25**	**14.38**	**14.51**	**14.64**	

Figure 11.6 Present Value of All Paid Dividends, 2022–2026

Step 4:

Next, we calculate the PV of the single lump-sum terminal value:

$$\begin{aligned}\text{Future Value (FV)} &= 386.91\\ \text{Interest Rate (I/Y)} &= 12\\ \text{Number of Periods (N)} &= 5\\ \text{Payment (PMT)} &= 0\\ \text{Compute Present Value (CPTPV)} &= 219.54\end{aligned}$$

Remember that due to the sign convention, either the FV must be entered as a negative value or, if entered as a positive value, the resulting PV will be negative. This example shows the former.

Step 5:

Our next step is to find the current fair (intrinsic) value of the stock, which comprises the PV of all future dividends plus the PV of the terminal value. This is represented in the following formula, with all factors shown in Figure 11.7:

$$\text{Fair Value} = \text{PV}_{\text{Projected Dividends}} + \text{PV}_{\text{Terminal Value}}$$

	A	B	C	D	E	F	G	H	I
42	Step 5								
43		Current							
44		2021	2022	2023	2024	2025	2026	2027	
45									
46	Dividend at 13% Growth	14.00	15.82	17.88	20.20	22.83	25.79	27.08	
47									
48	Growth Rate of Dividends	N/A	13%	13%	13%	13%	13%	5%	
49	Terminal Value						386.91		
50	Required Rate of Return	0.12							
51									
52	**Present Value of Dividends**	**N/A**	**14.13**	**14.25**	**14.38**	**14.51**	**14.64**		**71.90**
53									
54	**Present Value of Terminal Value**						**219.54**		**219.54**
55									
56						**Fair Value**			**291.44**

Figure 11.7 Fair Value of the Stock

So, we end up with a total current fair value of Lore Ltd. stock of $291.44 (due to Excel's rounding), although the sum can also be calculated as shown below:

$$\text{Fair Value} = 14.13 + 14.25 + 14.38 + 14.51 + 14.64 + 219.54 = 291.45$$

LINK TO LEARNING

Determining Stock Value

Take a few minutes to review this video, which covers methods used to determine stock value (https://openstax.org/r/covers_methods_used_to_determine_stock_value) when dividend growth is nonconstant.

Advantages and Limitations of DDMs

Some of the primary advantages of DDMs are their basis in the sound logic of present value concepts, their consistency, and the implication that companies that pay dividends tend to be mature and stable entities. Also, because the model is essentially a mathematical formula, there is little room for misinterpretation or subjectivity. As a result of these advantages, DDMs are a very popular form of stock evaluation that most analysts show faith in.

Because dividends are paid in cash, companies may keep making their dividend payments even when doing so is not in their best long-term interests. They may not want to manipulate dividend payments, as this can directly lead to stock price volatility. Rather, they may manipulate dividend payments in the interest of buoying up their stock price.

To further illustrate limitations of DDMs, let's examine the Concepts in Practice case.

CONCEPTS IN PRACTICE

Limitations of DDMs

A major limitation of the dividend discount model is that it cannot be used to value companies that do not pay dividends. This is becoming a growing trend, particularly for young high-tech companies. Warren Buffett, CEO of Berkshire Hathaway, has stated that companies are usually better off if they take their excess funds and reinvest them into infrastructure, evolving technologies, and other profitable ventures. The payment of dividends to shareholders is "almost a last resort for corporate management,"[1] says Buffett, and cash balances should be invested in "projects to become more efficient, expand territorially, extend and improve product lines or . . . otherwise widen the economic moat separating the company from its competitors."[2] Berkshire follows this practice of reinvesting cash rather than paying dividends, as do tech companies such as Amazon, Google, and Biogen.[3] So, rather than receiving cash dividends, stockholders of these companies are rewarded by seeing stock price appreciation in their investments and ultimately large capital gains when they finally decide to sell their shares.

The sensitivity of assumptions is also a drawback of using DDMs. The fair price of a stock can be highly sensitive to growth rates and the required rates of return demanded by investors. A single percentage point change in either of these two factors can have a dramatic impact on a company's stock, potentially changing it by as much as 10 to 20%.

1 Dan Caplinger. "Why Don't These Winning Stocks Pay Dividends?" The Motley Fool. Updated October 3, 2018. https://www.fool.com/investing/general/2015/03/01/why-dont-these-winning-stocks-pay-dividends.aspx
2 The Motley Fool. "Why Warren Buffet's Berkshire Hathaway Won't Pay a Dividend in 2015." Nasdaq. November 16, 2014. https://www.nasdaq.com/articles/why-warren-buffetts-berkshire-hathaway-wont-pay-dividend-2015-2014-11-16.
3 Caplinger, "Why Don't These Winning Stocks Pay Dividends?" The Motley Fool.

Finally, the results obtained using DDMs may not be related to the results of a company's operations or its profitability. Dividend payments should theoretically be tied to a company's profitability, but in some instances, companies will make misguided efforts to maintain a stable dividend payout even through the use of increased borrowing and debt, which is not beneficial to an organization's long-term financial health.

(sources: www.wallstreetmojo.com/dividend-discount-model/; pages.stern.nyu.edu/~adamodar/pdfiles/valn2ed/ch13d.pdf; www.managementstudyguide.com/disadvantages-of-dividend-discount-model.htm)

Stock Valuation with Changing Growth Rates and Time Horizons

Before we move on from our discussion of dividend discount models, let's work through some more examples of how the DDM can be used with a number of different scenarios, changing growth rates, and time horizons.

As we have seen, the value or price of a financial asset is equal to the present value of the expected future cash flows received while maintaining ownership of the asset. In the case of stock, investors receive cash flows in the form of dividends from the company, plus a final payout when they decide to relinquish their ownership rights or sell the stock.

Let's look at a simple illustration of the price of a single share of common stock when we know the future dividends and final selling price.

Problem:

Steve wants to purchase shares of Old Peak Construction Company and hold these common shares for five years. The company will pay $5.00 annual cash dividends per share for the next five years.

At the end of the five years, Steve will sell the stock. He believes that he will be able to sell the stock for $25.00 per share. If Steve wants to earn 10% on this investment, what price should he pay today for this stock?

Solution:

The current price of the stock is the discounted cash flow that Steve will receive over the next five years while holding the stock. If we let the final price represent a lump-sum future value and treat the dividend payments as an annuity stream over the next five years, we can apply the time value of money concepts we covered in earlier chapters.

Method 1: Using an Equation

$$
\begin{aligned}
\text{Price} &= \text{Future Price} \times \frac{1}{(1+r)^n} + \text{Dividend Stream} \times \frac{\left[1 - \frac{1}{(1+r)^n}\right]}{r} \\
&= \$25.00 \times \frac{1}{(1+0.10)^5} + \$5.00 \times \frac{\left[1 - \frac{1}{(1+0.10)^5}\right]}{0.10} \\
&= \$25.00 \times 0.6209 + \$5.00 \times 3.7908 \\
&= \$15.52 + \$18.95 = \$34.47
\end{aligned}
$$

Method 2: Using a Financial Calculator

We can also use a calculator or spreadsheet to find the price of the stock (see Table 11.2).

Step	Description	Enter	Display	
1	Clear calculator register	CE/C		0.00
2	Enter number of periods (5)	5 N	N =	5.00
3	Enter rate of return or interest rate (10%)	10 I/Y	I/Y =	10.00
4	Enter eventual sales price ($25)	25 FV	FV =	25.00
5	Enter dividend amount ($5)	5 PMT	PMT =	5.00
6	Compute present value	CPT PV	PV =	– 34.47

Table 11.2 Calculator Steps for Finding the Price of the Stock[4]

The stock price is calculated as $34.47.

Note that the value given is expressed as a negative value due to the sign convention used by financial calculators. We know the actual stock value is not negative, so we can just ignore the minus sign.

In cases such as the above, we find the present value of a dividend stream and the present value of the lump-sum future price. So, if we know the dividend stream, the future price of the stock, the future selling date of the stock, and the required return, it is possible to price stocks in the same manner that we price bonds.

Method 3: Using Excel

Figure 11.8 shows a spreadsheet setup in Excel to reach a solution to this problem.

	A	B	C	D	E	F
1						
2	Nper (N) or Number of Periods					5
3	Rate of Return or Interest Rate					10%
4	Future Value or Stock Sale Price					$ 25.00
5	Payment (Dividend Amount)					$ 5.00
6						$ (34.48)

Figure 11.8 **Excel Solution for Finding the Price of the Stock**

Due to the sign convention in Excel, we can ignore the parentheses around the solution, which indicate a negative value. Therefore, the price is $34.48. The Excel command used in cell F6 to calculate present value is as follows:

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

Finding Stock Price with Constant Dividends

Example 1:

Four Seasons Resorts pays a $0.25 dividend every quarter and will maintain this policy forever. What price should you pay for one share of common stock if you want an annual return of 10% on your investment?

Solution:

You can restate your annual required rate of 10% as a quarterly rate of 2.5% $\left(\frac{10\%}{4}\right)$. Apply the quarterly dividend amount and the quarterly rate of return to determine the price:

4 The specific financial calculator in these examples is the Texas Instruments BA II Plus™ Professional model, but you can use other financial calculators for these types of calculations.

$$\text{Price} = \frac{\text{Dividend}}{r}$$
$$\text{Price} = \frac{\$0.25}{0.025} = \$10.00$$

Even though we anticipate that companies will be in business "forever," we are not going to own a company's stock forever. Therefore, the dividend stream to which we would have legal claim is only for that period of the company's life during which we own the stock. We need to modify the dividend model to account for a finite period when we will sell the stock at some future time. This modification brings us from an infinite to a finite dividend pricing model, which we will use to price a finite amount of dividends and the future selling price of the stock. We will maintain a constant dividend assumption. Let's assume we will hold a share in a company that pays a $1 dividend for 20 years and then sell the stock.

Method 1: Using an Equation

The dividend pricing model under a finite horizon is a concept we have seen earlier. It is a simple present value annuity stream application:

$$\text{Value of Future Dividends for Specific Periods} = \text{Dividend} \times \text{PVIFA (Present Value Interest Factor of an Annuity)}$$

$$\text{Dividend Stream} \times \frac{\left[1 - \frac{1}{(1+r)^n}\right]}{r} = \$1.00 \times \frac{\left[1 - \frac{1}{(1+0.10)^{20}}\right]}{0.10}$$
$$= \$1.00 \times 8.5136 = \$8.51$$

We now need to determine the selling price that we would get in 20 years if we were to sell the stock to someone else at that time. What would a willing buyer give us for the stock 20 years from now? This price is difficult to estimate, so for the sake of this exercise, we will assume that the price in 20 years will be $30. So, what is the present value of the price in 20 years with a 10% discount rate? Again, this is just a simple application of the PV formula we covered earlier in the text:

$$\text{PV} = \frac{\text{Price}_{20}}{(1+r)^{20}} = \frac{\$30}{(1.10)^{20}} = \$4.46$$

We can now price the stock as if it were a bond with a dividend stream of 20 years, a sales price in 20 years, and a required return of 10%:

- The dividend stream is analogous to the coupon payments.
- The sales price is analogous to the bond's principal.
- The 20-year investment horizon is analogous to the bond's maturity date.
- The required return is analogous to the bond's yield.

Carrying on with the PV calculations, we have

$$\text{Price} = \$30 \times \frac{1}{(1+0.10)^{20}} + \frac{\left[\$1.00 \times 1 - \frac{1}{(1+0.10)^{20}}\right]}{0.10}$$
$$= \$4.46 + \$8.51 = \$12.97$$

Method 2: Using a Financial Calculator

We can also use a calculator or spreadsheet to find the price of the stock using constant dividends (see Table 11.3).

Step	Description	Enter	Display
1	Clear calculator register	`CE/C`	0.00

Table 11.3 Calculator Steps for Finding the Price of Stock Using Constant Dividends

Step	Description	Enter	Display	
2	Enter number of periods (20)	20 N	N =	20.00
3	Enter rate of return or interest rate (10%)	10 I/Y	I/Y =	10.00
4	Enter eventual sales price (30)	30 FV	FV =	30.00
5	Enter dividend amount ($1)	1 PMT	PMT =	1.00
6	Compute present value	CPT PV	PV =	−12.97

Table 11.3 Calculator Steps for Finding the Price of Stock Using Constant Dividends

The stock price resulting from the calculation is $12.97.

Method 3: Using Excel

This same problem can be solved using Excel with a setup similar to that shown in Figure 11.9.

	A	B	C	D	E	F
8						
9	Nper (N) or Number of Periods					20
10	Rate of Return or Interest Rate					10%
11	Payment (Dividend Amount)					$ 1.00
12	Future Value or Stock Sale Price					$ 30.00
13						$ (12.97)

Figure 11.9 **Excel Solution for Finding the Price of Stock Using Constant Dividends**

Once again, we can ignore the negative indicator that is generated by the Excel sign convention because we know that the stock will not have a negative value 20 years from now. Therefore, the price is $12.97. The Excel command used in cell F13 to calculate present value is as follows:

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

Example 2:

Let's look at an example and estimate current stock price given a 10.44% constant growth rate of dividends forever and a desired return on the stock of 13.5%. We will assume that the current stock owner has just received the most recent dividend, D_0, and the new buyer will receive all future cash dividends, beginning with D_1. This part of the setup of the model is important because the price reflects all future dividends, starting with D_1, discounted back to today. (Price_0 refers to the price at time zero, or today.) The first dividend the buyer would receive is one full period away. Using the discounted cash flow approach, we have

$$\text{Price}_0 = \frac{D_0 \times (1+g)^1}{(1+r)^1} + \frac{D_0 \times (1+g)^2}{(1+r)^2} + \frac{D_0 \times (1+g)^3}{(1+r)^3} + \frac{D_0 \times (1+g)^4}{(1+r)^4} \ldots$$

where g is the annual growth rate of the dividends and r is the required rate of return on the stock. We can simplify the equation above into the following:

$$\begin{aligned} \text{Price}_0 &= \frac{D_0 \times (1+g)}{r-g} \\ D_1 &= D_0 \times (1+g) \\ \text{Price}_0 &= \frac{D_1}{r-g} \end{aligned}$$

As we discussed above, this classic model of constant dividend growth, known as the Gordon growth model, is a fundamental method of stock pricing. The Gordon growth model determines a stock's value based on a future stream of dividends that grows at a constant rate. Again, we assume that this constantly growing dividend stream will pay forever. To see how the constant growth model works, let's use our example from above once again as a test case. The most recent dividend (D_0) is \$1.76, the growth rate (g) is 10.44%, and the required rate of return (r) is 13.5%, so applying our PV equation, we have

$$\text{Price}_0 = \frac{\$1.76 \times (1 + 0.1044)}{0.135 - 0.1044} = \frac{\$1.943774}{0.0306} = \$63.52$$

Our estimated price for this example is \$63.52. Notice that the formula requires the return rate r to be greater than the growth rate g of the dividend stream. If g were greater than r, we would be dividing by a negative number and producing a negative price, which would be meaningless.

Let's pick another company and see if we can apply the dividend growth model and price the company's stock with a different dividend history. In addition, our earlier example will provide a shortcut method to estimate g, although you could still calculate each year's percentage change and then average the changes over the 10 years.

Estimating a Stock Price from a Past Dividend Pattern

Problem:

Phased Solutions Inc. has paid the following dividends per share from 2011 to 2020:

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
\$0.070	\$0.080	\$0.925	\$1.095	\$1.275	\$1.455	\$1.590	\$1.795	\$1.930	\$2.110

Table 11.4

If you plan to hold this stock for 10 years, believe Phased Solutions will continue this dividend pattern forever, and you want to earn 17% on your investment, what would you be willing to pay per share of Phased Solutions stock as of January 1, 2021?

Solution:

First, we need to estimate the annual growth rate of this dividend stream. We can use a shortcut to determine the average growth rate by using the first and last dividends in the stream and the time value of money equation. We want to find the average growth rate given an initial dividend (present value) of \$0.70, the most recent dividend (future value) of \$2.11, and the number of years (n) between the two dividends, or the number of dividend changes, which is 9. So, we calculate the average growth rate as follows:

$$\begin{aligned} g &= \left(\frac{\text{FV}}{\text{PV}}\right)^{\frac{1}{n}} - 1 \\ &= \left(\frac{\$2.11}{\$0.70}\right)^{\frac{1}{9}} - 1 = 3.0142857^{\frac{1}{9}} - 1 \\ &= 0.1304, \text{ or } 13.04\% \end{aligned}$$

Table 11.5 shows the step-by-step process of using a financial calculator to solve for the growth rate.

Step	Description	Enter	Display	
1	Clear calculator register	CE/C		0.0000
2	Enter number of periods (9)	9 N	N =	9.0000
3	Enter present value or initial dividend (\$0.70) as a negative value	0.7 +|− PV	PV =	-0.7000

Table 11.5 Calculator Steps for Solving the Growth Rate

Step	Description	Enter	Display
4	Enter future value or the most recent dividend ($2.11)	2.11 FV	FV = 2.1100
5	Enter a zero value for payment as a placeholder, as this factor is not used here	0 PMT	PMT 0.0000
6	Compute annual growth rate	CPT I/Y	I/Y = 13.0427

Table 11.5 Calculator Steps for Solving the Growth Rate

The calculated growth rate is 13.04%.

We can also use Excel to set up a spreadsheet similar to the one in Figure 11.10 that will calculate this growth rate.

	A	B	C	D	E	F	G
15							
16							
17	Present Value or Current Dividend Amount (enter as a negative value)						$ (0.70)
18	Nper (N) or Number of Periods						9
19	Payment or PMT (unused here, so enter zero as a placeholder)						-
20	Future Value (dividend amount in nine years)					13.04%	$ 2.11
21							
22	Growth Rate						13.0427%

Figure 11.10 Excel Solution for Growth Rate

The Excel command used in cell G22 to calculate the growth rate is as follows:

```
=RATE(nper,pmt,pv,[fv],[type],[guess])
```

We now have two methods to estimate *g*, the growth rate of the dividends. The first method, calculating the change in dividend each year and then averaging these changes, is the arithmetic approach. The second method, using the first and last dividends only, is the geometric approach. The arithmetic approach is equivalent to a simple interest approach, and the geometric approach is equivalent to a compound interest approach.

To apply our PV formula above, we had to assume that the company would pay dividends forever and that we would hold on to our stock forever. If we assume that we will sell the stock at some point in the future, however, can we use this formula to estimate the value of a stock held for a finite period of time? The answer is a qualified yes. We can adjust this model for a finite horizon to estimate the present value of the dividend stream that we will receive while holding the stock. We will still have a problem estimating the stock's selling price at the end of this finite dividend stream, and we will address this issue shortly. For the finite growing dividend stream, we adjust the infinite stream in our earlier equation to the following:

$$\text{Price}_0 = D_0 \times \frac{1+g}{r-g} \times \left[1 - \left(\frac{1+g}{1+r}\right)^n\right]$$

where *n* is the number of future dividends.

This equation may look very complicated, but just focus on the far right part of the model. This part calculates the percentage of the finite dividend stream that you will receive if you sell the stock at the end of the *n*th year. Say you will sell Johnson & Johnson after 10 years. What percentage of the $60.23 (the finite dividend stream) will you get? Begin with the following:

$$\begin{aligned}\text{10 Years: Percent} &= 1 - \left(\tfrac{1 + 0.1304}{1 + 0.170}\right)^{10} \\ &= 1 - 0.966154^{10} \;=\; 1 - 0.7087 = 0.2913\end{aligned}$$

Now, multiply the result by the price for your portion of the infinite stream:

$$\text{Price} \;= \$60.23 \;\times\; 0.2913 \;=\; \$17.55$$

The next step is to discount the selling price of Johnson & Johnson in 10 years at 17% and then add the two values to get the stock's price. So, how do we estimate the stock's price at the end of 10 years? If we elect to sell the stock after 10 years and the company will continue to pay dividends at the same growth rate, what would a buyer be willing to pay? How could we estimate the selling price (value) of the stock at that time?

We need to estimate the dividend in 10 years and assume a growth rate and the required return of the new owner at that point in time. Let's assume that the new owner also wants a 17% return and that the dividend growth rate will remain at 13.04%. We calculate the dividend in 10 years by taking the current growth rate plus one raised to the tenth power times the current dividend:

$$D_{10} = \$2.11 \;\times\; (1.1304)^{10} = \$2.11 \;\times\; 3.4066 \;= \$7.1879$$

We then use the dividend growth model with infinite horizon to determine the price in 10 years as follows:

Your price for the stock today—given that you will receive the growing dividend stream for 10 years and sell for $258.10 in 10 years, and also given that you want a 17% return over the 10 years—is as shown below:

$$\begin{aligned}\text{Price} \;&=\; \frac{\$205.18}{(1.1700)^{10}} \;+\; \frac{\$2.11 \times (1 + 0.1304)}{(0.1700 - 0.1304)} \;\times\; \left[1 \;-\; \left(\tfrac{1 + 0.1304}{1 + 0.1700}\right)^{10}\right] \\ &= \$42.68 \;+\; \$17.55 \;=\; \$60.23\end{aligned}$$

Why did you get the same price of $60.23 for your stock with both the infinite growth model and the finite model? The reason is that the required rate of return of the stock remained at 17% (your rate) and the growth rate of the dividends remained at 13.04%. The infinite growth model gives the same price as the finite model with a future selling price as long as the required return and the growth rate are the same for all future sales of the stock.

Although this point may be subtle, what we have just shown is that a stock's price is the present value of its future dividend stream. When you sell the stock, the buyer purchases the remaining dividend stream. If that individual should sell the stock in the future, the new owner would buy the remaining dividends. That will always be the case; a stock's buyer is always buying the future dividend stream.

LINK TO LEARNING

Determining Stock Value Using Different Scenarios

This video explains methods for determining stock value (https://openstax.org/r/explains_methods_for_determining_stock_value) using scenarios of constant dividends and scenarios of constant dividend growth.

THINK IT THROUGH

Nonconstant Growth Dividends

One final issue to address in this section is how we price a stock when dividends are neither constant nor growing at a constant rate. This can make things a bit more complicated. When a future pattern is not an annuity or the modified annuity stream of constant growth, there is no shortcut. You have to estimate every future dividend and then discount each individual dividend back to the present. All is not lost, however. Sometimes you can see patterns in the dividends. For example, a firm might shift into a dividend stream pattern that will allow you to use one of the dividend models to take a shortcut for pricing the stock. Let's look at an example.

JM and Company is a small start-up firm that will institute a dividend payment—a $0.25 dividend—for the first time at the end of this year. The company expects rapid growth over the next four years and will increase its dividend to $0.50, then to $1.50, and then to $3.00 before settling into a constant growth dividend pattern with dividends growing at 5% every year (see Table 11.6). If you believe that JM and Company will deliver this dividend pattern and you desire a 13% return on your investment, what price should you pay for this stock?

T0	T1	T2	T3	T4	T5
$0.25	$0.50	$1.50	$1.275	$3.00	$\$3.00 \times 1.05$

Table 11.6

Solution: To price this stock, we will need to discount the first four dividends at 13% and then discount the constant growth portion of the dividends, the first payment of which will be received at the end of year 5. Let's calculate the first four dividends:

$$\text{PV} = \frac{\$0.25}{(1.13)^1} + \frac{\$0.50}{(1.13)^2} + \frac{\$1.50}{(1.13)^3} + \frac{\$3.00}{(1.13)^4}$$
$$= \$0.22 + \$0.39 + \$1.04 + \$1.84 = \$3.49$$

We now turn to the constant growth dividend pattern, where we can use our infinite horizon constant growth model as follows:

$$\text{Price}_4 = \frac{\$3.00 \times (1 + 0.05)}{0.13 - 0.05} = \frac{\$3.15}{0.08} = \$39.375$$

This figure is the price of the constant growth portion at the end of the fourth period, so we still need to discount it back to the present at the 13% required rate of return:

$$\text{Price} = \frac{\$39.375}{(1.13)^4} = \$24.15$$

So, the price of this stock with a nonconstant dividend pattern is

$$\text{Price} = \$3.49 + \$24.15 = \$27.64$$

Some Final Thoughts on Dividend Discount Models

The dividend used to calculate a price is the expected future payout and expected future dividend growth. This means the DDM is most useful when valuing companies that have long, consistent dividend records.

If the DDM formula is applied to a company with a limited dividend history, or in an industry exposed to significant risks that could affect a company's ability to maintain its payout, the resulting derived value may not be entirely accurate.

In most cases, dividend models, whether constant growth or constant dividend, appeal to a fundamental concept of asset pricing: the future cash flow to which the owner is entitled while holding the asset and the required rate of return for that cash flow determine the value of a financial asset. However, problems can arise when using these models because the timing and amounts of future cash flows may be difficult to predict.

11.3 Discounted Cash Flow (DCF) Model

Learning Outcomes

By the end of this section, you will be able to:

- Explain how the DCF model differs from DDMs.
- Apply the DCF model.
- Explain the advantages and disadvantages of the DCF model.

When investors buy stock, they do so in order to receive cash inflows at different points in time in the future. These inflows come in the form of cash dividends (provided the stock does indeed pay dividends, because not all do) and also in the form of the final cash inflow that will occur when the investor decides to sell the stock.

The investor hopes that the final sale price of the stock will be higher than the purchase price, resulting in a capital gain. The hope for capital gains is even stronger in the case of stocks that do not pay dividends. When securities have been held for at least one year, the seller is eligible for long-term capital gains tax rates, which are lower than short-term rates for most investors. This makes non-dividend-paying stocks even more attractive, provided that they do indeed appreciate in value over the investor's holding period. Meanwhile, short-term gains, or gains made on securities held for less than one year, are taxed at ordinary income tax rates, which are usually higher and offer no particular advantage to an investor in terms of reducing their taxes.

Understanding How the DCF Model Differs from DDMs

The valuation of an asset is typically based on the present value of future cash flows that are generated by the asset. It is no different with common stock, which brings us to another form of stock valuation: the **discounted cash flow (DCF)** model. The DCF model is usually used to evaluate firms that are relatively young and do not pay dividends to their shareholders. Examples of such companies include Facebook, Amazon, Google, Biogen, and Monster Beverage. The DCF model differs from the dividend discount models we covered earlier, as DDM methodologies are almost entirely based on a stock's periodic dividends.

The DCF model is an absolute valuation model, meaning that it does not involve comparisons with other firms within any specific industry but instead uses objective data to evaluate a company on a stand-alone basis. The DCF model focuses on a company's cash flows, determining the present value of the entire organization and then working this down to the share-value level based on total shares outstanding of the subject organization. This highly regarded methodology is the evaluation tool of choice for experienced financial analysts when evaluating companies and their common stock. Many analysts prefer DCF methods of valuation because these are based on a company's cash flows, which are far less easily manipulated through accounting treatments than revenues or bottom-line earnings.

The DCF model formula in its mathematical form is presented below:

$$\text{Stock Value} = \frac{\text{CF}_1}{(1+r)^1} + \frac{\text{CF}_2}{(1+r)^2} + \ldots + \frac{\left(\frac{\text{TCF}}{r-g}\right)}{(1\ +\ r)^{n-1}}$$

where CF_1 is the estimated cash flow in year 1, CF_2 is the estimated cash flow in year 2, and so on; TCF is the terminal cash flow, or expected cash flow from the ending asset sale; r is the discount rate or required rate of return; g is the anticipated growth rate of the cash flow; and n is the number of years covered in the model.

Applying the DCF Model

We can apply the DCF model to an example to demonstrate this methodology and how the formula works. Calculate the value of Mayweather Inc. and its common stock based on the next six years of cash flow results. Assume that the discount rate (required rate of return) is 8%, Mayweather's growth rate is 3%, and the terminal value (TCF) will be two and one-half times the discounted value of the cash flow in year 6.

Mayweather has a cash flow of $2.0 million in year 1, so its discounted cash flow after one year (CF_1) is $1,851,851.85. We arrive at this amount by applying the discount rate of 8% for a one-year period to determine the present value.

In subsequent years, Mayweather's cash flow will be increasing by 3%. These future cash flows also must be discounted back to present values at an 8% rate, so the discounted cash flow amounts over the next six years will be as follows:

Year 1: $1,851,852

Year 2: $1,766,118

Year 3: $1,684,353

Year 4: $1,606,374

Year 5: $1,532,005

Year 6: $1,461,079

Our earlier assumption that the terminal value will be 2.5 times the value in the sixth year gives us a total terminal cash flow (TCF) of $\$1{,}461{,}079 \times 2.5$, or $3,652,697. Now, if we take all these future discounted cash flows and add them together, we arrive at a grand total of $13,554,477. So, based on our DCF model analysis, the total value of Mayweather Inc. is just over $13.5 million.

At this point, we have the estimated value of the entire company, but we need to work this down to the level of per-share value of common stock.

Let's say that Mayweather is currently trading at $12 per share, and it has 1,000,000 common shares outstanding. This tells us that the market capitalization of the company is $\$12 \times 1{,}000{,}000$, or $12 million, and that a $12 share price may be considered relatively low. The reason for this is that based on our DCF model analysis, investors would theoretically be willing to pay $13,554,477 divided by 1,000,000 shares, or $13.55 per share, for Mayweather. The overall conclusion would be that at $12.00 per share, Mayweather common stock would be a good buy at the present time. Figure 11.11 shows the Excel spreadsheet approach for arriving at the total value of Mayweather.

	A	B	C	D	E
1					
2	Discount Rate =		8.00%		
3					
4		Year	Cash Flow	Present Value	
5					
6	CF	1	2,000,000	**1,851,852**	**=-PV($C$2,B6,0,C6)**
7	CF	2	2,060,000	1,766,118	
8	CF	3	2,121,800	1,684,353	
9	CF	4	2,185,454	1,606,374	
10	CF	5	2,251,018	1,532,005	
11	CF	6	2,318,548	1,461,079	
12					
13	Totals		$ 12,936,820	9,901,780	
14	TCF			3,652,697	
15	Grand Total			**$13,554,477**	

Figure 11.11 Excel Solution for Total Value

Cell E6 displays the present value formula that is active in cell D6.

Advantages and Limitations of the DCF Model

Due to several corporate accounting scandals in recent years, many analysts have given increasing credence to the use of cash flow as a metric for determining accurate corporate valuations. However, it should be noted that cash flow is not always the best means of measuring financial health. A company can always sell a large portion of its assets to generate a positive cash flow, even if it is operating at a loss or experiencing other financial difficulties. Additionally, investors prefer to see companies reinvesting their cash back into their businesses rather than sitting on excessive balances of idle cash.

Similar to other models, the discounted cash flow model is only as good as the information entered. As the common expression goes, "garbage in, garbage out." This can often be the case if reasonably accurate cash flow estimates are not available or if an unrealistic discount rate or required rate of return is used in the calculations. It is always best to use several different methods when valuing companies and their common stock.

LINK TO LEARNING

Discounted Cash Flow

Please view this short video on discounted cash flow (https://openstax.org/r/short_video_on_discounted) and how this method can be applied in stock valuation.

11.4 Preferred Stock

Learning Outcomes

By the end of this section, you will be able to:

- Define preferred stock.
- Calculate the intrinsic value of preferred stock.
- Understand the difference between common stock and preferred stock.

Features of Preferred Stock

Preferred stock is a unique form of equity sold by some firms that offers preferential claims in ownership. Preferred stock will often feature a dividend that a company is obligated to pay out before it makes any dividend payments to common stockholders. In cases of bankruptcy and liquidation of the issuing company, preferred stockholders have priority claim to assets before common stockholders. Additionally, preferred stockholders are usually entitled to a set (or constant) dividend every period.

Preferred stock carries a stated par value, but unlike bonds, they have no maturity date, and consequently, there is no final payment of the par value. The only time a company would pay this par value to the shareholder would be if the company ceased operations or retired the preferred stock. Many preferred stock issues are cumulative in nature, meaning that if a company skips or is otherwise unable to pay a cash dividend, it becomes a liability to the company and must eventually be paid out to preferred shareholders at some point in the future. Other preferred stocks may be noncumulative, in which case if the company skips dividends, they are forever lost to the shareholder.

The term *preferred* comes from preferred shareholders receiving all past (if cumulative) and present dividends before common shareholders receive any cash dividends. In other words, preferred shareholders' dividend claims are given preferential treatment over those of common shareholders. Preferred stock is usually a form of permanent funding, but there are circumstances or covenants that could alter the payoff stream.

For example, a company may convert preferred stock into common stock at a preset point in the future. It is not uncommon for companies to issue preferred stock that has a conversion feature. Such conversion features give preferred shareholders the right to convert to common shares after a predetermined period.

A review of the characteristics of preferred stock will lead to the conclusion that the constant growth dividend model is an excellent approach for valuing such stock. Because shares of preferred stock provide a constant cash dividend based on original par value and the stated dividend rate, these may be considered a form of perpetuity.

It is this constant, preferred dividend stream that makes preferred stock seem more like bonds or another form of debt than like stock. In addition, the constant dividend stream leads nicely to the pricing of preferred stock with the four dividend models we presented earlier in this chapter.

Determining the Intrinsic Value of Preferred Stock

We can apply a version of the present value of a perpetuity formula to value preferred stock, as in the following example. Oh-Well Heath Services Inc. has issued preferred stock that has a par value of $1,000 and pays an annual dividend rate of 5%. If the market considers the risk of Oh-Well to warrant a 10% discount rate, what would be a fair market price for Oh-Well preferred stock?

First, we find the dividend value of Oh-Well:

$$\begin{aligned}\text{Dividend Dollar Value} &= \text{Par Value} \times \text{Annual Dividend Rate}\\ &= \$1{,}000 \times 0.05\\ &= \$50\end{aligned}$$

We then use the constant dividend model with infinite horizon because we have *g* equal to zero and *n* equal to infinity:

$$\begin{aligned}\text{Stock Value} &= \frac{\text{Dividend}}{\text{Discount Rate}}\\ &= \frac{\$50}{.10}\\ &= \$500\end{aligned}$$

We can also rearrange the formula to determine the required return on this stock, given its annual dividend and current price.

THINK IT THROUGH

Calculating the Return on Preferred Stock

Data Forge Inc. has just issued preferred stock (cumulative) with a par value of $100.00 and an annual dividend rate of 7%. The preferred stock is currently selling for $35.00 per share. What is the yield or return on this preferred stock?

Solution:

The first step is to determine the annual dividend by multiplying the dividend rate by the par value:

$$\$100 \times 0.07 = \$7.00$$

Now, using this $7.00 annual dividend, the $35.00 current price, and the equation above, we calculate the rate of return as follows:

$$r = \frac{\$7.00}{\$35.00} = 0.20 \text{ or } 20\%$$

We have introduced the concept of return here, which should be thought of as both the anticipated return for the preferred stockholder and the company's cost of borrowing money for this particular type of capital.

Differences between Preferred and Common Stock

As we have discussed, preferred stock has important differences from common stock that apply to issuing firms and to investors. Some of the most important of these differences are listed in Table 11.7.

Feature	Common Stock	Preferred Stock
Dividends	Paid only after preferred stockholders are paid	Highest priority, paid first
Dividends	Variable and may increase or decrease	Predetermined rates, so constant dividend amounts
Growth	High potential but tied to company performance	
Liquidation	Paid out last, after all creditors and preferred stockholders are paid	Given preference in terms of payments, similar to bonds
Voting Rights	Yes	No
Arrears	No accrual of missed dividends	If cumulative, unpaid dividends become liability that must be paid out eventually
Certainty	Dividends potentially not paid if company earns no profits	Dividends paid even when company experiences financial losses

Table 11.7 Differences between Common Stock and Preferred Stock

11.5 Efficient Markets

Learning Outcomes

By the end of this section, you will be able to:

- Understand what is meant by the term *efficient markets*.
- Understand the term *operational efficiency* when referring to markets.
- Understand the term *informational efficiency* when referring to markets.
- Distinguish between strong, semi-strong, and weak levels of efficiency in markets.

Efficient Markets

For the public, the real concern when buying and selling of stock through the stock market is the question, "How do I know if I'm getting the best available price for my transaction?" We might ask an even broader question: Do these markets provide the best prices and the quickest possible execution of a trade? In other words, we want to know whether markets are efficient. By **efficient markets**, we mean markets in which costs are minimal and prices are current and fair to all traders. To answer our questions, we will look at two forms of efficiency: operational efficiency and informational efficiency.

Operational Efficiency

Operational efficiency concerns the speed and accuracy of processing a buy or sell order at the best available price. Through the years, the competitive nature of the market has promoted operational efficiency.

In the past, the **NYSE (New York Stock Exchange)** used a designated-order turnaround computer system known as SuperDOT to manage orders. SuperDOT was designed to match buyers and sellers and execute trades with confirmation to both parties in a matter of seconds, giving both buyers and sellers the best available prices. SuperDOT was replaced by a system known as the Super Display Book (SDBK) in 2009 and subsequently replaced by the Universal Trading Platform in 2012.

NASDAQ used a process referred to as the small-order execution system (SOES) to process orders. The practice for registered dealers had been for SOES to publicly display all limit orders (orders awaiting execution at specified price), the best dealer quotes, and the best customer limit order sizes. The SOES system has now been largely phased out with the emergence of all-electronic trading that increased transaction speed at ever higher trading volumes.

Public access to the best available prices promotes operational efficiency. This speed in matching buyers and sellers at the best available price is strong evidence that the stock markets are operationally efficient.

Informational Efficiency

A second measure of efficiency is informational efficiency, or how quickly a source reflects comprehensive information in the available trading prices. A price is efficient if the market has used all available information to set it, which implies that stocks always trade at their fair value (see Figure 11.12). If an investor does not receive the most current information, the prices are "stale"; therefore, they are at a trading disadvantage.

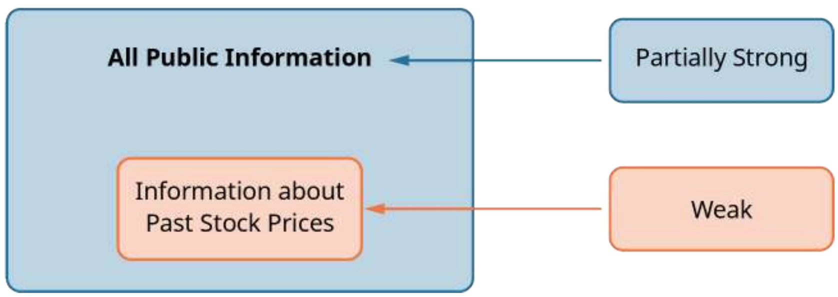

Figure 11.12 Forms of Market Efficiency A market is efficient if it provides all information that is available.

Forms of Market Efficiency

Financial economists have devised three forms of market efficiency from an information perspective: weak form, semi-strong form, and strong form. These three forms constitute the efficient market hypothesis. Believers in these three forms of efficient markets maintain, in varying degrees, that it is pointless to search for undervalued stocks, sell stocks at inflated prices, or predict market trends.

In weak form efficient markets, current prices reflect the stock's price history and trading volume. It is useless to chart historical stock prices to predict future stock prices such that you can identify mispriced stocks and routinely outperform the market. In other words, technical analysis cannot beat the market. The market itself is the best technical analyst out there.

Summary

11.1 Multiple Approaches to Stock Valuation

This section introduced common stock and some of the models and calculation methods used by investors and financial analysts to determine the prices or values of common shares. The most evaluative ratios that can be computed from a company's financial statements include the price-to-earnings (P/E), price-to book (P/B), price-to-sales (P/S), and price-to cash-flow (P/CF) ratios.

11.2 Dividend Discount Models (DDMs)

The dividend discount model, or DDM, is a method used to value a stock based on the concept that its worth is the present value of all of its future dividends. The most common DDM is the Gordon growth model, which values stock entirely on expected future dividends. Other techniques include the zero growth DDM, which depends on fixed dividends; the constant growth DDM, which assumes that dividends will grow at a constant rate; and the variable growth or nonconstant growth DDM, which is based on the assumption that stock value will progress through different stages of growth. There is also the two-stage DDM, which is based on the assumption of two stages of dividend growth: an initial period of higher growth and a subsequent period of lower, more stable growth.

11.3 Discounted Cash Flow (DCF) Model

Investors buy stock to receive cash inflows at different points in the future. These inflows may come in the form of dividends or a final cash inflow. If the investor chooses to wait for a final cash flow, the hope is that capital gains will be even stronger. The DCF model is usually used to evaluate firms that are relatively young and do not pay dividends to their shareholders. The DCF model focuses on a company's cash flows, determining the present value of an entire organization using objective data and then working this down to the share-value level based on total shares outstanding of the subject organization.

11.4 Preferred Stock

Preferred stock is a unique form of equity sold by some firms that offers preferential claims in ownership. Preferred stock carries a stated par value, but unlike bonds, there is no maturity date, and consequently, there is no final payment of the par value. The term *preferred* comes from preferred shareholders receiving all past (if cumulative) and present dividends before common shareholders receive any cash dividends.

11.5 Efficient Markets

Efficient markets are markets in which costs are minimal and prices are current and fair to all traders. There are two forms of efficiency: operational efficiency and informational efficiency. Operational efficiency concerns the speed and accuracy of processing a buy or sell order at the best available price. Informational efficiency concerns how quickly a source reflects comprehensive information in the available trading prices. Financial economists have devised three forms of efficient markets from an information perspective: weak form, semi-strong form, and strong form.

Key Terms

amortization the process of spreading business costs in accounting; similar to depreciation, but differs in that it generally refers to intangible assets such as patents or copyrights

capital employed also known as funds employed; the total amount of capital used for the acquisition of profits by a firm or on a project

common stock a security that represents partial ownership of a corporation

comparable company analysis (comps) a method for valuating a company using the metrics of other businesses of similar size in the same industry

depreciation the process of spreading business costs in accounting; similar to amortization, but differs in that it generally refers to fixed, tangible assets such as buildings, machinery, furniture, fixtures, and equipment

discounted cash flow (DCF) a method for estimating the value of an investment based on the present value of its expected future cash flows

dividend a sum of money paid regularly (typically quarterly) by a company to its shareholders out of its profits or reserves

dividend discount model (DDM) a quantitative method for predicting the price of a company's stock based on the theory that its present-day price is worth the sum of all of its future dividend payments when discounted back to their present value

dividend yield a financial ratio (dividend/price) that shows how much a company pays out in dividends each year relative to its stock price, expressed as a percentage

earnings per share (EPS) the ratio of a company's profits to the outstanding shares of its common stock; serves as an indicator of a company's profitability

EBIT short for earnings before interest and taxes; an indicator of a firm's profitability before the effects of interest or taxes; also referred to as operating earnings, operating profit, and profit before interest and tax

efficient markets markets in which costs are minimal and prices are current, fair, and reflective of all available relevant information

enterprise value (EV) a company's total value; often used as a more comprehensive alternative to equity market capitalization

enterprise value (EV) multiples also known as company value multiples; ratios used to determine the overall value of a company and, by extension, the value of its common stock

equity multiples metrics that calculate the expected or achieved total return on an initial investment

Gordon growth model a methodology used to determine the intrinsic value of a stock based on a future series of dividends that grow at a constant rate

growth rate the rate at which the dollar amount of dividends paid on a specific stock holding increases

intangible assets assets that are not physical in nature, such as goodwill, brand recognition, and intellectual property (i.e., patents, trademarks, and copyrights)

intrinsic value the value of a firm's stock based entirely on internal factors, such as products, management, and the strength of company brands in the marketplace

market capitalization the value of a company traded on the stock market, calculated by multiplying the total number of shares by the current share price

NASDAQ (National Association of Securities Dealers Automated Quotations) short for National Association of Securities Dealers Automated Quotations; an American stock exchange based in New York City, ranked second behind the New York Stock Exchange in terms of total market capitalization of shares traded

net book value also called net asset value (NAV); the total assets of a company minus its total liabilities

NYSE (New York Stock Exchange) the world's largest stock exchange by market capitalization of its listed companies, based in New York City; often referred to as the "Big Board"

perpetuity in terms of investments, an annuity with no end date

precedent transaction analysis (precedents) a method for valuating a company in which the price paid for similar companies in the past is considered an indicator of the company's current value

preferred stock stock that entitles the holder to a fixed dividend, the payment of which takes priority over payment of common stock dividends

price-to-book (P/B) ratio also called the market-to-book (M/B) ratio; a metric used to compare a company's market capitalization, or market value, to its book value

price-to-cash-flow (P/CF) ratio a stock valuation indicator or multiple that measures the value of a stock's price relative to its operating cash flow per share

price-to-earnings (P/E) ratio a ratio that indicates the dollar amount an investor can expect to invest in a company in order to receive one dollar of that company's earnings

price-to-sales (P/S) ratio a ratio that indicates how much investors are willing to pay for a company's stock

per dollar of that company's sales
required return the minimum return an investor expects to achieve by investing in a project
secondary markets markets where investors buy and sell securities they already own
stock value also called intrinsic value; the fundamental, objective value of a share of stock

CFA Institute

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Multiple Choice

1. The price-to-earnings (P/E) ratio is ____________.
   a. used to calculate a company's book value
   b. a multiplier used in enterprise valuation
   c. only applied when valuing preferred stock
   d. a metric for showing the expectations of the market

2. The price-to-book (P/B) ratio is also called the ____________ ratio.
   a. market-to-book
   b. enterprise-to-book
   c. asset-to-price
   d. liability-to-book

3. The two primary types of stock valuation multiples are ____________.
   a. enterprise value multiples and comparable company value multiples
   b. equity multiples and enterprise value multiples
   c. asset value multiples and liability value multiples
   d. None of the above

4. Dividend yield is a form of equity multiple that is primarily used when ____________.
   a. the subject company is operating at a loss
   b. conducting comparisons between companies in different industries
   c. conducting comparisons between cash returns and investment types
   d. analyzing mature companies that have been paying dividends for several years

5. Dividend yield is computed as the proportion of dividend per share to ____________.
   a. share price
   b. earnings per share
   c. market value per share
   d. book value per share

6. Which of the following statements about enterprise value metrics is NOT true?
   a. EV to revenue can be used to assess companies with negative cash flows or firms that are currently experiencing financial losses.
   b. ROCE is a profitability ratio that measures the return on the equity in a company in comparison to its financing over a short period of time.
   c. EBIT allows investors to assess the core operations of the business without worrying about the costs of the capital structure.
   d. EBITDAR is a metric that is used in businesses that have substantial rental and least expenses.

7. If an investor's required rate of return increases and all other characteristics of a stock remain the same, the value of the stock will ______________.
   a. remain the same
   b. increase
   c. decrease
   d. None of the above

8. A major limitation of the dividend discount model (DDM) is that ______________.
   a. it is extremely complicated to use
   b. it cannot be used with companies that do not pay dividends
   c. it must always be used in conjunction with another metric
   d. None of the above

9. In which of the following ways does preferred stock differ from common stock?
   a. Preferred stock carries voting rights for its ownership.
   b. Preferred stock must be purchased through a broker dealer.
   c. Preferred stock may have a cumulative dividend feature.
   d. In the event of corporate liquidation, preferred stockholders are paid last.

10. The term efficient markets refers to the idea that ______________.
   a. publicly traded companies always file their financial reports on time
   b. investors are able to identify underpriced stocks for purchase
   c. stocks trade with minimal costs and prices are current and fair to all traders
   d. financial information on companies and their stock is only available to efficient traders

Review Questions

1. Briefly discuss one of the primary benefits of using comparative P/E ratios.
2. Name an important characteristic of companies for which the price-to-book (P/B) ratio does not work well.
3. Briefly describe the main type of scenario in which the two-stage DDM approach might be used to value a firm and its stock.
4. Briefly describe a major shortcoming of the zero growth DDM model.
5. Briefly describe the required inputs for the discounted cash flow (DCF) model.
6. Briefly describe preferred stock and some of its ownership advantages compared to common stock.
7. Briefly explain what is meant by the terms *cumulative* and *noncumulative* as they relate to preferred stocks.
8. What were SuperDOT and SOES, and what were they designed to do?
9. What are operational efficiency and informational efficiency, and how do they differ in terms of trading markets?
10. What is meant by informational efficiency, and how does it affect the price of a stock?

Problems

1. Today, Sysco Enterprises paid dividends on its common stock of $1.25 per share. If dividends per share are expected to increase to $3.50 per share six years from now, what is the percentage dividend growth rate?

2. Let's say you want to purchase shares of Fontaine Ltd. and then hold this stock for six years. The company has a stated dividend policy of $2.00 annually per share for the next six years, at the end of which time you will sell the stock. You expect to be able to sell the stock for $35.00 at that time. If you want to earn an 8% return on this investment, what price should you pay today for this stock?
3. Damian Painting Systems has established a dividend policy of $3.00 per share per year. If the company plans to be in business forever, what is the value of this stock if an investor wants a 10% return?
4. Wilk Productions wants its shareholders to earn a 12% return on their investment in the company. At what value would Wilk stock be priced if the company paid $2.75 per share in constant annual dividends forever?
5. Dax Industrial Systems has stock currently priced at $50.00 per share. If investors are earning a 7% return on Dax Industrial, what is the company's annual dividend payment per share?
6. If a stock is selling at $400 with a current dividend of $40 and a potential investor's required rate of return is 15%, what would be the anticipated dividend growth rate?
7. Mind Max Inc. has a dividend policy that increases annual dividends by 3% each year. If last year's dividend was $2.00, the company intends to stay in business for 50 years, and an investor wants a 9% return, what would be the price of Mind Max stock?
8. Odon Corp. paid dividends today in the amount of $1.50 per share. If Odon will pay dividends of $5.00 10 years from today, what is the annual dividend growth rate over this 10-year period?
9. The Kirkson Distributors common stock is currently selling at $52.00 per share, pays dividends annually at $2.50 per share, and has an annual dividend growth rate of 2%. What is the required return?
10. If a preferred share of stock pays dividends of $2.50 per year and the required rate of return for the stock is 6%, what is its intrinsic value?

Video Activity

Efficient Markets

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1. In the efficient market hypothesis (EMH), describe what is meant by the terms *weak form efficiency, semi-strong form efficiency*, and *strong form efficiency*. How do these forms of market efficiency differ from each other, and what are their characteristics?
2. What is meant by the term *random walk*, and how does this concept relate to the EMH?

What Is Preferred Stock?

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3. Discuss the relative risks of the following financial instruments and how they compare to each other: bonds, common stocks, and preferred stocks. How and why will these three investment types typically carry different levels of risk to an investor?
4. Discuss some of the important differences between preferred stocks and common stocks.

12

Historical Performance of US Markets

Figure 12.1 Stock markets are affected by many factors, such as interest rates, inflation, and politics. (credit: modification of "That was supposed to be going up, wasn't it? by Rafael Matsunaga/flickr, CC BY 2.0)

Chapter Outline

Why It Matters

Author Mark Twain spoke for many when he wrote, "October—this is one of the peculiarly dangerous months to speculate in stocks. The others are July, January, September, April, November, May, March, June, December, August, and February." Twain's comment, though humorous, reflects the serious risks associated with investing in the stock market. So why should we study the history of the US financial markets? Financial experts regularly remind us that past performance is no guarantee of future results. However, past performance can provide targets or benchmarks around which to build expectations. We can learn about the past to prepare for future possibilities, or we can suffer what Winston Churchill warned, "Those that fail to learn from history are doomed to repeat it."

Carlos Slim Helu, a Mexican businessman and the richest person in the world from 2010 to 2013, once said, "With a good perspective on history, we can have a better understanding of the past and present, and thus a clear vision of the future."[1] In this chapter, we examine current and historical performance in money, bond, and stock markets. Studying past market risk and return also allows investors to understand what is reasonable and what is not.

1 Dan Western. "45 Carlos Slim Helu Quotes About Wealth and Success." *Wealthy Gorilla*. https://wealthygorilla.com/carlos-slim-helu-quotes/

12.1 Overview of US Financial Markets

Learning Outcomes

By the end of this section, you will be able to:

- Identify the various aspects of the US money markets.
- Characterize government and corporate bond markets.
- Detail the structure and operations of US equity markets.

Money Markets

The money market is a multitrillion-dollar market. Features of money market securities include being short-term (with maturities of less than one year) and very low risk (rarely failing to make their required payments). Further, money market securities are also liquid, which means that they trade easily without losing value.

Financial institutions, corporations, and governments that have short-term borrowing and/or lending needs issue securities in the money market. Most of the transactions are quite large, with typical amounts of $10,000, $100,000, $1 million, or more. Money market securities are available in smaller amounts if you choose to invest in money market mutual funds (MMMFs) or certain types of exchange-traded funds (ETFs).

Treasury bills (T-bills) are short-term debt instruments issued by the federal government. T-bills are auctioned weekly by the Treasury Department through the trading window of the Federal Reserve Bank of New York, with maturities of 4, 8, 13, or 26 weeks. The Treasury also auctions 52-week T-bills once every four weeks. The federal government uses T-bills to meet short-term liquidity needs. T-bills have very short maturities and a broad secondary market and are default-risk free. T-bills are also exempt from state and local income taxes. As a result, they carry some of the lowest effective interest rates on publicly traded debt securities.

The volume of T-bills auctioned depends upon government borrowing needs. Much of the money raised at weekly T-bill auctions goes to repay the money borrowed 4, 8, 13, 26, or 52 weeks earlier. The gross amount of new T-bills issued in December 2020 was $1,591.1 billion, and the amount of T-bills retired in the same month was $1,570.6 billion, resulting in net new borrowing of “only” $20.5 billion.

In addition to the regular auction of new T-bills, there is also an active secondary market where investors can trade used or previously issued T-bills. Since 2001, the average daily trading volume for T-bills has exceeded $75 billion.

Commercial paper (CP) is a short-term, unsecured debt security issued by corporations and financial institutions to meet short-term financing needs such as inventory and receivables. For example, credit card companies use commercial paper to finance credit card payments. Commercial paper is a short-term debt instrument, with a typical maturity of 30 days and up to 270 days. The short maturity reduces US Securities and Exchange Commission (SEC) oversight. The lesser oversight and the unsecured nature of CP means that only highly rated firms are able to issue the uninsured paper.

Commercial paper typically carries a minimum face value of $100,000 and sells at a discount, with the face value as the repayment amount. Corporations and financial institutions, not the government, issue CP; thus, returns are taxable. Further, unlike T-bills, there is not a robust secondary market for CP. Most purchasers are large, such as mutual fund investment companies, and they tend to hold commercial paper until maturity. The default rate on commercial paper is typically low, but default rates did increase into the double-digit range during the financial crisis of 2008.

Negotiable certificates of deposit (NCDs) are very large CDs issued by financial institutions. They are redeemable only at maturity, but they can and often do trade prior to maturity in a broad secondary market. NCDs, or jumbo CDs, are so called because they sell in increments of $100,000 or more. However, typical amounts are $1 million, with a maturity of two weeks to six months.

NCDs differ in some important ways from the typical CD you may be familiar with from your local bank or credit union. The typical CD has a maturity date, interest rate, and face amount and has FDIC insurance. However, if an investor wishes to cash out prior to maturity, they will incur a substantial penalty from the issuer (bank or credit union). An NCD also has a maturity date and amount, but it is much larger than a regular CD and appeals to institutional investors. The principal is not insured. When the investor wishes to cash out early, there is a robust secondary market for trading the NCD. The issuing institution can offer higher rates on NCDs compared to CDs because it knows it will have use of the purchase amount for the entire maturity of the NCD and because the reserve requirements on NCDs by the Federal Reserve is lower than for other types of deposits.

Investment companies such as Vanguard and Fidelity, among many others, sell shares in money market mutual funds (MMMFs). The investment company purchases money market instruments, such as T-bills, CP, or NCDs; pools them; and then sells shares of ownership to investors (see Table 12.1). Generally, MMMFs invest only in taxable securities, such as commercial paper and negotiable certificates of deposit, or only in tax-exempt government securities, such as T-bills. Investors can then choose which type of short-term liquid securities they would like to hold, taxable or nontaxable. MMMFs provide smaller firms and investors the opportunity to participate in the money market by facilitating smaller individual investment amounts.

Financial Instrument	Typical Maturity	Minimum Amount	Issuer
Treasury bills	4–52 weeks	\$10,000	Federal government
Commercial paper	270 days	\$100,000	Businesses
Negotiable CDs	6 months	\$100,000	Financial institutions
MMMFs			Investment companies
Federal funds	1 day	\$1 million	Financial institutions

Table 12.1 Money Market Instrument Characteristics (Selected)

The market for federal funds is notable because the Federal Reserve (Fed) targets the equilibrium interest rate on federal funds as one of its most important monetary policy tools. The federal funds market traditionally consists of the overnight borrowing and lending of immediately available funds among depository financial institutions, notably domestic commercial banks. Financial institutions such as banks are required to keep a fraction of their deposits on reserve with the Fed. When banks find they are short of reserves and immediately need cash to meet reserve requirements, they can borrow directly from the Fed through the so-called “discount window” or purchase excess reserves from other banks in the federal funds market. Often, the maturity of a federal funds contract is as short as a single day or overnight. The participants in the market negotiate the federal funds interest rate. However, the Federal Reserve effectively sets the target interest rate range in the federal funds market by controlling the supply of funds available for use in the market.

Since the financial crisis of 2008, the activities and functioning of the federal funds market has changed. The federal funds rate is still the rate targeted by the Fed for monetary policy, but the participants have evolved for several reasons. The market now includes foreign banks and non-depository financial institutions, such as the Federal Home Loan Banks. These institutions do not need to meet Fed reserve requirements and are not required to keep reserves with the Fed. In addition, the Fed now pays interest to commercial banks for reserves held at the Federal Reserve banks. Paying interest on reserves reduces the incentive for domestic commercial banks to enter the federal funds market since they can already earn interest on their excess reserves.

Daily trading volume in the federal funds market from 2016 through 2020 ranged from a high of $115 billion in March of 2018 to a low of only $34 billion on December 31, 2020.[2] The volume of federal funds activity is lower in periods of slower economic growth because banks have fewer good opportunities to issue loans and are less likely to be short of required reserves.

Bond Markets

Bond markets are financial markets that make payments to investors for a specific period of time. Investors decide how much to pay for a bond depending on how much they expect **inflation** to affect the value of the fixed payment. There are several types of bonds: government bonds, corporate bonds, and municipal bonds.

Government Bond Markets

In the section on money markets, we discussed T-bills, and we now discuss longer-term government securities in the form of Treasury notes and Treasury bonds.

We learned in Bonds and Bond Valuation that the federal government issues Treasury notes and bonds to raise money for current spending and to repay past borrowing. The size of the Treasury market is quite large, as the US federal government over the years has accumulated a total indebtedness of over $28 trillion dollars. The debt has grown so large we even have a real-time debt calculator online at https://www.usdebtclock.org/ (https://openstax.org/r/usdebtclock).

Treasury notes (T-notes) are US government debt instruments with maturities of 2, 3, 5, 7, or 10 years. The Treasury auctions notes on a regular basis, and investors may purchase new notes from TreasuryDirect.gov (https://openstax.org/r/treasurydirect.gov) in the same way they would a T-bill. T-notes differ from T-bills in that they are longer term and pay semiannual coupon interest payments, as well as the par or face value of the note at maturity. T-bills, as you will recall, sell at a discount and pay the face value at maturity with no explicit interest payments. Upon issue of a note, the size, number, and timing of note payments is fixed. However, prices do change in the secondary market as interest rates change. Like T-bills, T-notes are generally exempt from state and local taxes.

Economists and investors keep a close eye on the 10-year T-note for several reasons. Mortgage lenders use it as a basis for setting and adjusting mortgage interest rates. In general, the rate on the 10-year T-note is a reliable market indicator of investor confidence.

There is an active secondary market for Treasury notes. From 2001 to 2020, the daily trading volume for Treasury notes has averaged $395 billion, or roughly five times the daily trading volume of T-bills. Treasury notes are the largest single type of government debt instrument, with over $11 trillion outstanding. As you can see from Figure 12.2, the Treasury dramatically increased borrowing by issuing notes following the 2008 financial crisis.

Brokers, dealers, and investment companies provide secondary market opportunities for individual and institutional investors. Exchange-traded funds (ETFs) are popular investment vehicles for many types of government T-bill, T-note, and T-bond portfolios. An ETF is a basket of securities that can trade like stocks on a stock exchange. For example, IEI is an iShares ETF managed by BlackRock that invests in Treasury securities with three to seven years to maturity. When investors buy this ETF, they purchase a small bundle of Treasury notes that they can buy or sell, just as if they owned an individual share of stock. ETFs are a convenient way for investors to own broad portfolios of securities while still being able to trade the whole group in a single transaction if they choose.

2 Federal Reserve Bank of New York. “Effective Federal Funds Rate.” *Federal Reserve Bank of New York*. https://www.newyorkfed.org/markets/reference-rates/effr

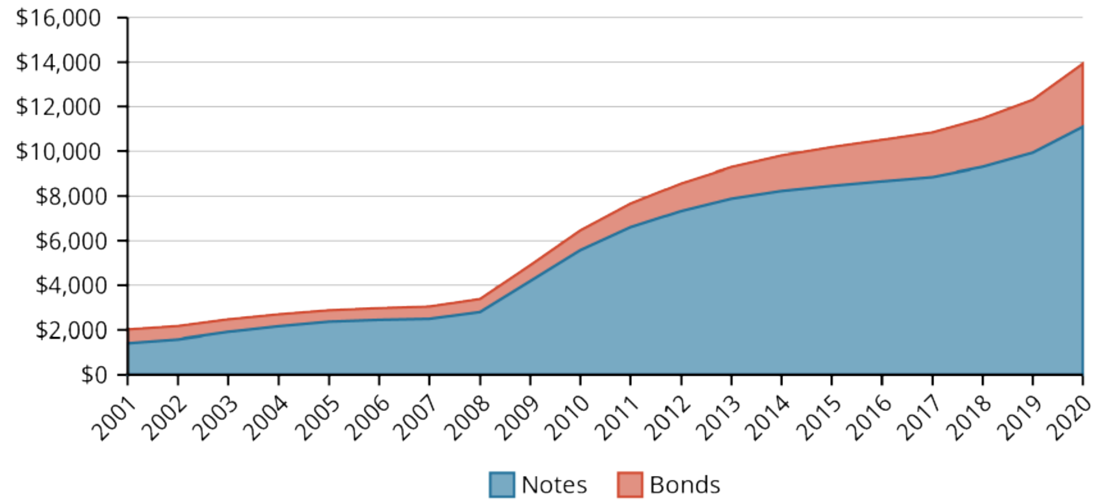


Figure 12.2 Daily Trading Volume for US Treasury Notes and Bonds (data source: treasurydirect.gov)

Longer-term Treasury issues, **Treasury bonds**, have maturities of 20 or 30 years. T-bonds are like T-notes in that they pay semiannual coupon interest payments for the life of the security and pay the face value at maturity. They are longer term than notes and typically have higher coupon rates. T-bonds with maturities of 20 and 30 years are each auctioned only once per month. At the end of 2020, there were approximately $2.8 trillion of T-bonds outstanding, compared to approximately $11.1 trillion and $5 trillion of T-notes and T-bills.

In 1997, the Treasury began offering a new type of longer-term debt instrument, Treasury Inflation-Protected Securities, or TIPS. TIPS currently have maturities of 5, 10, or 30 years and are auctioned by the Treasury once per month. Like T-notes and T-bonds, they offer semiannual coupon interest payments for the life of the security and pay face value at maturity. The coupon interest rates are fixed, but the principal value adjusts monthly in response to changes in the consumer price index (CPI). Inflation and deflation cause the value of the principal to increase or decrease, which results in a larger or smaller semiannual coupon payment. With a total outstanding value of approximately $1.6 trillion at the end of 2020, TIPS are the smallest form of Treasury borrowing we have discussed.[3]

State and local governments and taxing districts can issue debt in the form of **municipal bonds (*munis*)**. Local borrowing carries more risk than Treasury securities, and default or bankruptcy is atypical but possible. Thus, munis have ratings that run a spectrum similar to corporate bonds in that they receive a bond rating based on the perceived default risk. The defining feature of municipal bonds is that some interest payments are tax-free. Interest on munis (municipal bonds) is always exempt from federal taxes and sometimes exempt from state and local taxes. This makes them very attractive to investors in high income brackets.

There are two primary types of municipal bonds: revenue bonds and general obligation (GO) bonds. GO bonds generate cash flows to repay the bonds by taxing a project. For instance, a local school district may tax residents to pay for capital construction, or a city may tax citizens to pay for a new public works building. Revenue bonds, on the other hand, may apply to projects that generate sufficient cash flows to repay the bond—perhaps a utility or local toll road.

Corporate Bond Markets

Just as governments borrow money in the long-term from investors, so do corporations. A corporation often uses bank loans, commercial paper, or supplier credit for short-term borrowing needs and issues bonds for longer-term financing. Bond contracts identify very specific terms of agreement and outline the rules for the order, timing, and amount of contractual payments, as well as processes for when one or more of the required activities lapse. **Indenture** is the legal term for a bond contract. The indenture also includes limitations on the

3 Nick Lioudis. "Where Can I Buy Government Bonds?" *Investopedia.* December 30, 2020. https://www.investopedia.com/ask/answers/where-can-i-buy-government-bonds/; TreasuryDirect. "Today's Auction Results." *TreasuryDirect.* https://www.treasurydirect.gov/instit/annceresult/press/press_auctionresults.htm

corporation for how they may use the bond proceeds.

A bond indenture includes both standard boilerplate contract language and specific conditions unique to a particular issue. Because of these non-standardized features of a bond contract, the secondary market for trading used bonds typically requires a broker, dealer, or investment company to facilitate a trade.

When a corporation uses a real asset, such as property or buildings, to guarantee a bond, the firm has issued a **mortgage bond**. However, it is more common for a corporation to issue an unsecured bond known as a **debenture**. The risk of a debenture reflects the risk of the entire corporation and does not rely on the value of a specific underlying asset, as is the case with a mortgage bond.

The risk a bondholder bears for buying a bond depends in part on the terms of the bond indenture, market conditions over the life of the bond contract, and the ability or inability of the firm to generate sufficient cash flows to meet its bond obligations. Fortunately, investors do not have to make these determinations about risk on their own. They can rely on bond rating services such as Moody's, Standard and Poor's, or Fitch to generate evaluations of the creditworthiness of bond issuers.

Ratings firms must adhere to rigorous standards when evaluating client creditworthiness. For example, Standard and Poor's begins the explanation of its evaluation process with these paragraphs:

"S&P Global Ratings provides a Credit Rating only when, in its opinion, there is information of satisfactory quality to form a credible opinion on creditworthiness, consistent with its Quality of the Rating Process – Sufficient Information (Quality of Information) Policy, and only after applicable quantitative, qualitative, and legal analyses are performed. Throughout the ratings and surveillance process, the analytical team reviews information from both public and nonpublic sources."

"For corporate, government, and financial services company or entity (collectively referred to as "C&G" Credit Ratings), the analysis generally includes historical and projected financial information, industry and/or economic data, peer comparisons, and details on planned financings. In addition, the analysis is based on qualitative factors, such as the institutional or governance framework, the financial strategy of the rated entity and, generally, the experience and credibility of management."[4]

Table 12.2 is a summary of how the three major credit rating agencies identify their ratings. Bond ratings are important for many reasons. The higher a firm's rating, the lower the expected default risk and the lower the cost of borrowing for the firm. Pension funds may be restricted to investing in only medium- or higher-grade bonds. This could limit the number of investors who can participate in the market for lower-grade bonds, thereby reducing the liquidity, price, and tradability of those debt securities.

There are only two US companies with AAA credit ratings: Microsoft and Johnson & Johnson.[5] Over the past 40 years, there has been a steady decline of AAA-rated companies (from sixty in 1980). Many institutions have found that this rating requires a more conservative approach to debt that can inhibit growth and revenue. So, in today's market, credit ratings have begun to lose their importance. It seems that the ability to pay debts has become secondary to the potential for growth.

Fitch	Moody's	S&P	Bond Grade/Risk
AAA	Aaa	AAA	Investment/low risk
AA	Aa	AA	Investment/low risk
A	A	A	Investment/low risk

Table 12.2 Credit Scale Ratings from the Three Credit Rating Agencies

4 S&P Global Ratings. "Transparency Statement." *S&P Global Ratings*. https://www.spglobal.com/ratings/en/about/transparency
5 The Wall Street Insider. "Why Only Two Companies Are Left with the AAA Rating." *The Wall Street Insider.* June 12, 2020. https://www.thewallstreetinsider.com/trends/why-only-two-companies-are-left-with-the-aaa-rating

Fitch	Moody's	S&P	Bond Grade/Risk
BBB	Baa	BBB	Investment/medium risk
BB	Ba	BB	Junk/high risk
B	B	B	Junk/high risk
CCC	Caa	CCC	Junk/highest risk

Table 12.2 Credit Scale Ratings from the Three Credit Rating Agencies

Equity Markets

An important goal of firm managers is to maximize owners' wealth. For corporations, shares of stock represent ownership. A corporation could have 100 shares, one million shares, or even several billion shares of stock. Stocks are difficult to value compared to bonds. Bonds typically provide periodic interest payments and a principal payment at maturity. The bond indenture specifies the timing and the amount of payments. Stocks might have periodic dividend payments, and an investor can plan to sell the stock at some point in the future. However, no contract guarantees the size of the dividends or the time and resale price of the stock. Thus, the cash flows from stock ownership are more uncertain and risky.

Corporations are the dominant form of business enterprise in the United States because of the ability to raise capital, the ease of transfer of ownership, and the benefit of limited liability to the owners. There are generally two types of stock, preferred and common. Preferred stock is a hybrid between common stock and bonds. Preferred stock has a higher claim to cash flows than common stockholders have (thus the term *preferred*), but it is lower than that of bondholders. In addition, preferred stock has fixed cash flows as bonds have and typically has no or few voting rights. Preferred stock dividends are after-tax payments by the corporation, as are common stock dividends, but bond interest payments, paid prior to taxes, are tax-deductible for firms. Of the three, preferred stock is the least used form of capital financing for corporations.

Common stockholders are the residual claimants and owners of the corporation. After all others who have a claim against the firm are paid, the common stockholders own all that remains. Common stockholders have voting rights, typically one vote per share, and choose the board of directors.

One popular way to rank the size of companies is to determine the value of their market capitalization, or market cap. Market cap is equal to the current stock price multiplied by the number of shares outstanding. According to the World Bank, the total market cap of US firms at the end of 2020 was $50.8 trillion, making up over half of the world's total value of equity, estimated at $90 trillion.[6] The largest US company at that time was Apple, followed by Microsoft, Amazon, Alphabet (Google), and Facebook. The largest company by sales volume in 2020 was Walmart.[7]

Geographical Location of Exchanges

Ownership is easily transferable for stocks that trade in one of the organized stock exchanges or in an over-the-counter (OTC) market. Definitions of a stock exchange and an OTC market blur as financial markets quickly adapt to innovations. However, stock markets have a centralized trading location, transactions require a broker to connect buyers and sellers, and the exchanges guarantee a basic level of liquidity so that investors are always able to buy or sell their stocks. An OTC market is an electronic market conducted on computer screens and consists of direct transactions among buyers and sellers, with no broker to bring the two

6 Siblis Research. "Total Market Value of US Stock Market." *Siblis Research*. https://siblisresearch.com/data/us-stock-market-value/; The World Bank. "Market Capitalization of Listed Domestic Companies (current US$)." *The World Bank*. https://data.worldbank.org/indicator/CM.MKT.LCAP.CD
7 Companies Market Cap. "Largest American Companies by Market Capitalization." *Companies Market Cap*. https://companiesmarketcap.com/usa/largest-companies-in-the-usa-by-market-cap/; National Retail Federation. "Top 100 Retailers 2020 List." *National Retail Federation*. 2020. https://nrf.com/resources/top-retailers/top-100-retailers/top-100-retailers-2020-list

together. Because there is no formal exchange present, it is possible that investors will have trouble finding buyers or sellers for their stocks.

Most of the trading consists of used or previously issued stocks in over-the-counter markets and organized exchanges. The two largest stock exchanges in the world, as measured by the market capitalization of the companies listed on the exchange, are the New York Stock Exchange (NYSE) and the NASDAQ. Both exchanges are located in the United States. Other large stock exchanges are located in Japan, China, Hong Kong, continental Europe, London, and Saudi Arabia.

Process of Offering Equities

The **primary market** is the market for new securities, and the **secondary market** is the market for used securities. When issuing new equity, the issuing firm receives the proceeds of the sale. Having an active secondary market makes it easier for corporations to issue stock, as investors know they can resell if desired. Most of the trading of equity securities is for used securities on the secondary market.

An **initial public offering**, or IPO, occurs when a firm offers stock to the public for the first time. With a typical IPO, a private company decides to raise capital and go public with the help of an investment banker. The investment banker agrees to provide financial advice, recommend the price and number of shares to issue, and establish a syndicate of underwriters to finance and ultimately distribute the new shares to investors (see Figure 12.3). An IPO is expensive for the issuing firm, and it can expect to incur costs of 5% to 8% or more of the value of the IPO. As of the end of 2020, the largest successful IPO belongs to Saudi Aramco, a petroleum company, valued at $25.6 billion at issue in December 2019.[8] The Ant Group had planned an IPO valued at over $34 billion dollars in 2020, but as of the end of 2020 that issue was put on hold by the Chinese government.[9]

Institutional and preferred individual investors are typically the initial purchasers of IPOs. Smaller investors rarely have the opportunity to purchase. However, any investor can buy the new shares once available for public trading. Investment author and financial expert Professor Burton Malkiel cautions that buying IPOs immediately after issue can be a money-losing investment. He cites research showing that, historically, IPOs have underperformed the market by an average of 4% per year.[10]

Another way for a corporation to raise capital in the equity market is through a **seasoned equity offering (SEO)**. An IPO occurs when a firm transitions from a private to a public company. An SEO takes place when a corporation that is already publicly traded issues additional shares of stock to the public. An SEO is often part of a SEC Rule 415 offering, or so-called **shelf registration**. Shelf registrations allow a company to register with the SEC to issue new shares but wait up to two years before issuing the shares. This gives companies the ability to register their intent to issue new shares and to "set them on the shelf" until market conditions are most favorable for issuance to the public.

8 Jennifer Rudden. "Largest IPOs Worldwide as of January 21, 2021." *Statista*. 2021. https://www.statista.com/statistics/269343/worlds-largest-ipos/
9 Deborah D'Souza. "Ant Group Set to Be World's Largest IPO Ever." *Investopedia*. October 27, 2020. https://www.investopedia.com/ant-group-set-to-be-world-s-largest-ipo-ever-5084457; Jasper Jolly. "Ant Group Forced to Suspend Biggest Share Offering in History." *The Guardian*. https://www.theguardian.com/business/2020/nov/03/biggest-share-offering-in-history-on-hold-as-ant-group-suspends-launch
10 Burton Malkiel. *A Random Walk down Wall Street*. 10th ed. W. W. Norton, 2012.

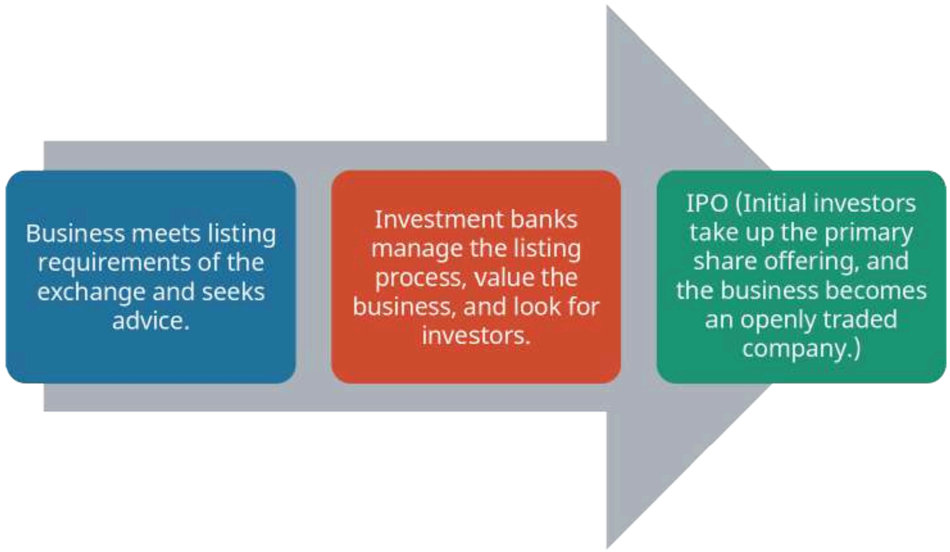


Figure 12.3 The IPO Process

Alternative Methods of Raising Capital

Special purpose acquisition companies (SPACs) were born in the 1990s and came of age in 2019.[11] SPACs are a special form of IPO. We know that firms with products or services to sell and a documented operational and financial history often initiate an IPO to raise money by going public. A SPAC, however, is like an IPO that puts the cart before the horse. By this, we mean that rather than having a company ready to go public to raise capital, with a SPAC, a sponsor raises capital in anticipation of finding a firm ready to go public. This is why we sometimes refer to SPACs as "blank check" companies. Investors are providing capital to a firm that has no assets with the expectation that the sponsor will find a good investment.

Forming a SPAC shifts the risk and expenses associated with a firm going public. Because the money raised by the SPAC sponsor is the only asset, the process of filing with the SEC is less complicated, less expensive, and less time-consuming than filing an IPO. Often, when formed, a SPAC has a target company in mind, but this is not a requirement. Once the SPAC identifies a target firm, the sponsor can negotiate a purchase price and essentially merge with the target. Underpricing of IPOs is well documented,[12] and the owners of a private company going public do not capture the significant increase in stock price that frequently occurs in the months following an IPO.

A SPAC offering allows the private firm owners to negotiate for a better price. A July 2020 study from Renaissance Capital reports that "of 223 SPAC IPOs conducted from the start of 2015 through July 2020, 89 have completed mergers and taken a company public." According to the study, of those 89 mergers, "the common shares have delivered an average loss of 18.8% and a median return of minus 36.1%. That compares with the average after-market return from traditional IPOs of 37.2%" over the same time period.[13]

Sequence of Trade Execution

Investors who wish to trade stocks (buy or sell) execute trades via a broker. Many online brokers today will execute your trades at low to no cost once you have established a brokerage account. When trading, it is most

11 Nicholas Jasinksi. "Blank Check Companies Are Hot on Wall Street. Investors Can't Ignore Them." *Barron's*. January 17, 2020. https://www.barrons.com/articles/boom-in-blank-check-companies-or-spacs-what-investors-need-to-know-51579299261; Julie Young. "Special Purpose Acquisition Company (SPAC)." *Investopedia*. November 24, 2020. https://www.investopedia.com/terms/s/spac.asp

12 R. G. Ibbotson, J. L. Sindelar, and J. R. Ritter. "The Market's Problems with the Pricing of Initial Public Offerings." *Journal of Applied Corporate Finance* 7 (Spring 1994).

13 Ciara Linnane. "2020 Is the Year of the SPAC—Yet Traditional IPOs Offer Better Returns, Report Finds." *MarketWatch.* September 16, 2020. https://www.marketwatch.com/story/2020-is-the-year-of-the-spac-yet-traditional-ipos-offer-better-returns-report-finds-2020-09-04; Barron's. "What Is a SPAC?" *Barron's* (video). December 11, 2020. https://www.barrons.com/video/what-is-a-spac/86E80342-FBC2-44DA-99E2-DF808CD147FF.html

common to make a market order or a limit order. A market order executes a trade at the current price, while a limit order specifies the price at which the investor is willing to buy or sell. Figure 12.4 provides a visual representation of how payment for an order flow works.

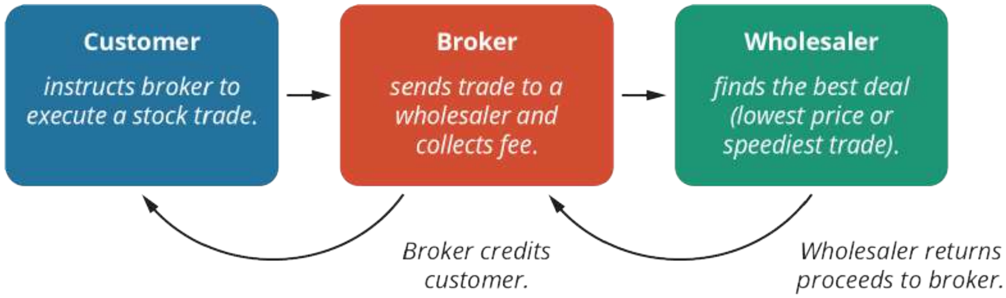


Figure 12.4 The Order of Payments for Trade Executions

12.2 Historical Picture of Inflation

Learning Outcomes

By the end of this section, you will be able to:

- Define inflation with concrete examples.
- Describe the practical impact of inflation on consumption and salary.
- Explain how expected and actual inflation are measured.
- Detail the behavior of inflation over various historical periods.

Over time, returns in the stock market have easily outperformed returns in the bond market. However, not everyone is comfortable investing in stocks. Taking a more informed and opposing view, financial economist Jeremy Siegel queries, “You have never lost money in stocks over any 20-year period, but you have wiped out half your portfolio in bonds (after inflation). So which is the riskier asset?”[14] Siegel brings up a valid point about inflation. Returns adjusted for changes in prices provide a better measure of value or wealth. Baseball pundit Sam Ewing noted, “Inflation is when you pay fifteen dollars for the ten-dollar haircut you used to get for five dollars when you had hair.”[15] If what you have earned on your investments fails to keep up with changing prices, you may have a larger portfolio with less purchasing power.

Expected versus Actual Inflation

Inflation occurs when things cost more and your money buys less today than it did yesterday. It is understandable to dislike inflation and to be concerned over the prospect of rising prices. In fact, two of the primary policy objectives of the Federal Reserve are to work for price stability and moderate interest rates. However, is inflation necessarily good or bad? In practice, inflation can benefit some people and harm others at the same time. Consider the impact of differences in expected and actual realized inflation. Empirical evidence suggests that, on average, economists do a good job of developing inflation rate forecasts that match the actual rate of inflation. Estimated inflation is built into the interest rates investors require or are willing to pay for financial products, such as fixed-rate loans or bonds. When the actual rate of inflation exceeds the estimated rate on a product, such as a mortgage loan, this means borrowers are repaying the loan with less-valuable dollars and benefit from the increased inflation rate. Lenders, however, receive those inflation-impacted dollars and are harmed due to their unexpected decrease in purchasing power.

Deflation, or falling prices, is associated with economic recessions or even depressions and is thought to be an even more serious problem than inflation. Generally, policy makers tend to support moderate inflation, being careful to stay away from zero or negative price changes.

14 Jeremy J. Siegel. *Stocks for the Long Run: The Definitive Guide to Financial Market Returns & Long-Term Investment Strategies.* McGraw-Hill, 2002. First published 1994.
15 Sam Ewing. “Sam Ewing Quotes.” *Brainy Quotes.* https://www.brainyquote.com/authors/sam-ewing-quotes

Inflation Impacts

Ultimately, inflation redistributes wealth. Lenders providing fixed-rate loans receive less-valuable dollars in return. Borrowers repay with those same less-valuable dollars. Workers receive less-valuable dollars, especially when their wage increases lag behind changes in prices. Modest inflation can benefit a consumer-driven economy like the United States if consumers are motivated to spend money before prices increase. However, too much inflation can cause frenzied buying, drive prices even higher, and outpace the rate of wage increases. Higher inflation raises the rates on new borrowing instruments and can slow the rate of business investment and economic growth. Inflation raises overall prices and may cause hardship for consumers on a fixed income.

Finally, inflation does not have an equal impact on all goods and services. As Table 12.3 shows, consumer prices did not increase at the same rate for the selected items shown. From 1980 to 2020, inflation, as measured by the consumer price index (CPI), grew at an average annual rate of 2.90%. However, the price of college tuition and fees increased at more than double that rate. Rent, another large expense for most college students, increased at an annual rate of 3.67%, also well above the average increase in the CPI. The price increases for ground beef and butter were slightly less than the CPI average. For the selected items presented here, only the average price for used cars and trucks rose at a rate significantly lower than the average rate of inflation.

Year	1980	2000	2020	Annual Change
College tuition and fees	70.8	331.9	877.3	6.49%
Rent	80.9	183.9	341.5	3.67%
Used cars and trucks	62.3	155.8	144.2	2.12%
Ground beef	104.6	125.2	296.2	2.64%
Butter	89.4	135.9	248.7	2.59%
CPI (1982 to 1984 = 100)	**82.4**	**172.2**	**258.8**	**2.90%**

Table 12.3 **Changing Consumer Price Levels—Selected Goods** (source: US Bureau of Labor Statistics, Consumer Price Index)

Using Graphs and Charts to Plot Inflation Behavior

The CPI is a measure of how prices have changed for a basket of goods across the United States. Figure 12.5 shows the eight major categories of expenditures included in the CPI.[16] Different regions of the country and population subgroups may experience different rates of inflation. Retired people may spend a greater portion of their income on healthcare than someone in their twenties.[17] Residents on the East and West Coasts spend a higher percentage of their earnings on housing than those living in the Midwest.[18] As such, there are several different measures of inflation based on geographic region or other factors.[19] It is worth noting that a basket of goods and services that cost $100 in 1984 would cost approximately $260 by the end of 2020, an increase of 160% (see Figure 12.6)! Over that same period, the average annual rate of inflation as measured by the CPI was 2.55%. These numbers make it easy to see that even a relatively modest annual inflation rate, lower than the long-run annual US inflation rate of 3%, results in significant price increases.

16 US Bureau of Labor Statistics. "Consumer Price Index." *US Bureau of Labor Statistics*. https://www.bls.gov/cpi/
17 Chris Farrell. "The Truth About Health Care Costs in Retirement." *Forbes*. June 28, 2018. https://www.forbes.com/sites/nextavenue/2018/06/28/the-truth-about-health-care-costs-in-retirement/
18 US Department of Housing and Urban Development, Office of Policy Development and Research. "Rental Burdens: Rethinking Affordability Measures." PD&R Edge. September 22, 2014. https://www.huduser.gov/portal/pdredge/pdr_edge_featd_article_092214.html
19 Khan Academy. "How Changes in the Cost of Living Are Measured." *Khan Academy*. https://www.khanacademy.org/economics-finance-domain/macroeconomics/macro-economic-indicators-and-the-business-cycle/macro-price-indices-and-inflation/a/how-changes-in-the-cost-of-living-are-measured-cnx

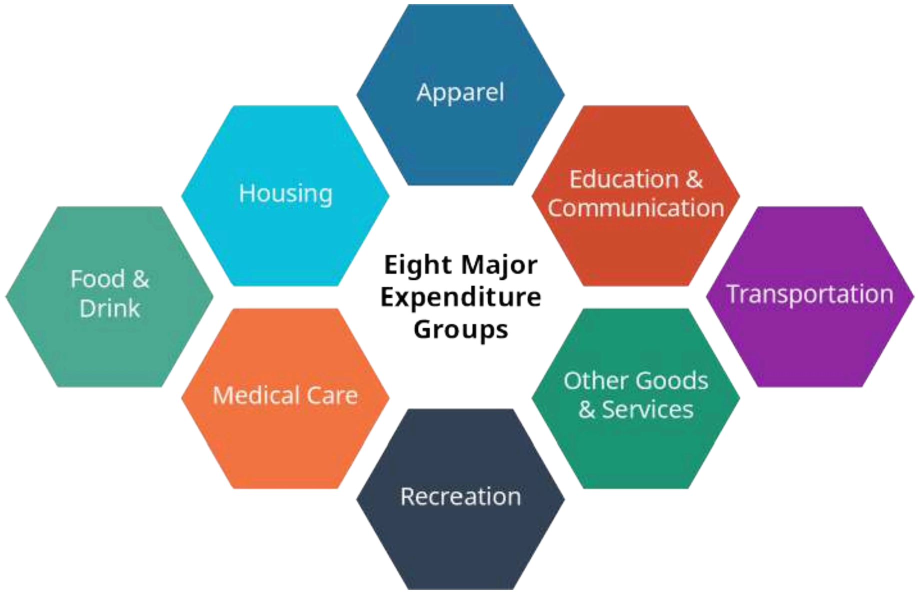


Figure 12.5 The Market Basket Categories of the CPI

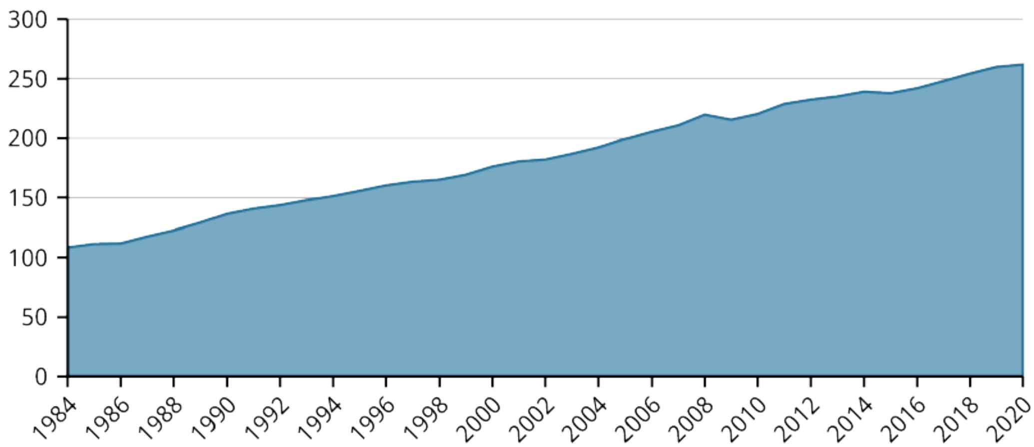


Figure 12.6 United States Consumer Price Index (CPI) 1984–2020 (data source: US Bureau of Labor Statistics)

CONCEPTS IN PRACTICE

Profile of Janet Yellen

Figure 12.7 Janet Yellen (credit: “Janet Yellen Official Federal Reserve Portrait.” United States Federal Reserve/Wikimedia Commons, Public Domain)

Janet Yellen has led a life of firsts. After graduating as valedictorian of her high school class, Yellen later attended Yale University and was the only woman in her 1971 PhD graduating class in economics. Men have long dominated the “dismal science” of economics, but Yellen has proved to be an exception.

Motivated by an undergraduate economics professor at Pembroke College of Brown University, Yellen realized how much the US central bank, known as the Federal Reserve, could influence the lives of ordinary people. She changed her major to economics, and the rest, as they say, is history.

In her first stint working with the Federal Reserve in 1977, Yellen met and married George Ackerlof. Ackerlof would go on to win a Nobel Prize in Economics. Ackerlof and Yellen eventually established themselves as faculty members at the University of California, Berkeley. Yellen was twice named Outstanding Teacher in the Haas School of Business and was recognized for her award-winning research.

In 1993, Yellen began her second tour at the Federal Reserve as an appointed member of the Board of Governors. She left this position in 1997 to head President Bill Clinton’s Council of Economic Advisers. Yellen became just the second woman to head the presidential council.

She then returned to California and the Bay Area, eventually becoming president of the Federal Reserve Bank of San Francisco from 2004 to 2010. Later that year she became the vice chair of the Federal Reserve. Four years later, in 2014, Yellen assumed leadership as the first woman chair of the Federal Reserve System.

As Fed chair, Yellen earned an enviable record. During her four-year tenure, the rate of unemployment decreased by more than 2.5%, and employment increased in every month of her term. This is the first and only time in the history of the Federal Reserve that the board chair has overseen continuous increases in employment over their entire tenure.

Now, another first: In 2021, President Joe Biden appointed Yellen as the first woman Secretary of the Treasury. Yellen has a storied career and a long list of accomplishments, but surely her record of firsts will prove to be an important and lasting legacy for women in business, government, and economics everywhere.

(Sources: Ann Saphir. "Factbox: Janet Yellen's Road to US Treasury Secretary." Reuters. November 24, 2020. https://www.reuters.com/article/idUSKBN2832WS; Ylan Q. Mui. "New Fed Chief Janet Yellen Lets a Long Career of Breaking Barriers Speak for Itself." *Washington Post.* February 2, 2014. https://www.washingtonpost.com/business/economy/new-fed-chief-janet-yellen-has-long-history-of-breaking-barriers/2014/02/02/9e8965ca-876d-11e3-833c-33098f9e5267_story.html; Stephanie Grace. "Banker to the Nation." *Brown Alumni Magazine.* October 30, 2013. https://www.brownalumnimagazine.com/articles/2013-10-30/banker-to-the-nation)

12.3 Historical Picture of Returns to Bonds

Learning Outcomes

By the end of this section, you will be able to:

- Detail the behavior of sovereign (government) bonds over various historical periods.
- Detail the behavior of corporate bonds over various historical periods.
- Extract sovereign and corporate bond investment results from plots and charts.

Federal Government Bond Behavior, Discussion, Charts, and Graphs

United States Treasury (sovereign) bonds are among the safest investments available. In fact, T-bonds often serve as the proxy for a risk-free investment in financial modeling. However, even though T-bonds may be essentially default-risk free, they do change value as interest rates change. Look at Figure 12.8, showing annual T-bond returns from 1980 to 1999. None of these bonds defaulted, yet investors realized very different returns on their investments from year to year. The **total returns** reflect interest payments plus the change in price because of changes in interest rates.

The late 1970s experienced high rates of inflation and interest rates. As those rates began to fall in late 1981, bond prices rose. Investors holding T-bond portfolios realized very large returns on their risk-free investments in 1982. That year provided the highest annual return in the 20-year period, with an annual return of 32.81%. The lowest annual return was in 1999, as the Federal Reserve began to raise rates to temper an overheating stock market caused by dot-com speculation gaining momentum. When the Fed raised interest rates, the prices on existing bonds fell, and investors realized a -8.25% return on their bond portfolios. Thus, the range in returns on these "low risk" investment securities was over 41% from the highest to the lowest annual return in this particular two-decade span. Overall, the average annual return on T-bonds from 1980 to 1999 was a robust 10.21%, boosted in part by the above average annual inflation rate of 4.28%.

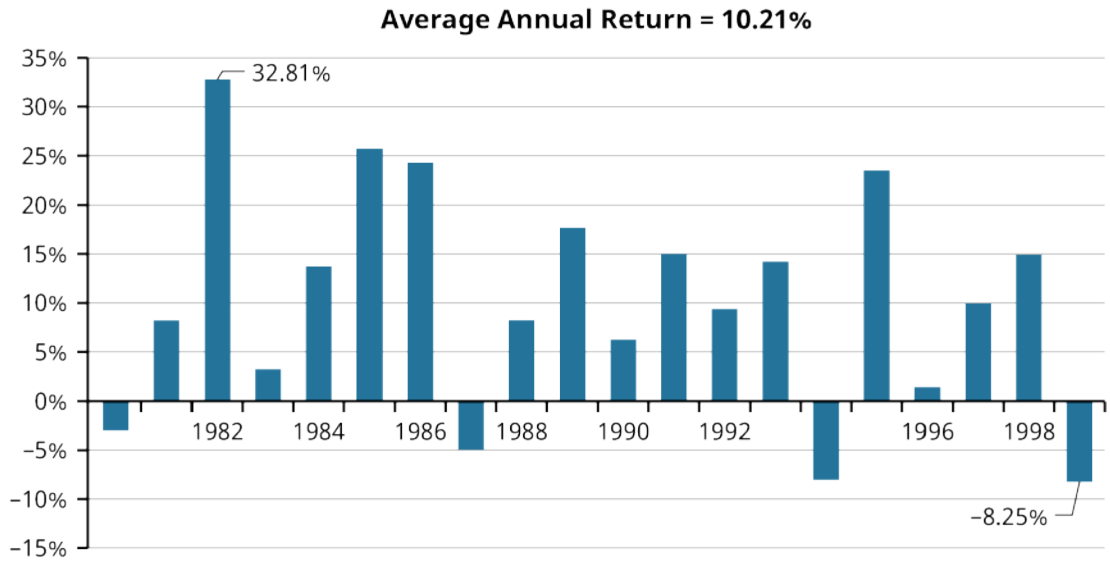


Figure 12.8 Treasury Bond Performance, 1980–1999 (data source: Aswath Damodaran Online)

Inflation slowed from 2000 to 2020, and the average annual rate of return on T-bonds fell accordingly (see Figure 12.9). With reduced variability of interest rates in the new century and interest rates in general being lower, the returns on bond portfolios were also lower on average. T-bonds in the first two decades of the twenty-first century averaged an annual return of 5.77%, very close to the long-run average return in the previous century. The range of returns was also smaller than the previous two decades, with the highest annual return topping out at 20.10% in 2008 and the lower end dipping down to -11.12% in 2009 as the Fed made a significant effort to reduce interest rates in an attempt to stimulate the economy following the Great Recession.

Corporate Bond Behavior, Discussion, Charts, and Graphs

The performance of Baa bonds is very similar to T-Bonds over the four decades spanning 1980 to 2020 (see Figure 12.10). These bonds are not default-risk free and require a risk premium for investors. The average annual return of 12.07% from 1980 to 1999 topped T-bonds by 1.86%. The margin was greater in the period from 2000 to 2020 (see Figure 12.11), with Baa bonds (mid-tier corporate bonds) realizing an average annual premium of 2.30% over the default-risk free T-bonds.

These premiums translate to a substantial increase in investment performance. For example, had an investor placed $100 into a T-bond portfolio in 1980, the value of the investment would have been $1,931 by year-end 2020. This would have easily outpaced the rate of inflation but significantly lagged the ending value of $4,506 on a similar Baa bond portfolio investment (see Figure 12.12).

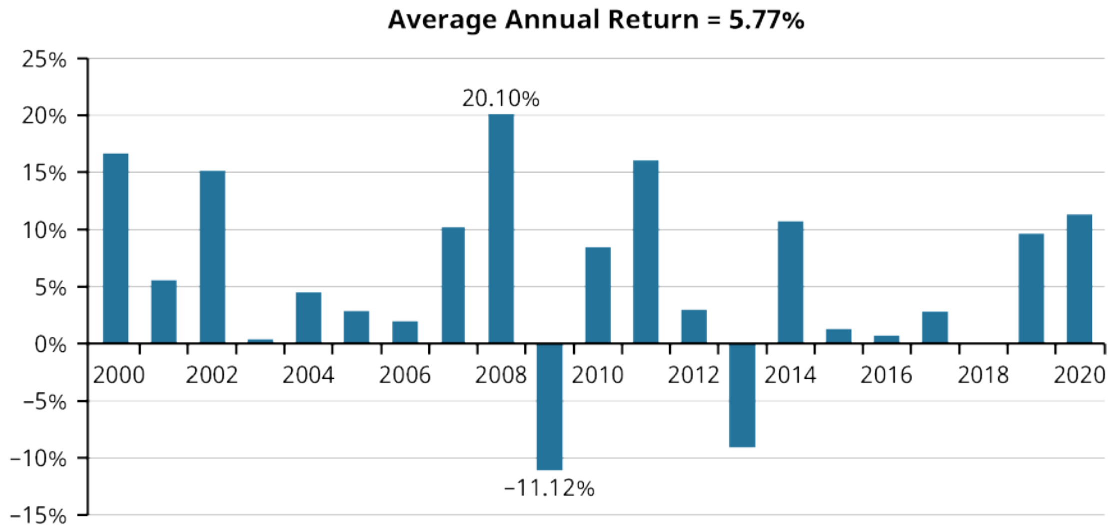


Figure 12.9 Treasury Bond Performance, 2000–2020 (data source: Aswath Damodaran Online)

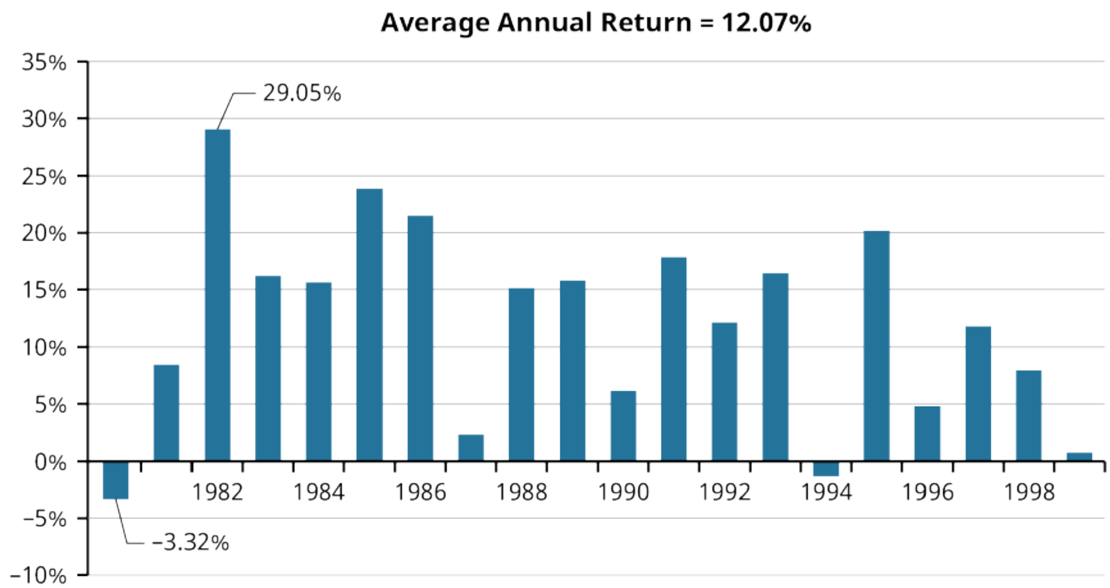


Figure 12.10 Baa Bond Performance, 1980–1999 (data source: Aswath Damodaran Online)

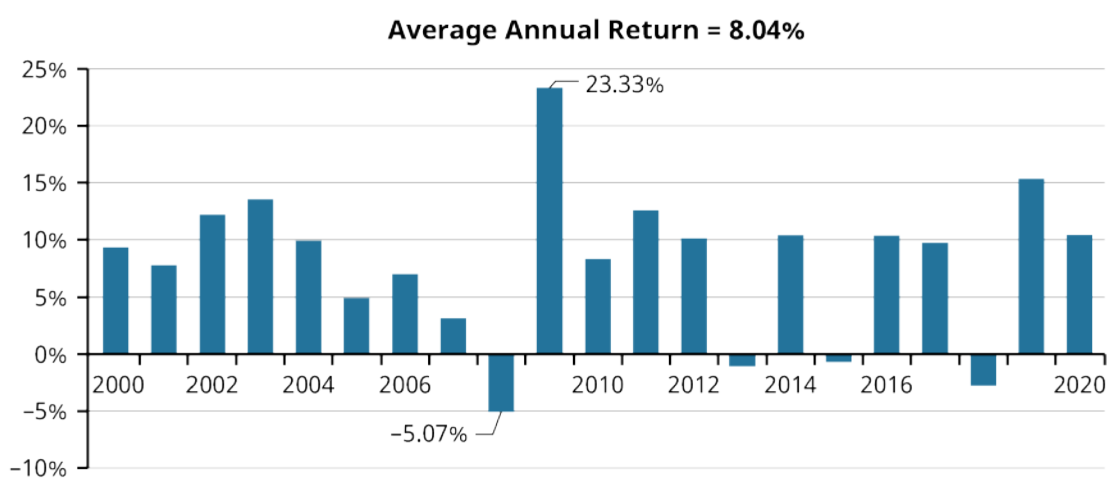


Figure 12.11 Baa Bond Performance, 2000–2020 (data source: Aswath Damodaran Online)

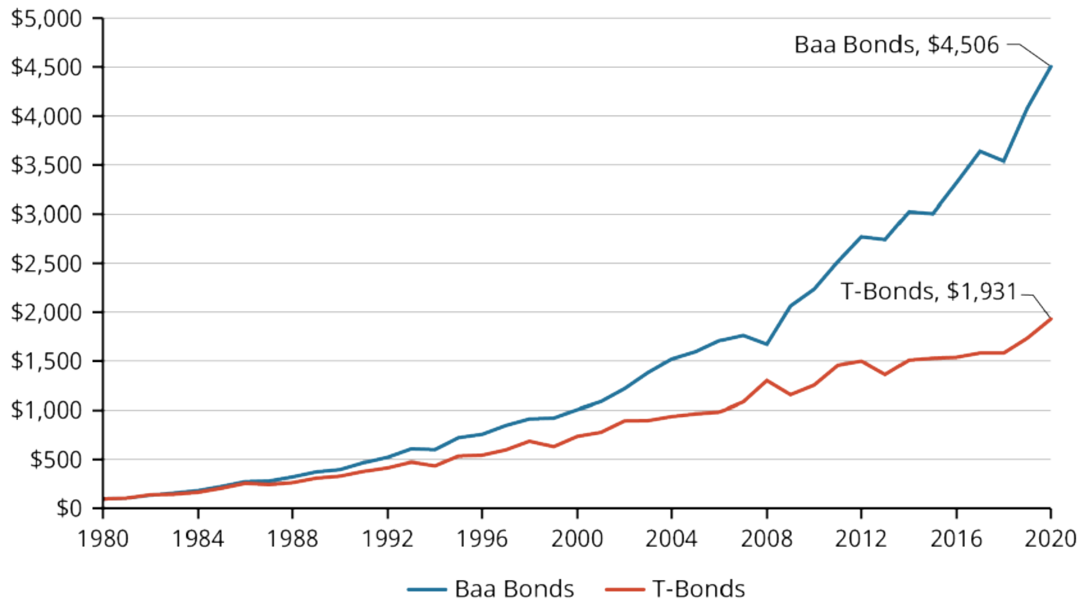


Figure 12.12 Baa Bonds versus T-Bonds Performance, 1980–2020 (data source: Aswath Damodaran Online)

CONCEPTS IN PRACTICE

Profile of Bill Gross

Bill Gross may be the most successful fixed-income investor ever, but he is also a prime example of the application of the efficient market theory. In over 40 years of investing in bonds and other types of fixed-income securities worldwide, Bill Gross earned his moniker “the bond king.”

In 1971, Gross cofounded and began his long tenure as managing director and chief investment officer of Pacific Investment Management Company, better known as Pimco. Gross was not yet 30 years old, but he had already graduated from college, served in the Navy in Vietnam, and even briefly worked as a professional blackjack player in Las Vegas to bankroll the cost of his MBA from UCLA.

Gross helped change the definition of success for bond investors by focusing on total returns, including price changes, rather than simply bond yields. He used mathematical modeling and invested worldwide and in different types of bond markets seeking risk-adjusted returns. Gross made active rather than passive management of bond funds a successful investment strategy. In the process, he changed how mangers oversee fixed-income portfolios today.

Pimco grew into an investment powerhouse under Gross’s direction, eventually managing over $1.5 trillion dollars in assets. During the financial crisis of 2008, Gross served as an adviser to the US Treasury. Morningstar named him “fixed income fund manager of the decade” in 2010. In addition, Gross profited from his investment prowess, amassing a fortune in excess of $2 billion.

Gross’s investment strategy was to carefully analyze the known factors about debt instruments and pair that analysis with the unknown future. He was uncanny in his ability to estimate future prices, interest rates, and macroeconomic conditions to make profitable investments.

However, as efficient markets would posit, the odds began to catch up with Gross in the latter part of his investing career. After leaving Pimco in 2014, Gross was unable to match his earlier performance successes and failed to beat bond fund performance averages. Much of Gross’s investment strategy allowed him to look for **bond returns** by investing in any type of bond, with any maturity, in any country, and in any location. For decades, he was right more often than wrong in his investment choices. However, statistically, his approach to investing suggested that, unless he could see the future, at some point his expectations would be incorrect. Perhaps Gross's greatest competition comes from a generation of investment managers who learned and improved upon his proven strategies. He retired as an active public fund manager in 2019.

Today, Gross continues to manage his personal fortune, as well as the assets in his family charitable foundation. Gross and the foundation have donated over $800 million to several causes over the last two decades. In 2020, Gross joined Bill Gates, Warren Buffett, and hundreds of other billionaires in signing the Giving Pledge, whose signees promise to donate over 50% of their wealth during their lifetime and/or upon their death.

(Sources: Mary Childs. "Bill Gross Made the Bond Market What It Is Today." *Barron's.* February 8, 2019. https://www.barrons.com/articles/bill-gross-bond-market-investing-legacy-51549669974; Jeff Sommer. "Once the 'Bond King,' Bill Gross Is Retiring, His Star Dimmed." *New York Times.* February 4, 2019. https://www.nytimes.com/2019/02/04/business/bond-king-bill-gross-retirement.html; CNN. "Bill Gross Fast Facts." *CNN.* March 31, 2021. https://www.cnn.com/2013/04/08/us/bill-gross-fast-facts/)

12.4 Historical Picture of Returns to Stocks

Learning Outcomes

By the end of this section, you will be able to:

- Explain overall equity market behavior over various historical periods.
- Explain different equity style and size behavior over various historical periods.
- Extract various equity market performance results from plots and charts.

Using Graphs and Charts to Plot Equity Market Behavior Stock Size Considerations

The Dow Jones Industrial Average (DJIA), also known as the Dow 30) and the S&P 500 Index are the most frequently quoted stock market indices among scholars, businesses, and the public in general. Both indices track the change in value of a group of large capitalization stocks. The changes in the two indices are highly correlated.

It may be fair to question if either index is a good representation of the value of equity and the changes in value in the market because there are over 6,000 publicly traded companies listed on organized exchanges and thousands of additional companies that trade only over the counter. As of year-end 2020, the S&P 500 firms had a combined market capitalization of $33.4 trillion, about 66% of the estimated US equity market capitalization of $50.8 trillion.[20] It is widely agreed that the performance of the S&P 500 is a good representation of the broader market and more specifically of large capitalization firms.

Figure 12.13 provides a visualization of how S&P 500 **stock returns** have stacked up since 1900. This figure makes it clear that equity returns roughly follow a bell curve, or normal distribution. Thus, we are able to measure risk with standard deviation. A lower standard deviation of returns suggests less uncertainty of returns and therefore less risk.

Capital market history demonstrates that the average return to stocks has significantly outperformed other financial security classes, such as government bonds, corporate bonds, or the money market. Table 12.4 provides the return and standard deviation of several US investment classes over the 40-year period 1981–2020. As you can see, stocks outperformed bonds, bills, and inflation. This has led many investment advisers to emphasize asset allocation first and individual security selection second. The intuition is that the

20 Spencer Israel. "The Number of Companies Publicly Traded in the US Is Shrinking—Or Is It?" *MarketWatch.* October 30, 2020. https://www.marketwatch.com/story/the-number-of-companies-publicly-traded-in-the-us-is-shrinkingor-is-it-2020-10-30; Siblis Research. "Total Market Value of US Stock Market." *Siblis Research.* https://siblisresearch.com/data/us-stock-market-value/

decision to invest in stocks rather than bonds has a greater long-run payoff than the change in performance resulting from the selection of any individual or group of stocks.

Figure 12.14 demonstrates the growth of a $100 investment at the start of 1928. Note that the value of the large company portfolio is more than 50 times greater than the equal investment in long-term US government bonds. This supports the importance of thoughtful asset allocation.

Still, the size of a firm has a significant impact on how investors choose equity securities. Capital market history also shows that a portfolio of small company stocks has realized larger average annual returns, as well as greater variability, than a portfolio of large companies as represented by the S&P 500. Small-cap stock total returns ranged from a high of 142.9% in 1933 to a low of -58.0% in 1937.

More recently, the differential return between small and large capital stocks has not been as pronounced. From 1980 through 2020, the Wilshire US Small-Cap Index has averaged an annual compound return of 12.13% compared to the Wilshire US Large Cap Index average of 11.82% over the same period. The 31-basis point premium is much smaller than that realized in the 1926–2019 period, which saw a small-cap average annual compounded return of 11.90% versus 10.14% for the large-cap portfolio.

The historical returns of US stocks over an approximately 90-year period result in a tabular pyramid when returns are listed by the number of years in each category.

–50% to –40%	–40% to –30%	–30% to –20%	–20% to –10%	–10% to 0%	0% to 10%	10% to 20%	20% to 30%	30% to 40%	40% to 50%	50% to 60%
						2004				
						1968				
						2016				
						1959				
						1965				
					1960	2014				
				1966	1994	1971	1999			
				2000	2015	2010	2017	1991		
				1962	2011	2006	1983	1950		
				1932	1970	2012	1963	2019		
				1946	2005	1964	1996	1985		
				1929	1947	1988	1951	1989		
				1969	2007	2020	1967	1980		
				1977	1948	1952	1976	1936		
				1981	1987	1949	1943	2013		
			1973	2018	1984	1986	2009	1955		
			1941	1990	1978	1979	1961	1997	1958	
		1974	2001	1953	1956	1972	1998	1945	1928	
	2008	1930	1940	1934	1992	1944	2003	1975	1935	
1931	1937	2002	1957	1939	1993	1942	1938	1995	1933	1954

Figure 12.13 The Pyramid of Equity Returns: Distribution of Annual Returns for the S&P 500 Index, 1928–2020 (data source: Aswath Damodaran Online)

Asset Class	Nominal Average Annual Returns 1981–2020	Standard Deviation of Returns 1981–2020
Large company stocks	12.64%	16.06%
Baa bonds	10.34%	7.67%
10-year T-bonds	8.21%	9.92%
US T-bills	3.94%	3.39%
Inflation	2.93%	1.76%

Table 12.4 Arithmetic Average Annual Returns and Standard Deviation by Asset Class, 1981–2020 (source: Aswatch Damodaran Online)

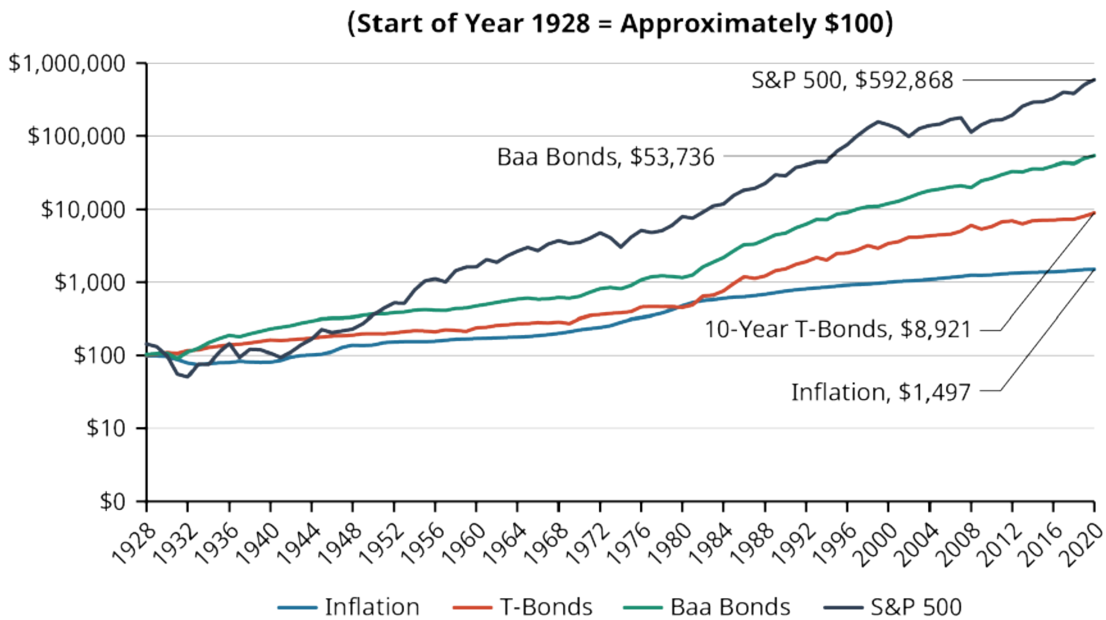


Figure 12.14 Growth of a $100 Investment into Selected Asset Portfolios, 1928–2020 (data source: Aswath Damodaran Online)

LINK TO LEARNING

Would You Like to Research More Historical Returns?

This article on historical returns and risks (https://openstax.org/r/6-what-to-invest-in) contains calculators that can help you find returns over your selected periods for US stocks, bonds, and inflation. How have the markets done since you were born? This second article about global equity markets (https://openstax.org/r/returns-of-global-stocks) has a comparable calculator. You can also go to the *Global Wealth Report (https://openstax.org/r/global-wealth-report)*, an annual publication by Credit Suisse, to dig more deeply.

LINK TO LEARNING

Does It Pay to Time the Market?

Over the period 1980 to mid-2020, an investment of $10,000 into an S&P 500 index fund would have yielded the investor $697,421. However, missing the 5 best-performing days in the market would have reduced the final portfolio balance to $432,411. Stay out of the market on the 10 best days, and the balance would have ended at only $313,377, or less than half of the return earned in the full time period. Watch this *Wall Street Journal (https://openstax.org/r/wall-street-journal-video)* video on the DJIA to learn more.

CONCEPTS IN PRACTICE

Warren Buffett

Figure 12.15 Warren Buffett (credit: "Warren Buffet at the 2015 Select USA Investment Summit." USA International Trade Administration/Wikimedia Commons, CC Public Domain Mark)

Warren Buffett has not always been one of the richest people in the world, but he has always been one of the hardest workers. An entrepreneur from an early age, Buffett's yearbook photo caption noted that he "likes math: a future stockbroker." Before leaving high school, Buffett had already earned thousands of dollars running a paper route and through one of his start-up businesses of installing and maintaining pinball machines in barbershops.

As they say in Nebraska, "you need to make hay while the sun shines," and Buffett has made his share of hay, so to speak. In his career, Buffett has accumulated enough hay to be one of the wealthiest people in the world, with a net worth of over $80 billion by the end of 2020.

The "Oracle of Omaha," as Buffett is known, grew his fortune through investing partnerships and most notably as the chairman, president, CEO, and largest stockholder of Berkshire Hathaway (BRK). Berkshire Hathaway was a New England textile manufacturer when Buffett and his investment partners began buying shares in the 1960s. By 1966, after a dispute with the then CEO of Berkshire, Buffett assumed control of the company and fired the CEO. Soon, Buffett's partnerships merged into Berkshire and moved the business away from textiles; it eventually became the largest financial services company in the world, including total ownership of the Geico Insurance Company.

Buffett's career is notable for how he developed his fortune, how he explained his philosophy, and for his current and future plans. Buffett followed the method of Benjamin Graham, famous value investor and author of *Security Analysis*, *The Intelligent Investor*. However, Buffett expanded beyond Graham's analysis of financial statements and intrinsic value to examine the character of executive management. He applied the same criteria to hiring employees as well. Buffett once noted, “We look for three things when we hire people. We look for intelligence, we look for initiative or energy, and we look for integrity. And if they don’t have the latter, the first two will kill you, because if you’re going to get someone without integrity, you want them lazy and dumb.” When speaking of integrity, Buffett went on to say, “Only when the tide goes out do you discover who’s been swimming naked.”

Buffett’s folksy way of making his point will undoubtedly be another of his legacies. When asked repeatedly about how he managed to be such a successful investor, Buffett replied, “Never invest in a business you can’t understand.” Never was this truer than in the late 1990s and 2000, when the dot-com craze fueled the stock market with technology firms enjoying tremendous price increases without the corresponding earnings. Buffett’s value investing lagged until the bubble burst, and suddenly he was back on top. When asked about his change in fortune he replied, “In the business world, the rearview mirror is always clearer than the windshield.”

Buffett believes in long-term rather than short-term investing. He once remarked that “Someone’s sitting in the shade today because someone planted a tree a long time ago” and “If you aren’t willing to own a stock for 10 years, don’t even think about owning it for 10 minutes.”

The third aspect of Buffett’s legacy will be how his money works now and after he is gone. With Bill and Melinda Gates, Buffett started the Giving Pledge, and to date they have gathered the pledge of over 200 billionaires to give away half or more of their fortune during and after their lifetimes. Buffett states, “If you’re in the luckiest 1% of humanity, you owe it to the rest of humanity to think about the other 99%.” Buffett has begun the process to give away most of his fortune, but he has left this pearl of wisdom for his own children: “A very rich person should leave his kids enough to do anything, but not enough to do nothing.”

(Sources: Joshua Kennon. “How Warren Buffett Became One of the Wealthiest People in America.” *The Balance.* May 4, 2021. https://www.thebalance.com/warren-Buffett-timeline-356439; Ty Haqqi. “Five Largest Financial Services Companies in the World.” *Insider Monkey.* November 26, 2020. https://www.insidermonkey.com/blog/5-largest-financial-services-companies-in-the-world-891348/2/; Mohit Oberoi. “Warren Buffett: Growth Stocks Look Like Dot-Com Bubble.” *Market Realist.* September 4, 2020. https://marketrealist.com/2020/07/warren-buffett-growth-stocks-like-dot-com-bubble/)

LINK TO LEARNING

Does It Pay to Invest Globally?

On a global basis, US equity markets have been among the highest performing since 1900. Only Australia shows a higher average annual return over the 121-year period. Many factors contribute to long-run stock performance in any given country. However, over the period studied, the United States benefited from an entrepreneurial spirit and distance from the center of two world wars. An article reviewing global stock market returns from 1900 to 2020 summarizes and analyzes global market return information created by researchers Elroy Dimson, Paul Marsh, and Mike Staunton for Credit Suisse.[21]

While most established economies have not generated higher returns than the US equity markets, they do offer the benefits of diversification. Further, the greatest return potential—and the greatest risk of

21 Karl Steiner. “Historical Returns of Global Stocks.” *Mindfully Investing*. July 6, 2020. https://www.mindfullyinvesting.com/historical-returns-of-global-stocks/; Elroy Dimson, Paul Marsh, and Mike Staunton. *Summary Edition Credit Suisse Global Investment Returns Yearbook 2020*. Credit Suisse, February 2020. https://www.credit-suisse.com/media/assets/corporate/docs/about-us/research/publications/credit-suisse-global-investment-returns-yearbook-2020-summary-edition.pdf

loss—may lie in developing economies. Investing experts are not in complete agreement about the advantages and disadvantages of investing in foreign equity markets. This article provides a framework for analysis and tools (https://openstax.org/r/returns-of-global-stocks) for comparing equity returns by country from 1970 through 2020. Has Australia continued to be the top-performing equity market since 1970? Have equity markets performed as well or better in the last 21 years compared to the 121-year period? Does the article encourage you to diversify internationally or focus only on domestic securities?

Summary

12.1 Overview of US Financial Markets

One way to parse financial markets is by the maturity of financial instruments. With this dichotomy, we explored the money market and the capital market. The money market consists of short-term securities and the capital market of longer-term securities. The capital market discussion focused on debt and equity as financial instruments used to finance longer-term capital financing needs. IPOs or SPACs are vehicles for raising new equity. Most trading on organized exchanges or over-the-counter markets is for used, or secondary, securities.

12.2 Historical Picture of Inflation

The Federal Reserve considers moderate inflation rates optimal in their oversight of the US economy. We measure inflation by comparing the price of a bundle or basket of goods over time and documenting how prices change. Since not everyone consumes similar baskets of goods, we calculate several different measures of inflation. The most commonly quoted measure of inflation uses changes in the Consumer Price Index (CPI).

12.3 Historical Picture of Returns to Bonds

Historical bond yields are published going back hundreds of years but are only reliably available for the last 100 years or so. In large part, the returns realized on portfolios of bonds have been smaller and less variable than the returns realized for equities.

12.4 Historical Picture of Returns to Stocks

Stocks have produced the greatest average annual rates of return of the money and capital market assets discussed in this chapter. Stockholders bear more risk than bondholders or money market investors and receive on average higher average annual returns. Despite the relatively high average annual rate of return for portfolios of stock, history shows that the equity markets earn negative annual returns about 25% of the time. The negative returns realized by equities occur far more often than the negative results realized by money market or debt market instruments.

Key Terms

bond returns sums the periodic interest payments and the change in bond price in a given period and divides by the bond price at the beginning of the period

commercial paper (CP) a short-term, unsecured security issued by corporations and financial institutions to meet short-term financing needs such as inventory and receivables

debenture a common type of unsecured bond issued by a corporation

indenture legal term for a bond contract

inflation a general increase in prices and a reduction in purchasing power; expected rate is a key component of interest rates

initial public offering (IPO) the first time a firm offers stock to the public

mortgage bond bond issued by a corporation using a real asset, such as property or buildings, to guarantee it

municipal bonds (munis) bonds issued by a local government, territory, or agency; generally used to finance infrastructure projects

negotiable certificates of deposit (NCDs) large CDs issued by financial institutions; redeemable at maturity but can trade prior to maturity in a broad secondary market

primary market market for new securities

seasoned equity offering (SEO) a method used by new IPOs to raise capital by offering additional shares of stock to the public

secondary market market for used securities

shelf registration part of Securities and Exchange Commission (SEC) Rule 415; allows a company to register with the SEC to issue new shares but allows up to two years before issuing the shares

special purpose acquisition companies (SPACs) a special form of IPO

stock returns sums the periodic dividend payments plus the change in stock price in a given period divided by the stock price at the beginning of the period

total returns the sum of all cash flows received from an investment; includes periodic cash flows plus price appreciation or price depreciation

Treasury bills (T-bills) short-term debt instruments issued by the federal government and maturing in a year or less

Treasury bonds government debt instruments with maturities of 20 or 30 years

Treasury notes (T-notes) government debt instruments with maturities of 2, 3, 5, 7, or 10 years

Multiple Choice

1. Which of the following statements about Treasury bills is false?
   a. T-bills sell at a discount from face value and pay the face value at maturity.
   b. T-bills have maturities of 2, 3, 5, 7, or 10 years.
   c. T-bill auctions take place weekly.
   d. T-bill denominations are relatively small compared to other money market instruments, with initial auction sizes of as little as $10,000 per T-bill.

2. If an investor wishes to simply execute a stock trade at the current market price, they should issue a ________.
   a. limit order
   b. stop loss order
   c. market order
   d. hedge order

3. Based on nominal average annual returns over the period 1980–2020, list the order of returns by asset class from highest to lowest.
   a. large company stocks, Baa bonds, small company stocks, T-bills
   b. small company stocks, large company stocks, Baa bonds, T-bills
   c. T-bills, Baa bonds, small company stocks, large company stocks
   d. small company stocks, large company stocks, T-bills, Baa bonds

4. A $1 investment in a portfolio of small company stocks in 1928 would have grown to over ________ by mid-2019.
   a. $35,000
   b. $8,000
   c. $800
   d. $80

5. Since 1980, the compound average annual growth rate for large company stocks has been ________.
   a. greater than Baa bonds but less than small company stocks
   b. greater than small company stocks but less than Baa bonds
   c. greater than Baa bonds and small company stocks
   d. less than Baa bonds and small company stocks

Review Questions

1. Define the competitive and noncompetitive bid process for US Treasury bills.
2. How does a negotiable certificate of deposit (NCD) differ from the typical certificate of deposit you may see advertised by your local bank?
3. If you are an investor concerned about unexpected inflation in the coming years which of the following investments offers the greatest protection against inflation, and why: T-notes, T-bonds, or TIPS?
4. Debentures are more common than mortgage bonds issued by corporations. Why do you think debentures are more popular with investors? Be sure to define each bond contract in your discussion.
5. Market capitalization is a common way to rank firm size. Search the internet to identify and define at least two other ways to rank firms based on size. Identify at least one reason you prefer market capitalization as the method of choice to rank firm size.
6. Compare and contrast an SEO, IPO, and SPAC. If Ford Motor Company wished to raise new equity capital, which of these vehicles would they use?
7. Compared to a "best efforts" form of underwriting, how does "firm commitment" underwriting transfer risk from the issuing firm to the underwriter?
8. How would a decrease in inflation affect the interest rate on an adjustable-rate debenture?
9. If inflation unexpectedly rises by 3%, would a corporation that had recently borrowed money by issuing fixed-rate bonds to pay for a new investment benefit or lose?
10. If wages on average rise at least as fast as inflation, why do people worry about how inflation affects incomes?
11. Identify at least one item that you use regularly whose price has changed significantly.
12. What has been the average annual rate of inflation between 1985 and 2020? What is the long-run average annual rate of inflation over the last century?
13. Between 1985 and 2020, what year had the lowest realized annual rate of inflation in the United States? Why do you think inflation was so low in this particular year?
14. Go to https://www.usinflationcalculator.com/ (https://openstax.org/r/usinflationcalculator). How much money would it take today to purchase what one dollar would have bought in 1950, in 1975, and in your birth year?
15. Are US Treasury bonds truly risk free?
16. At the end of 2020 and the beginning of 2021, coupon rates on long-term T-notes and T-bonds were near historic lows. Further, the federal government was running a historically large budget deficit in an effort to stimulate an economy battered by COVID-19 and to support millions of unemployed workers. Some investment advisers warned that this could be a particularly bad time to invest in government bonds or bonds in general. Why?
17. Which group of securities earned a higher average annual return from 2000 to 2020, T-bonds or Baa bonds? Why do think this was so?
18. Which earned a higher average annual return, a portfolio of T-bonds from 1980 to 2000 or from 2000 to 2020? Why do think this was so?
19. Why is standard deviation of returns a reasonable measure of risk for a portfolio of equity securities?
20. Many popular-press articles claim that growth investing is "clearly better" than value investing or that

value investing is "dead." How would you respond to proponents of growth investing after observing Figure 12.15?

21. Over the last 120 years, few countries have achieved the realized rate of returns enjoyed by US equity markets. Does this mean investors should ignore international investments and focus only on domestic markets in an effort to maximize returns?

Video Activity

How Private Companies Are Bypassing the IPO Process

Click to view content (https://openstax.org/r/blank-check-companies)

1. Can you identify three apparent advantages and three disadvantages for investors in a SPAC (special purpose acquisition company) versus a traditional IPO process?
2. The video concludes with a question about whether SPACs are a current fad doomed to fade away or a new and growing method of publicly financing firms. What do you think? Search for information related to SPACs and proposals for SPAC regulation, and report your conclusion.

A Secret Meeting and the Birth of the Federal Reserve

Click to view content (https://openstax.org/r/the-birth-of-the-federal)

3. How can an institution like the United State Federal Reserve System prevent bank runs?
4. After the passage of the Federal Reserve Act in 1913 (https://openstax.org/r/federal-reserve-act), the United States has suffered through three great global financial crises: the Great Depression of the 1930s, the Great Recession of 2007–2009 (https://openstax.org/r/the-worlds-most-devastating), and the COVID-19 pandemic of 2020–2021 (https://openstax.org/r/tracking-the-covid-19-recessions-effects). Research one of the latter two crises, and identify and discuss some of the tools used by the Fed to lessen the length and economic severity of the economic hardships. In what ways has this research project supported or changed your opinion about the United States having the Federal Reserve System?

13 Statistical Analysis in Finance

Figure 13.1 Graphical displays are used extensively in the finance field. (credit: modification of "Analysing target market" by Marco Verch/flickr CC BY 2.0)

Chapter Outline

Why It Matters

Statistical analysis is used extensively in finance, with applications ranging from consumer concerns such as credit scores, retirement planning, and insurance to business concerns such as assessing stock market volatility and predicting inflation rates. As a consumer, you will make many financial decisions throughout your life, and many of these decisions will be guided by statistical analysis. For example, what is the probability that interest rates will rise over the next year, and how will that affect your decision on whether to refinance a mortgage? In your retirement planning, how should the investment mix be allocated among stocks and bonds to minimize volatility and ensure a high probability for a secure retirement? When running a business, how can statistical quality control methods be used to maintain high quality levels and minimize waste? Should a business make use of consumer focus groups or customer surveys to obtain business intelligence data to improve service levels? These questions and more can benefit from the use and application of statistical methods.

Running a business and tracking its finances is a complex process. From day-to-day activities such as managing inventory levels to longer-range activities such as developing new products or expanding a customer base, statistical methods are a key to business success. For finance considerations, a business must manage risk versus return and optimize investments to ensure shareholder value. Business managers employ a wide range of statistical processes and tools to accomplish these goals. Increasingly, companies are also interested in data analytics to optimize the value gleaned from business- and consumer-related data, and statistical analysis forms the core of such analytics.

13.1 Measures of Center

By the end of this section, you will be able to:

- Calculate various measures of the average of a data set, such as mean, median, mode, and geometric mean.
- Recognize when a certain measure of center is more appropriate to use, such as weighted mean.
- Distinguish among arithmetic mean, geometric mean, and weighted mean.

Arithmetic Mean

The *average* of a data set is a way of describing location. The most widely used measures of the *center* of a data set are the mean (average), median, and mode. The arithmetic mean is the most common measure of the average. We will discuss the geometric mean later.

Note that the words *mean* and *average* are often used interchangeably. The substitution of one word for the other is common practice. The technical term is *arithmetic mean*, and *average* technically refers only to a center location. Formally, the arithmetic mean is called the first moment of the distribution by mathematicians. However, in practice among non-statisticians, *average* is commonly accepted as a synonym for *arithmetic mean*.

To calculate the **arithmetic mean** value of 50 stock portfolios, add the 50 portfolio dollar values together and divide the sum by 50. To calculate the arithmetic mean for a set of numbers, add the numbers together and then divide by the number of data values.

In statistical analysis, you will encounter two types of data sets: **sample data** and **population data**. Population data represents all the outcomes or measurements that are of interest. Sample data represents outcomes or measurements collected from a subset, or part, of the population of interest.

The notation $\overline{x}$ is used to indicate the sample mean, where the arithmetic mean is calculated based on data taken from a sample. The notation $\sum x$ is used to denote the sum of the data values, and n is used to indicate the number of data values in the sample, also known as the sample size.

The sample mean can be calculated using the following formula:

$$\overline{x} = \frac{\sum x}{n}$$

Finance professionals often rely on averages of Treasury bill auction amounts to determine their value. Table 13.1 lists the Treasury bill auction amounts for a sample of auctions from December 2020.

Maturity	Amount ($Billions)
4-week T-bills	$32.9
8-week T-bills	38.4
13-week T-bills	63.1
26-week T-bills	59.6
52-week T-bills	39.7
Total	**$233.7**

Table 13.1 United States Treasury Bill Auctions, December 22 and 24, 2020 (source: Treasury Direct)

To calculate the arithmetic mean of the amount paid for Treasury bills at auction, in billions of dollars, we use the following formula:

$$\bar{x} = \frac{\sum x}{n} = \frac{\$233.7}{5} = \$46.74$$

Median

To determine the **median** of a data set, order the data from smallest to largest, and then find the middle value in the ordered data set. For example, to find the median value of 50 portfolios, find the number that splits the data into two equal parts. The portfolio values owned by 25 people will be below the median, and 25 people will have portfolio values above the median. The median is generally a better measure of the average when there are **extreme values** or **outliers** in the data set.

An outlier or extreme value is a data value that is significantly different from the other data values in a data set. The median is preferred when outliers are present because the median is not affected by the numerical values of the outliers.

The ordered data set from Table 13.1 appears as follows:

$$32.9,\ 38.4,\ 39.7,\ 59.6,\ 63.1$$

The middle value in this ordered data set is the third data value, which is 39.7. Thus, the median is $39.7 billion.

You can quickly find the location of the median by using the expression $\frac{n+1}{2}$. The variable n represents the total number of data values in the sample. If n is an odd number, the median is the middle value of the data values when ordered from smallest to largest. If n is an even number, the median is equal to the two middle values of the ordered data values added together and divided by 2. In the example from Table 13.1, there are five data values, so $n = 5$. To identify the position of the median, calculate $\frac{n+1}{2}$, which is $\frac{5+1}{2}$, or 3. This indicates that the median is located in the third data position, which corresponds to the value 39.7.

As mentioned earlier, when outliers are present in a data set, the mean can be nonrepresentative of the center of the data set, and the median will provide a better measure of center. The following Think It Through example illustrates this point.

THINK IT THROUGH

Finding the Measure of Center

Suppose that in a small village of 50 people, one person earns a salary of $5 million per year, and the other 49 individuals each earn $30,000. Which is the better measure of *center*: the mean or the median?

Solution:

The *mean*, in dollars, would be arrived at mathematically as follows:

$$\bar{x} = \frac{5{,}000{,}000 + 49(30{,}000)}{50} = 129{,}400$$

However, the *median* would be $30,000. There are 49 people who earn $30,000 and one person who earns $5,000,000.

The median is a better measure of the "average" than the mean because 49 of the values are $30,000 and one is $5,000,000. The $5,000,000 is an outlier. The $30,000 gives us a better sense of the middle of the data set.

Mode

Another measure of center is the **mode**. The mode is the most frequent value. There can be more than one mode in a data set as long as those values have the same frequency and that frequency is the highest. A data set with two modes is called *bimodal*. For example, assume that the weekly closing stock price for a technology stock, in dollars, is recorded for 20 consecutive weeks as follows:

$$50,\ 53,\ 59,\ 59,\ 63,\ 63,\ 72,\ 72,\ 72,\ 72,\ 72,\ 76,\ 78,\ 81,\ 83,\ 84,\ 84,\ 84,\ 90,\ 93$$

To find the mode, determine the most frequent score, which is 72. It occurs five times. Thus, the mode of this data set is 72. It is helpful to know that the most common closing price of this particular stock over the past 20 weeks has been $72.00.

Geometric Mean

The arithmetic mean, median, and mode are all measures of the *center* of a data set, or the *average*. They are all, in their own way, trying to measure the common point within the data—that which is “normal.” In the case of the arithmetic mean, this is accomplished by finding the value from which all points are equal linear distances. We can imagine that all the data values are combined through addition and then distributed back to each data point in equal amounts.

The **geometric mean** redistributes not the sum of the values but their product. It is calculated by multiplying all the individual values and then redistributing them in equal portions such that the total product remains the same. This can be seen from the formula for the geometric mean, $\tilde{x}$ (pronounced *x*-tilde):

$$\tilde{x} = \sqrt[n]{x_1 \cdot x_2 \cdots x_n}$$

The geometric mean is relevant in economics and finance for dealing with growth—of markets, in investments, and so on. For an example of a finance application, assume we would like to know the equivalent percentage growth rate over a five-year period, given the yearly growth rates for the investment.

For a five-year period, the annual rate of return for a certificate of deposit (CD) investment is as follows: 3.21%, 2.79%, 1.88%, 1.42%, 1.17%. Find the single percentage growth rate that is equivalent to these five annual consecutive rates of return. The geometric mean of these five rates of return will provide the solution. To calculate the geometric mean for these values (which must all be positive), first multiply[1] the rates of return together—after adding 1 to the decimal equivalent of each interest rate—and then take the *n*th root of the product. We are interested in calculating the equivalent overall rate of return for the yearly rates of return, which can be expressed as 1.0321, 1.0279, 1.0188, 1.0142, and 1.0117:

$$\tilde{x} = \sqrt[n]{x_1 \cdot x_2 \cdots x_n} = \sqrt[5]{1.0321 \cdot 1.0279 \cdot 1.0188 \cdot 1.0142 \cdot 1.0117} = 1.0209$$

Based on the geometric mean, the equivalent annual rate of return for this time period is 2.09%.

LINK TO LEARNING

Arithmetic versus Geometric Means

In this video on arithmetic versus geometric means (https://openstax.org/r/arithmetic-versus-geometric), the returns of the S&P 500 are tracked using an arithmetic mean versus a geometric mean, and the difference between these two measurements is discussed.

Weighted Mean

A **weighted mean** is a measure of the center, or average, of a data set where each data value is assigned a corresponding weight. A common financial application of a weighted mean is in determining the average price

1 In this chapter, the interpunct dot will be used to indicate the multiplication operation in formulas.

per share for a certain stock when the stock has been purchased at different points in time and at different share prices.

To calculate a weighted mean, create a table with the data values in one column and the weights in a second column. Then create a third column in which each data value is multiplied by each weight on a row-by-row basis. Then, the weighted mean is calculated as the sum of the results from the third column divided by the sum of the weights.

THINK IT THROUGH

Calculating the Weighted Mean

Assume your portfolio contains 1,000 shares of XYZ Corporation, purchased on three different dates, as shown in Table 13.2. Calculate the weighted mean of the purchase price for the 1,000 shares.

Date Purchased	Purchase Price ($)	Number of Shares Purchased	Price ($) Times Number of Shares
January 17	78	200	15,600
February 10	122	300	36,600
March 23	131	500	65,500
Total	**NA**	**1,000**	**117,700**

Table 13.2 1,000 Shares of XYZ Corporation

Solution:

In this example, the purchase price is weighted by the number of shares. The sum of the third column is $117,700, and sum of the weights is 1,000. The weighted mean is calculated as $117,700 divided by 1,000, which is $117.70.

Thus, the average cost per share for the 1,000 shares of XYZ Corporation is $117.70.

13.2 Measures of Spread

By the end of this section, you will be able to:

- Define and calculate standard deviation for a data set.
- Define and calculate variance for a data set.
- Explain the relationship between standard deviation and variance.

Standard Deviation

An important characteristic of any set of data is the variation in the data. In some data sets, the data values are concentrated close to the mean; in other data sets, the data values are more widely spread out. For example, an investor might examine the yearly returns for Stock A, which are 1%, 2%, -1%, 0%, and 3%, and compare them to the yearly returns for Stock B, which are -9%, 2%, 15%, -5%, and 0%.

Notice that Stock B exhibits more volatility in yearly returns than Stock A. The investor may want to quantify this variation in order to make the best investment decisions for a particular investment objective.

The most common measure of variation, or spread, is standard deviation. The **standard deviation** of a data set is a measure of how far the data values are from their mean. A standard deviation

- provides a numerical measure of the overall amount of variation in a data set; and

- can be used to determine whether a particular data value is close to or far from the mean.

The standard deviation provides a measure of the overall variation in a data set. The standard deviation is always positive or zero. It is small when the data values are all concentrated close to the mean, exhibiting little variation or spread. It is larger when the data values are more spread out from the mean, exhibiting more variation.

Suppose that we are studying the variability of two different stocks, Stock A and Stock B. The average stock price for both stocks is $5. For Stock A, the standard deviation of the stock price is 2, whereas the standard deviation for Stock B is 4. Because Stock B has a higher standard deviation, we know that there is more variation in the stock price for Stock B than in the price for Stock A.

There are two different formulas for calculating standard deviation. Which formula to use depends on whether the data represents a sample or a population. The notation s is used to represent the sample standard deviation, and the notation σ is used to represent the population standard deviation. In the formulas shown below, $\bar{x}$ is the sample mean, μ is the population mean, n is the sample size, and N is the population size.

Formula for the sample standard deviation:

$$s = \sqrt{\frac{\sum(x - \overline{x})^2}{n - 1}}$$

Formula for the population standard deviation:

$$\sigma = \sqrt{\frac{\sum(x - \mu)^2}{N}}$$

Variance

Variance also provides a measure of the spread of data values. The variance of a data set measures the extent to which each data value differs from the mean. The more the individual data values differ from the mean, the larger the variance. Both the standard deviation and the variance provide similar information.

In a finance application, variance can be used to determine the volatility of an investment and therefore to help guide financial decisions. For example, a more cautious investor might opt for investments with low volatility.

Similar to standard deviation, the formula used to calculate variance also depends on whether the data is collected from a sample or a population. The notation s^2 is used to represent the sample variance, and the notation σ^2 is used to represent the population variance.

Formula for the sample variance:

$$s^2 = \frac{\sum(x - \overline{x})^2}{n - 1}$$

Formula for the population variance:

$$\sigma^2 = \frac{\sum(x - \mu)^2}{N}$$

This is the method to calculate standard deviation and variance for a sample:

1. First, find the mean $\overline{x}$ of the data set by adding the data values and dividing the sum by the number of data values.
2. Set up a table with three columns, and in the first column, list the data values in the data set.
3. For each row, subtract the mean from the data value $(x - \overline{x})$, and enter the difference in the second

column. Note that the values in this column may be positive or negative. The sum of the values in this column will be zero.

4. In the third column, for each row, square the value in the second column. So this third column will contain the quantity (Data Value – Mean)^2 for each row. We can write this quantity as $(x - \overline{x})^2$. Note that the values in this third column will always be positive because they represent a squared quantity.
5. Add up all the values in the third column. This sum can be written as $\sum (x - \overline{x})^2$.
6. Divide this sum by the quantity (n – 1), where n is the number of data points. We can write this as $\frac{\sum (x - \overline{x})^2}{n - 1}$.
7. This result is called the sample variance, denoted by s^2. Thus, the formula for the sample variance is $s^2 = \frac{\sum (x - \overline{x})^2}{n - 1}$.
8. Now take the square root of the sample variance. This value is the sample standard deviation, called s. Thus, the formula for the sample standard deviation is $s = \sqrt{\frac{\sum (x - \overline{x})^2}{n - 1}}$.
9. Round-off rule: The sample variance and sample standard deviation are typically rounded to one more decimal place than the data values themselves.

THINK IT THROUGH

Finding Standard Deviation and Variance

A brokerage firm advertises a new financial analyst position and receives 210 applications. The ages of a sample of 10 applicants for the position are as follows:

$$40,\ 36,\ 44,\ 51,\ 54,\ 55,\ 39,\ 47,\ 44,\ 50$$

The brokerage firm is interested in determining the standard deviation and variance for this sample of 10 ages.

Solution:

Find the sample variance and sample standard deviation by creating a table with three columns (see Table 13.3).

1. The data set is 40, 36, 44, 51, 54, 55, 39, 47, 44, 50.
2. This data set has 10 data values. Thus, $n = 10$.
3. The mean is calculated as $\overline{x} = 46$.
4. Column 1 will contain the data values themselves.
5. Column 2 will contain $x - \overline{x}$.
6. Column 3 will contain $(x - \overline{x})^2$.

Column 1 x	Column 2 $(x - \overline{x})$	Column 3 $(x - \overline{x})^2$
40	$40 - 46 = -6$	$(-6)^2 = 36$
36	$36 - 46 = -10$	$(-10)^2 = 100$
44	$44 - 46 = -2$	$(-2)^2 = 4$
51	$51 - 46 = 5$	$(5)^2 = 25$

Table 13.3 Calculations for Standard Deviation for Age Example

Column 1 x	Column 2 $(x - \overline{x})$	Column 3 $(x - \overline{x})^2$
54	$54 - 46 = 8$	$(8)^2 = 64$
55	$55 - 46 = 9$	$(9)^2 = 81$
39	$39 - 46 = -7$	$(-7)^2 = 49$
47	$47 - 46 = 1$	$(1)^2 = 1$
44	$44 - 46 = -2$	$(-2)^2 = 4$
50	$50 - 46 = 4$	$(4)^2 = 16$
	$\mathbf{Sum = 0}$	$\mathbf{Sum = 380}$

Table 13.3 Calculations for Standard Deviation for Age Example

7. To calculate the sample variance, use the sample variance formula:

$$s^2 = \frac{\sum (x - \overline{x})^2}{n - 1} = \frac{380}{10 - 1} = \frac{380}{9} \approx 42.2$$

8. To calculate the sample standard deviation, use the sample standard deviation formula:

$$s = \sqrt{\frac{\sum (x - \overline{x})^2}{n - 1}} = \sqrt{\frac{380}{9}} \approx 6.5$$

As the above example illustrates, calculating the variance and standard deviation is a tedious process. A financial calculator can calculate statistical measurements such as mean and standard deviation quickly and efficiently.

There are two steps needed to perform statistical calculations on the calculator:

1. Enter the data in the calculator using the `[DATA]` function, which is located above the `7` key.
2. Access the statistical results provided by the calculator using the `[STAT]` function, which is located above the `8` key.

Follow the steps in Table 13.4 to calculate mean and standard deviation using the financial calculator. The ages data set from the Think It Through example above is used again here: 40, 36, 44, 51, 54, 55, 39, 47, 44, 50.

Step	Description	Enter	Display	
1	Enter `[DATA]` entry mode	`2ND [DATA]`	X01	0.00
2	Clear any previous data	`2ND [CLR WORK]`	X01	0.00
3	Enter first data value of 40	40 `ENTER`	X01 =	40.00
4	Move to next data entry	↓	Y01 =	1.00
5	Move to next data entry	↓	X02	0.0
6	Enter second data value of 36	36 `ENTER`	X02 =	36.00

Table 13.4 Calculator Steps for Mean and Standard Deviation[2]

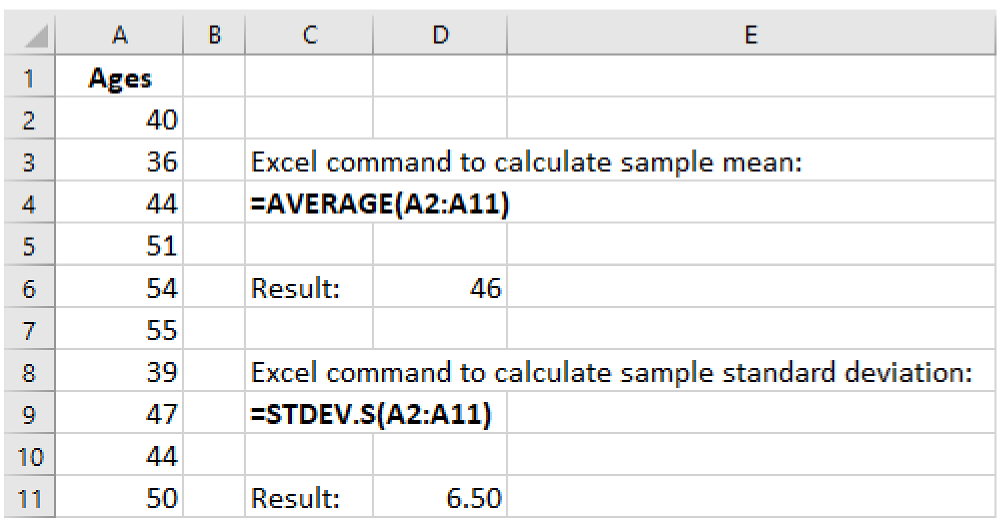
2 The specific financial calculator in these examples is the Texas Instruments BA II Plus™ Professional model, but you can use other financial calculators for these types of calculations.

Step	Description	Enter	Display	
7	Move to next data entry	↓	Y02 =	1.00
8	Move to next data entry	↓	X03	0.00
9	Enter third data value of 44	44 `ENTER`	X03 =	44.00
10	Move to next data entry	↓	Y03 =	1.00
11	Continue to enter remaining data values			
12	Enter `[STAT]` mode	2^{nd} `[STAT]`	LIN	
13	Move to first statistical result	↓	$n =$	10.00
14	Move to next statistical result	↓	$\overline{x} =$	46.00
15	Move to next statistical result	↓	$Sx =$	6.50

Table 13.4 Calculator Steps for Mean and Standard Deviation[2]

From the statistical results, the mean is shown as 46, and the sample standard deviation is shown as 6.50.

Excel provides a similar analysis using the built-in functions =AVERAGE (for the mean) and =STDEV.S (for the sample standard deviation). To calculate these statistical results in Excel, enter the data values in a column. Let's assume the data values are placed in cells A2 through A11. In any cell, type the Excel command =AVERAGE(A2:A11) and press enter. Excel will calculate the arithmetic mean in this cell. Then, in any other cell, type the Excel command =STDEV.S(A2:A11) and press enter. Excel will calculate the sample standard deviation in this cell. Figure 13.2 shows the mean and standard deviation for the 10 ages.



	A	B	C	D	E
1	**Ages**				
2	40				
3	36		Excel command to calculate sample mean:		
4	44		**=AVERAGE(A2:A11)**		
5	51				
6	54		Result:	46	
7	55				
8	39		Excel command to calculate sample standard deviation:		
9	47		**=STDEV.S(A2:A11)**		
10	44				
11	50		Result:	6.50	

Figure 13.2 Mean and Standard Deviation in Excel.

Relationship between Standard Deviation and Variance

In the formulas shown above for variance and standard deviation, notice that the variance is the square of the standard deviation, and the standard deviation is the square root of the variance.

Once you have calculated one of these values, you can directly calculate the other value. For example, if you know the standard deviation of a data set is 12.5, you can calculate the variance by squaring this standard deviation. The variance is then 12.5^2, which is 156.25.

In the same way, if you know the value of the variance, you can determine the standard deviation by calculating the square root of the variance. For example, if the variance of a data set is known to be 31.36, then the standard deviation can be calculated as the square root of 31.36, which is 5.6.

One disadvantage of using the variance is that the variance is measured in *square units*, which are different from the units in the data set. For example, if the data set consists of ages measured in years, then the variance would be measured in years squared, which can be confusing. The standard deviation is measured in the same units as the original data set, and thus the standard deviation is used more commonly than the variance to measure the spread of a data set.

13.3 Measures of Position

By the end of this section, you will be able to:

- Define and calculate *z*-scores for a measurement.
- Define and calculate quartiles and percentiles for a data set.
- Use quartiles as a method to detect outliers in a data set.

z-Scores

A ***z*-score**, also called a ***z*-value**, is a measure of the position of an entry in a data set. It represents the number of standard deviations by which a data value differs from the mean. For example, suppose that in a certain year, the rates of return for various technology-focused mutual funds are examined, and the mean return is 7.8% with a standard deviation of 2.3%. A certain mutual fund publishes its rate of return as 12.4%. Based on this rate of return of 12.4%, we can calculate the relative standing of this mutual fund compared to the other technology-focused mutual funds. The corresponding *z*-score of a measurement considers the given measurement in relation to the mean and standard deviation for the entire population.

The formula for a *z*-score calculation is as follows:

$$z = \frac{x - \mu}{\sigma}$$

where x is the measurement, μ is the mean, and σ is the standard deviation.

THINK IT THROUGH

Interpreting a *z*-Score

A certain technology-based mutual fund reports a rate of return of 12.4% for a certain year, while the mean rate of return for comparable funds is 7.8% and the standard deviation is 2.3%. Calculate and interpret the *z*-score for this particular mutual fund.

Solution:

In this example, the measurement $x = 12.4$, $\mu = 7.8$, and $\sigma = 2.3$. Using the *z*-score formula, the calculation is performed as follows:

$$z = \frac{x - \mu}{\sigma} = \frac{12.4 - 7.8}{2.3} = \frac{4.6}{2.3} = 2$$

The resulting *z*-score indicates the number of standard deviations by which a particular measurement is above or below the mean. In this example, the rate of return for this particular mutual fund is 2 standard deviations above the mean, indicating that this mutual fund generated a significantly better rate of return than all other technology-based mutual funds for the same time period.

Quartiles and Percentiles

If a person takes an IQ test, their resulting score might be reported as in the *87th percentile*. This percentile indicates the person’s relative performance compared to others taking the IQ test. A person scoring in the 87th percentile has an IQ score higher than 87% of all others taking the test. This is the same as saying that the person is in the top 13% of all people taking the IQ test.

Common measures of location are **quartiles** and **percentiles**. Quartiles are special percentiles. The first quartile, Q_1, is the same as the 25th percentile, and the third quartile, Q_3, is the same as the 75th percentile. The median, M, is called both the second quartile and the 50th percentile.

To calculate quartiles and percentiles, the data must be ordered from smallest to largest. Quartiles divide ordered data into quarters. Percentiles divide ordered data into hundredths. If you score in the 90th percentile of an exam, that does not necessarily mean that you receive 90% on the test. It means that 90% of the test scores are the same as or less than your score and the remaining 10% of the scores are the same as or greater than your score.

Percentiles are useful for comparing values. In a finance example, a mutual fund might report that the performance for the fund over the past year was in the 80th percentile of all mutual funds in the peer group. This indicates that the fund performed better than 80% of all other funds in the peer group. This also indicates that 20% of the funds performed better than this particular fund.

Quartiles are values that separate the data into quarters. Quartiles may or may not be part of the data. To find the quartiles, first find the median, or second quartile. The first quartile, Q_1, is the middle value, or median, of the lower half of the data, and the third quartile, Q_3, is the middle value of the upper half of the data. As an example, consider the following ordered data set, which represents the rates of return for a group of technology-based mutual funds in a certain year:

$$5.4,\ 6.0,\ 6.3,\ 6.8,\ 7.1,\ 7.2,\ 7.4,\ 7.5,\ 7.9,\ 8.2,\ 8.7$$

The median, or second quartile, is the middle value in this data set, which is 7.2. Notice that 50% of the data values are below the median, and 50% of the data values are above the median. The lower half of the data values are 5.4, 6.0, 6.3, 6.8, 7.1 Notice that these are the data values below the median. The upper half of the data values are 7.4, 7.5, 7.9, 8.2, 8.7, which are the data values above the median.)

To find the first quartile, Q_1, locate the middle value of the lower half of the data. The middle value of the lower half of the data set is 6.3. Notice that one-fourth, or 25%, of the data values are below this first quartile, and 75% of the data values are above this first quartile.

To find the third quartile, Q_3, locate the middle value of the upper half of the data. The middle value of the upper half of the data set is 7.9. Notice that one-fourth, or 25%, of the data values are above this third quartile, and 75% of the data values are below this third quartile.

The **interquartile range (IQR)** is a number that indicates the spread of the middle half, or the middle 50%, of the data. It is the difference between the third quartile, Q_3, and the first quartile, Q_1.

$$IQR = Q_3 - Q_1$$

In the above example, the IQR can be calculated as

$$IQR = Q_3 - Q_1 = 7.9 - 6.3 = 1.6$$

Outlier Detection

Quartiles and the IQR can be used to flag possible outliers in a data set. For example, if most employees at a company earn about $50,000 and the CEO of the company earns $2.5 million, then we consider the CEO’s salary to be an outlier data value because is significantly different from all the other salaries in the data set. An outlier data value can also be a value much lower than the other data values, so if one employee only makes $15,000, then this employee’s low salary might also be considered an outlier.

To detect outliers, use the quartiles and the IQR to calculate a lower and an upper bound for outliers. Then any data values below the lower bound or above the upper bound will be flagged as outliers. These data values should be further investigated to determine the nature of the outlier condition.

To calculate the lower and upper bounds for outliers, use the following formulas:

$$\text{Lower Bound for Outliers} = Q_1 - (1.5 \cdot IQR)$$
$$\text{Upper Bound for Outliers} = Q_3 + (1.5 \cdot IQR)$$

THINK IT THROUGH

Calculating the IQR

Calculate the IQR for the following 13 portfolio values, and determine if any of the portfolio values are potential outliers. Data values are in dollars.

389,950; 230,500; 158,000; 479,000; 639,000; 114,950; 5,500,000; 387,000; 659,000; 529,000; 575,000; 488,800; 1,095,000

Solution:

Order the data from smallest to largest.

114,950; 158,000; 230,500; 387,000; 389,950; 479,000; 488,800; 529,000; 575,000; 639,000; 659,000; 1,095,000; 5,500,000

$$M = 488{,}800$$
$$Q_1 = \frac{230{,}500 + 387{,}000}{2} = 308{,}750$$
$$Q_3 = \frac{639{,}000 + 659{,}000}{2} = 649{,}000$$
$$IQR = 649{,}000 - 308{,}750 = 340{,}250$$
$$(1.5)(IQR) = (1.5)(340{,}250) = 510{,}375$$
$$\text{Lower Bound} = Q_1 - (1.5)(IQR) = 308{,}750 - 510{,}375 = -201{,}625$$
$$\text{Upper Bound} = Q_3 + (1.5)(IQR) = 649{,}000 + 510{,}375 = 1{,}159{,}375$$

No portfolio value price is less than -201,625. However, 5,500,000 is more than 1,159,375. Therefore, the portfolio value of 5,500,000 is a potential outlier. This is important because the presence of outliers could potentially indicate data errors or some other anomalies in the data set that should be investigated.

13.4 Statistical Distributions

By the end of this section, you will be able to:

- Construct and interpret a frequency distribution.
- Apply and evaluate probabilities using the normal distribution.
- Apply and evaluate probabilities using the exponential distribution.

Frequency Distributions

A **frequency distribution** provides a method to organize and summarize a data set. For example, we might be interested in the spread, center, and shape of the data set's distribution. When a data set has many data values, it can be difficult to see patterns and come to conclusions about important characteristics of the data. A frequency distribution allows us to organize and tabulate the data in a summarized way and also to create graphs to help facilitate an interpretation of the data set.

To create a basic frequency distribution, set up a table with three columns. The first column will show the intervals for the data, and the second column will show the frequency of the data values, or the count of how many data values fall within each interval. A third column can be added to include the relative frequency for each row, which is calculated by taking the frequency for that row and dividing it by the sum of all the frequencies in the table.

THINK IT THROUGH

Graphing Demand and Supply

A financial consultant at a brokerage firm records the portfolio values for 20 clients, as shown in Table 13.5, where the portfolio values are shown in thousands of dollars.

278	318	422	577	618
735	798	864	903	944
1,052	1,099	1,132	1,180	1,279
1,365	1,471	1,572	1,787	1,905

Table 13.5 Portfolio Values for 20 Clients at a Brokerage Firm ($000s)

Create a frequency distribution table using the following intervals for the portfolio values:

0–299

300–599

600–899

900–1,199

1,200–1,499

1,500–1,799

1,800–2,099

Solution:

Create a table where the intervals for portfolio value are listed in the first column. For this example, it was decided to create a frequency distribution table with seven rows and a class width set to 300. The class width is the distance from the start of one interval to the start of the next interval in the subsequent row. For example, the interval for the second row starts at 300, the interval for the third row starts at 600, and so on.

In the second column, record the frequency, or the number of data values that fall within the interval, for each row. For example, for the first row, count the number of data values that fall between 0 and 299. Because there is only one data value (278) that falls in this interval, the corresponding frequency is 1. For the second row, there are 3 data values that fall between 300 and 599 (318, 422, and 577). Thus, the frequency for the second row is 3.

For the third column, called relative frequency, take the frequency for each row and divide it by the sum of the frequencies, which is 20. For example, in the first row, the relative frequency will be 1 divided by 20, which is 0.05. The relative frequency for the second row will be 3 divided by 20, which is 0.15. The resulting frequency distribution table is shown in Table 13.6.

Portfolio Value Interval ($000s)	Frequency	Relative Frequency
0–299	1	0.05
300–599	3	0.15
600–899	4	0.20
900–1,199	6	0.30
1,200–1,499	3	0.15
1,500–1,799	2	0.10
1,800–2,099	1	0.05

Table 13.6 Frequency Distribution of Portfolio Values for 20 Clients at a Brokerage Firm ($000s)

The frequency table indicates that most customers have portfolio values between $300,000 and $599,000, as this row in the table shows the highest frequency. Very few customers have portfolios with a value below $299,000 or above $1,800,000, as these frequencies in these rows are very low. Because the highest frequency corresponds to the row in the middle of the table and the frequencies decrease with each interval below and above this middle interval, the frequency table indicates that this distribution is a bell-shaped distribution.

The following is a summary of how to create a frequency distribution table (for integer data). Note that the number of classes in a frequency table is the same as the number of rows in the table.

1. Calculate the class width using the formula $\text{Class Width} = \frac{\text{Max} \; - \; \text{Min}}{\text{Number of Classes}}$
   - Note: For integer data, round the class width up to the next whole number.
2. Create a table with a number of rows equal to the number of classes. Create columns for Lower Class Limit, Upper Class Limit, Frequency, and Relative Frequency.
3. Set the lower class limit for the first row equal to the minimum value from the data set, or some other appropriate value.
4. Calculate the lower class limit for the second row by adding the class width to the lower class limit from the first row. Add the class width to each new lower class limit to calculate the lower class limit for each subsequent row.
5. The upper class limit for each row is 1 less than the lower class limit of the subsequent row. You can also add the class width to each upper class limit to determine the upper class limit for the subsequent row.
6. Record the frequency for each row by counting how many data values fall between the lower class limit and the upper class limit for that row.
7. Calculate the relative frequency for each row by taking the frequency for that row and dividing by the total number of data values.

Normal Distribution

The normal probability density function, a continuous distribution, is the most important of all the distributions. The **normal distribution** is applicable when the frequency of data values decreases with each class above and below the mean. The normal distribution can be applied to many examples from the finance industry, including average returns for mutual funds over a certain time period, portfolio values, and others. The normal distribution has two parameters, or numerical descriptive measures: the mean, μ, and the standard deviation, σ. The variable *x* represents the quantity being measured whose data values have a normal distribution.

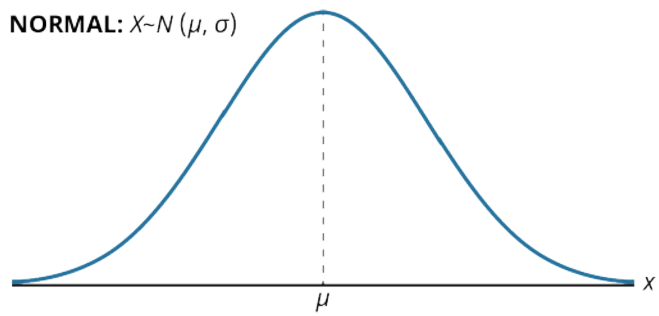


Figure 13.3 Graph of the Normal Distribution

The curve in Figure 13.3 is symmetric about a vertical line drawn through the mean, μ. The mean is the same as the median, which is the same as the mode, because the graph is symmetric about μ. As the notation indicates, the normal distribution depends only on the mean and the standard deviation. Because the area under the curve must equal 1, a change in the standard deviation, σ, causes a change in the shape of the normal curve; the curve becomes fatter and wider or skinnier and taller depending on σ. A change in μ causes the graph to shift to the left or right. This means there are an infinite number of normal probability distributions.

To determine probabilities associated with the normal distribution, we find specific areas under the normal curve, and this is further discussed in Apply the Normal Distribution in Financial Contexts. For example, suppose that at a financial consulting company, the mean employee salary is $60,000 with a standard deviation of $7,500. A normal curve can be drawn to represent this scenario, in which the mean of $60,000 would be plotted on the horizontal axis, corresponding to the peak of the curve. Then, to find the probability that an employee earns more than $75,000, you would calculate the area under the normal curve to the right of the data value $75,000.

Excel uses the following command to find the area under the normal curve to the *left* of a specified value:

```
=NORM.DIST(XVALUE, MEAN, STANDARD_DEV, TRUE)
```

For example, at the financial consulting company mentioned above, the mean employee salary is $60,000 with a standard deviation of $7,500. To find the probability that a random employee's salary is less than $55,000 using Excel, this is the command you would use:

```
=NORM.DIST(55000, 60000, 7500, TRUE)

Result: 0.25249
```

Thus, there is a probability of about 25% that a random employee has a salary less than $55,000.

Exponential Distribution

The **exponential distribution** is often concerned with the amount of time until some specific event occurs. For example, a finance professional might want to model the time to default on payments for company debt holders.

An exponential distribution is one in which there are fewer large values and more small values. For example, marketing studies have shown that the amount of money customers spend in a store follows an exponential distribution. There are more people who spend small amounts of money and fewer people who spend large amounts of money.

Exponential distributions are commonly used in calculations of product reliability, or the length of time a product lasts. The random variable for the exponential distribution is continuous and often measures a passage of time, although it can be used in other applications. Typical questions may be, What is the probability that some event will occur between x_1 hours and x_2 hours? or What is the probability that the event will take more than x_1 hours to perform? In these examples, the random variable x equals either the time between events or the passage of time to complete an action (e.g., wait on a customer). The probability density function is given by

$$f(x) = \frac{1}{\mu} e^{-\frac{1}{\mu} x}$$

where μ is the historical average of the values of the random variable (e.g., the historical average waiting time). This probability density function has a mean and standard deviation of $\frac{1}{\mu}$.

To determine probabilities associated with the exponential distribution, we find specific areas under the exponential distribution curve. The following formula can be used to calculate the area under the exponential curve to the left of a certain value:

$$F(x) = 1 - e^{-\frac{1}{\mu} x}$$

THINK IT THROUGH

Calculating Probability

At a financial company, the mean time between incoming phone calls is 45 seconds, and the time between phone calls follows an exponential distribution, where the time is measured in minutes. Calculate the probability of having 2 minutes or less between phone calls.

Solution:

To calculate the probability, find the area under the curve to the left of 1 minute. The mean time is given as 45 seconds, which is the same as 0.75 minutes. The probability can then be calculated as follows:

$$\text{Probability} = 1 - e^{-\frac{1}{0.75}(1)} = 0.736$$

13.5 Probability Distributions

By the end of this section, you will be able to:

- Calculate portfolio weights in an investment.
- Calculate and interpret the expected values.
- Apply the normal distribution to characterize average and standard deviation in financial contexts.

Calculate Portfolio Weights

In many financial analyses, the **weightings** by asset category in a **portfolio** are a key index used to assess if the portfolio is meeting allocation metrics. For example, an investor approaching retirement age may wish to shift assets in a portfolio to more conservative and lower-volatility investments. Weightings can be calculated in several different ways—for example, based on individual stocks in a portfolio or on various sectors in a portfolio. Weightings can also be calculated based on number of shares or the value of shares of a stock.

To calculate a weighting in a portfolio based on value, take the value of the particular investment and divide it by the total value of the overall portfolio. As an example, consider an individual's retirement account for which the desired portfolio weighting is determined to be 40% stocks, 50% bonds, and 10% cash equivalents. Table 13.7 shows the current assets in the individual's portfolio, broken out according to stocks, bonds, and cash equivalents.

Asset	Value ($)
Stock A	134,000
Stock B	172,000
Bond C	38,000
Bond D	102,000
Bond E	96,000
Cash in CDs	35,700
Cash in savings	22,500
Total Value	**600,200**

Table 13.7 Portfolio Assets in Stocks, Bonds, and Cash Equivalents

To determine the weighting in this portfolio for stocks, bonds, and cash, take the total value for each category and divide it by the total value of the entire portfolio. These results are summarized in Table 13.8. Notice that the portfolio weightings shown in the table do not match the target, or desired, allocation weightings of 40% stocks, 50% bonds, and 10% cash equivalents.

Asset Category	Category Value ($)	Portfolio Weighting
Stocks	$306{,}000$	$\frac{306{,}000}{600{,}200} = 0.51$
Bonds	$236{,}000$	$\frac{236{,}000}{600{,}200} = 0.39$
Cash	$58{,}200$	$\frac{58{,}200}{600{,}200} = 0.10$
Total Value	$\mathbf{600{,}200}$	

Table 13.8 Portfolio Weightings for Stocks, Bonds, and Cash Equivalents

Portfolio rebalancing is a process whereby the investor buys or sells assets to achieve the desired portfolio weightings. In this example, the investor could sell approximately 10% of the stock assets and purchase bonds with the proceeds to align the asset categories to the desired portfolio weightings.

Calculate and Interpret Expected Values

A **probability distribution** is a mathematical function that assigns probabilities to various outcomes. For example, we can assign a probability to the outcome of a certain stock increasing in value or decreasing in value. One application of a probability distribution function is determining **expected value**.

In many financial situations, we are interested in determining the expected value of the return on a particular investment or the expected return on a portfolio of multiple investments. To calculate expected returns, we formulate a probability distribution and then use the following formula to calculate expected value:

$$\text{Expected Value} = P_1 \cdot R_1 + P_2 \cdot R_2 + P_3 \cdot R_3 + \ldots + P_n \cdot R_n$$

where P_1, P_2, P_3, $\cdots$ P_n are the probabilities of the various returns and R_1, R_2, R_3, $\cdots$ R_n are the various rates of return.

In essence, expected value is a weighted mean where the probabilities form the weights. Typically, these values for P_n and R_n are derived from historical data. As an example, consider a probability distribution for potential returns for United Airlines common stock. Assume that from historical data gathered over a certain time period, there is a 15% probability of generating a 12% return on investment for this stock, a 35% probability of generating a 5% return, a 25% probability of generating a 2% return, a 14% probability of generating a 5% loss, and an 11% probability of resulting in a 10% loss. This data can be organized into a probability distribution table as seen in Table 13.9.

Using the expected value formula, the expected return of United Airlines stock over an extended period of time follows:

$$\text{Expected Value} = P_1 \cdot R_1 + P_2 \cdot R_2 + P_3 \cdot R_3 + \ldots + P_n \cdot R_n$$
$$\text{Expected Value} = 0.15(0.12) + 0.35(0.05) + 0.25(0.02) + 0.14(-0.05) + 0.11(-0.10) = 0.0225$$

Based on the probability distribution, the expected value of the rate of return for United Airlines common stock over an extended period of time is 2.25%.

Historical Return (%)	Associated Probability (%)
12	15
5	35
2	25
-5	14
-10	11

Table 13.9 Probability Distribution for Historical Returns on United Airlines Stock

We can extend this analysis to evaluate the expected return for an investment portfolio consisting of various asset categories, such as stocks, bonds, and cash equivalents, where the probabilities are associated with the weighting of each category relative to the total value of the portfolio. Using historical return data for each of the asset categories, the expected return of the overall portfolio can be calculated using the expected value formula.

Assume an investor has assets in stocks, bonds, and cash equivalents as shown in Table 13.10.

Asset Category	Value ($)	Portfolio Weighting	Historical Return (%)
Stocks	306,000	$\frac{306{,}000}{600{,}200} = 0.51$	13.0
Bonds	236,000	$\frac{236{,}000}{600{,}200} = 0.39$	4.0
Cash	58,200	$\frac{58{,}200}{600{,}200} = 0.10$	2.5
Total Value	**$600,200**		

Table 13.10 Portfolio Weightings and Historical Returns for Various Asset Categories

$$\text{Expected Value} = P_1 \cdot R_1 + P_2 \cdot R_2 + P_3 \cdot R_3 + \ldots + P_n \cdot R_n$$
$$\text{Expected Value} = 0.51(0.130) + 0.39(0.040) + 0.10(0.025) = 0.0844$$

Based on the probability distribution, the expected value of the rate of return for this portfolio over an extended period of time is 8.44%.

Apply the Normal Distribution in Financial Contexts

The normal, or bell-shaped, distribution can be utilized in many applications, including financial contexts.

Remember that the normal distribution has two parameters: the mean, which is the center of the distribution, and the standard deviation, which measures the spread of the distribution. Here are several examples of applications of the normal distribution:

- IQ scores follow a normal distribution, with a mean IQ score of 100 and a standard deviation of 15.
- Salaries at a certain company follow a normal distribution, with a mean salary of $52,000 and a standard deviation of $4,800.
- Grade point averages (GPAs) at a certain college follow a normal distribution, with a mean GPA of 3.27 and a standard deviation of 0.24.
- The average annual gain of the Dow Jones Industrial Average (DJIA) over a 40-year time period follows a normal distribution, with a mean gain of 485 points and a standard deviation of 1,065 points.
- The average annual return on the S&P 500 over a 50-year time period follows a normal distribution, with a mean rate of return of 10.5% and a standard deviation of 14.3%.
- The average annual return on mid-cap stock funds over the five-year period from 2010 to 2015 follows a normal distribution, with a mean rate of return of 8.9% and a standard deviation of 3.7%.

When analyzing data sets that follow a normal distribution, probabilities can be calculated by finding areas under the normal curve. To find the probability that a measurement is within a specific interval, we can compute the area under the normal curve corresponding to the interval of interest.

Areas under the normal curve are available in tables, and Excel also provides a method to find these areas. The **empirical rule** is one method for determining areas under the normal curve that fall within a certain number of standard deviations of the mean (see Figure 13.4).

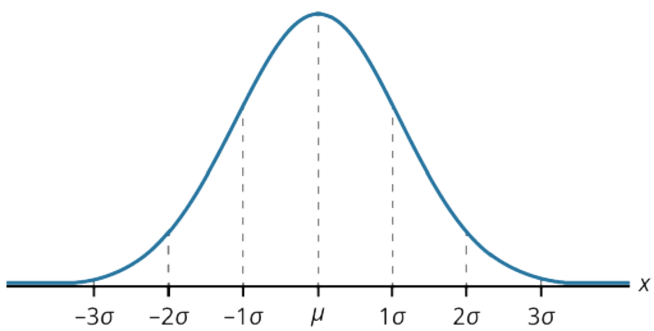


Figure 13.4 **Normal Distribution Showing Mean and Increments of Standard Deviation**

If *x* is a random variable and has a normal distribution with mean μ and standard deviation σ, then the empirical rule states the following:

- About 68% of the *x*-values lie between -1σ and $+1\sigma$ units from the mean μ (within one standard deviation of the mean).
- About 95% of the *x*-values lie between -2σ and $+2\sigma$ units from the mean μ (within two standard deviations of the mean).
- About 99.7% of the *x*-values lie between -3σ and $+3\sigma$ units from the mean μ (within three standard deviations of the mean). Notice that almost all the *x*-values lie within three standard deviations of the mean.
- The *z*-scores for $+1\sigma$ and -1σ are $+1$ and -1, respectively.
- The *z*-scores for $+2\sigma$ and -2σ are $+2$ and -2, respectively.
- The *z*-scores for $+3\sigma$ and -3σ are $+3$ and -3, respectively.

As an example of using the empirical rule, suppose we know that the average annual return for mid-cap stock funds over the five-year period from 2010 to 2015 follows a normal distribution, with a mean rate of return of 8.9% and a standard deviation of 3.7%. We are interested in knowing the likelihood that a randomly selected mid-cap stock fund provides a rate of return that falls within one standard deviation of the mean, which implies a rate of return between 5.2% and 12.6%. Using the empirical rule, the area under the normal curve within one standard deviation of the mean is 68%. Thus, there is a probability, or likelihood, of 0.68 that a mid-cap stock fund will provide a rate of return between 5.2% and 12.6%.

If the interval of interest is extended to two standard deviations from the mean (a rate of return between 1.5% and 16.3%), using the empirical rule, we can determine that the area under the normal curve within two standard deviations of the mean is 95%. Thus, there is a probability, or likelihood, of 0.95 that a mid-cap stock fund will provide a rate of return between 1.5% and 16.3%.

13.6 Data Visualization and Graphical Displays

By the end of this section, you will be able to:

- Determine appropriate graphs to use for various types of data.
- Create and interpret univariate graphs such as bar graphs and histograms.
- Create and interpret bivariate graphs such as time series graphs and scatter plot graphs.

Graphing Univariate Data

Data visualization refers to the use of graphical displays to summarize data to help to interpret patterns and trends in the data. *Univariate data* refers to observations recorded for a single characteristic or attribute, such as salaries or blood pressure measurements. When graphing univariate data, we can choose from among several types of graphs, such as bar graphs, time series graphs, and so on.

The most effective type of graph to use for a certain data set will depend on the nature of the data and the purpose of the graph. For example, a time series graph is typically used to show how a measurement is changing over time and to identify patterns or trends over time.

Below are some examples of typical applications for various graphs and displays.

Graphs used to show the distribution of data:

- Bar chart: used to show frequency or relative frequency distributions for categorical data
- Histogram: used to show frequency or relative frequency distributions for continuous data

Graphs used to show relationships between data points:

- Time series graph: used to show measurement data plotted against time, where time is displayed on the horizontal axis
- Scatter plot: used to show the relationship between a dependent variable and an independent variable

Bar Graphs

A **bar graph** consists of bars that are separated from each other and compare percentages. The bars can be rectangles, or they can be rectangular boxes (used in three-dimensional plots), and they can be vertical or horizontal. The bar graph shown in the example below has age groups represented on the ***x*-axis** and proportions on the ***y*-axis**.

By the end of 2021, a certain social media site had over 146 million users in the United States. Table 13.11 shows three age groups, the number of users in each age group, and the proportion (%) of users in each age group. A bar graph using this data is shown in Figure 13.5.

Age Groups	Number of Site Users	Percent of Site Users
13–25	65,082,280	45
26–44	53,300,200	36

Table 13.11 Data for Bar Graph of Age Groups

Age Groups	Number of Site Users	Percent of Site Users
45–64	27,885,100	19

Table 13.11 Data for Bar Graph of Age Groups

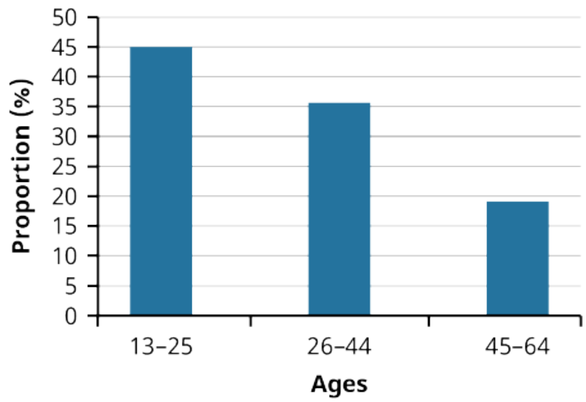


Figure 13.5 Bar Graph of Age Groups

Histograms

A **histogram** is a bar graph that is used for continuous numeric data, such as salaries, blood pressures, heights, and so on. One advantage of a histogram is that it can readily display large data sets. A rule of thumb is to use a histogram when the data set consists of 100 values or more.

A histogram consists of contiguous (adjoining) boxes. It has both a horizontal axis and a vertical axis. The horizontal axis is labeled with what the data represents (for instance, distance from your home to school). The vertical axis is labeled either Frequency or Relative Frequency (or Percent Frequency or Probability). The graph will have the same shape regardless of the label on the vertical axis. A histogram, like a stem-and-leaf plot, can give you the shape of the data, the center, and the spread of the data.

The relative frequency is equal to the frequency of an observed data value divided by the total number of data values in the sample. Remember, frequency is defined as the number of times a solution occurs. Relative frequency is calculated using the formula

$$RF = \frac{f}{n}$$

where f = frequency, n = the total number of data values (or the sum of the individual frequencies), and RF = relative frequency.

To construct a histogram, first decide how many bars or intervals, also called classes, will represent the data. Many histograms consist of 5 to 15 bars or classes for clarity. The number of bars needs to be chosen. Choose a starting point for the first interval that is less than the smallest data value. A convenient starting point is a lower value carried out to one more decimal place than the value with the most decimal places. For example, if the value with the most decimal places is 6.1, and if this is the smallest value, a convenient starting point is 6.05 (because $6.1 - 0.05 = 6.05$). We say that 6.05 has more precision. If the value with the most decimal places is 2.23 and the lowest value is 1.5, a convenient starting point is 1.495 ($1.5 - 0.005 = 1.495$). If the value with the most decimal places is 3.234 and the lowest value is 1.0, a convenient starting point is 0.995 ($1.0 - 0.0005 = 0.9995$). If all the data values happen to be integers and the smallest value is 2, then a convenient starting point is 1.5 ($2 - 0.05 = 1.5$). Also, when the starting point and other boundaries are carried to one additional decimal place, no data value will fall on a boundary. The next two examples go into detail about how to construct a histogram using continuous data and how to create a histogram using discrete data.

Example: The following data values are the portfolio values, in thousands of dollars, for 100 investors.

60, 60.5, 61, 61, 61.5
63.5, 63.5, 63.5
64, 64, 64, 64, 64, 64, 64, 64.5, 64.5, 64.5, 64.5, 64.5, 64.5, 64.5, 64.5
66, 66, 66, 66, 66, 66, 66, 66, 66, 66, 66.5, 66.5, 66.5, 66.5, 66.5, 66.5, 66.5, 66.5, 66.5, 66.5, 66.5, 67, 67, 67, 67, 67, 67, 67, 67, 67, 67, 67, 67, 67.5, 67.5, 67.5, 67.5, 67.5, 67.5, 67.5
68, 68, 69, 69, 69, 69, 69, 69, 69, 69, 69, 69, 69.5, 69.5, 69.5, 69.5, 69.5
70, 70, 70, 70, 70, 70, 70.5, 70.5, 70.5, 71, 71, 71
72, 72, 72, 72.5, 72.5, 73, 73.5
74

The smallest data value is 60. Because the data values with the most decimal places have one decimal place (for instance, 61.5), we want our starting point to have two decimal places. Because the numbers 0.5, 0.05, 0.005, and so on are convenient numbers, use 0.05 and subtract it from 60, the smallest value, to get a convenient starting point: $60 - 0.05 = 59.95$, which is more precise than, say, 61.5 by one decimal place. Thus, the starting point is 59.95. The largest value is 74, and $74 + 0.05 = 74.05$, so 74.05 is the ending value.

Next, calculate the width of each bar or class interval. To calculate this width, subtract the starting point from the ending value and divide the result by the number of bars (you must choose the number of bars you desire). Suppose you choose eight bars. The interval width is calculated as follows:

$$\frac{74.05 - 59.95}{8} = 1.76$$

We will round up to 2 and make each bar or class interval 2 units wide. Rounding up to 2 is one way to prevent a value from falling on a boundary. Rounding to the next number is often necessary, even if it goes against the standard rules of rounding. For this example, using 1.76 as the width would also work. A guideline that is followed by some for the width of a bar or class interval is to take the square root of the number of data values and then round to the nearest whole number if necessary. For example, if there are 150 data values, take the square root of 150 and round to 12 bars or intervals. The boundaries are as follows:

$$\begin{array}{c} 59.95 \\ 59.95 + 2 = 61.95 \\ 61.95 + 2 = 63.95 \\ 63.95 + 2 = 65.95 \\ 65.95 + 2 = 67.95 \\ 67.95 + 2 = 69.95 \\ 69.95 + 2 = 71.95 \\ 71.95 + 2 = 73.95 \\ 73.95 + 2 = 75.95 \end{array}$$

The data values 60 through 61.5 are in the interval 59.95–61.95. The data values of 63.5 are in the interval 61.95–63.95. The data values of 64 and 64.5 are in the interval 63.95–65.95. The data values 66 through 67.5 are in the interval 65.95–67.95. The data values 68 through 69.5 are in the interval 67.95–69.95. The data values 70 through 71 are in the interval 69.95–71.95. The data values 72 through 73.5 are in the interval 71.95–73.95. The data value 74 is in the interval 73.95–75.95. The histogram shown in Figure 13.6 displays the portfolio values on the *x*-axis and relative frequency on the *y*-axis.

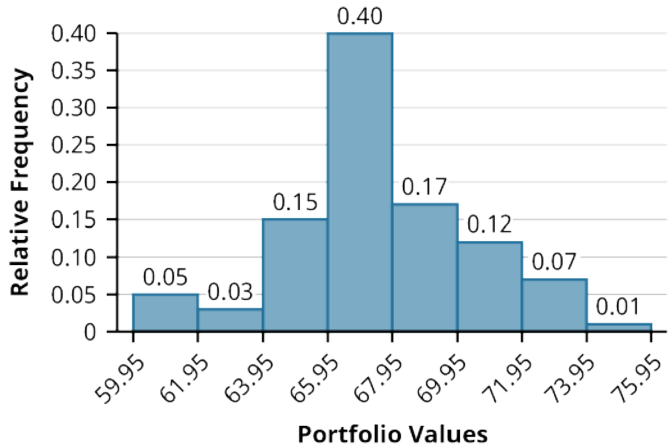


Figure 13.6 Histogram of Portfolio Values

Graphing Bivariate Data

Bivariate data refers to paired data, where each value of one variable is paired with a value of a second variable. An example of paired data would be if data were collected on employees' years of experience and their corresponding salaries. Typically, it is of interest to investigate possible associations or correlations between the two variables under analysis.

Time Series Graphs

Suppose that we want to track the consumer price index (CPI) over the past 10 years. One feature of the data that we may want to consider is the element of time. Because each year is paired with the CPI value for that year, we do not have to think of the data as being random. We can instead use the years given to impose a chronological order on the data. A graph that recognizes this ordering and displays the changing CPI value as the decade progresses is called a time series graph.

To construct a **time series graph**, we must look at both pieces of our paired data set. We start with a standard Cartesian coordinate system. The horizontal axis is used to plot the time increments, and the vertical axis is used to plot the values of the variable that we are measuring. By doing this, we make each point on the graph correspond to a point in time and a measured quantity. The points on the graph are typically connected by straight lines in the order in which they occur.

Example: The following data set shows the annual CPI for 10 years. We need to construct a time series graph for the (rounded) annual CPI data (see Table 13.12). The time series graph is shown in Figure 13.7.

Year	CPI
2012	226.65
2013	230.28
2014	233.91

Table 13.12 **Data for Time Series Graph of Annual CPI, 2012–2021** (source: US Bureau of Labor Statistics)

Year	CPI
2015	233.70
2016	236.91
2017	242.84
2018	247.87
2019	251.71
2020	257.97
2021	261.58

Table 13.12 **Data for Time Series Graph of Annual CPI, 2012–2021** (source: US Bureau of Labor Statistics)

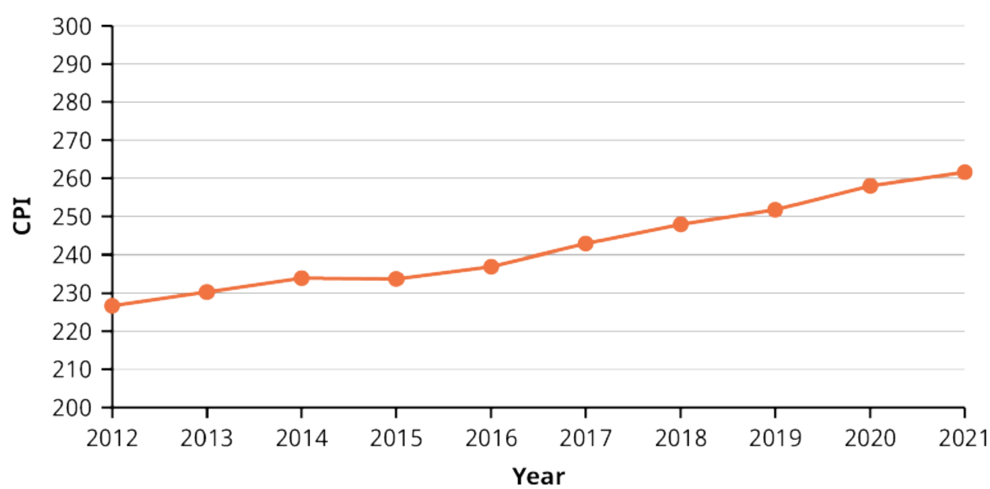


Figure 13.7 Time Series Graph of Annual CPI, 2012–2021

Scatter Plots

A **scatter plot**, or scatter diagram, is a graphical display intended to show the relationship between two variables. The setup of the scatter plot is that one variable is plotted on the horizontal axis and the other variable is plotted on the vertical axis. Then each pair of data values is considered as an (x, y) point, and the various points are plotted on the diagram. A visual inspection of the plot is then made to detect any patterns or trends. Additional statistical analysis can be conducted to determine if there is a correlation or other statistically significant relationship between the two variables.

Assume we are interested in tracking the closing price of Nike stock over the one-year time period from April 2020 to March 2021. We would also like to know if there is a correlation or relationship between the price of Nike stock and the value of the S&P 500 over the same time period. To visualize this relationship, we can create a scatter plot based on the (x, y) data shown in Table 13.13. The resulting scatter plot is shown in Figure 13.8.

Date	S&P 500	Nike Stock Price ($)
4/1/2020	2,912.43	87.18
5/1/2020	3,044.31	98.58
6/1/2020	3,100.29	98.05
7/1/2020	3,271.12	97.61
8/1/2020	3,500.31	111.89
9/1/2020	3,363.00	125.54
10/1/2020	3,269.96	120.08
11/1/2020	3,621.63	134.70
12/1/2020	3,756.07	141.47
1/1/2021	3,714.24	133.59
2/1/2021	3,811.15	134.78
3/1/2021	3,943.34	140.45
3/12/2021	3,943.34	140.45

Table 13.13 **Data for S&P 500 and Nike Stock Price over a 12-Month Period** (source: Yahoo! Finance)

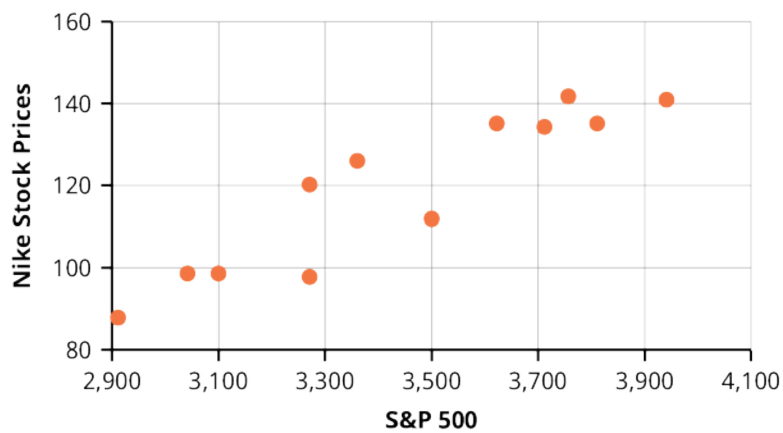


Figure 13.8 Scatter Plot of Nike Stock Price versus S&P 500

Note the linear pattern of the points on the scatter plot. Because the data points generally align along a straight line, this provides an indication of a linear correlation between the price of Nike stock and the value of the S&P 500 over this one-year time period.

The scatter plot can be generated using Excel as follows:

1. Enter the *x*-data in column A of a spreadsheet.
2. Enter the *y*-data in column B.
3. Highlight the data with your mouse.
4. Go to the Insert menu and select the icon for a scatter plot, as shown in Figure 13.9.

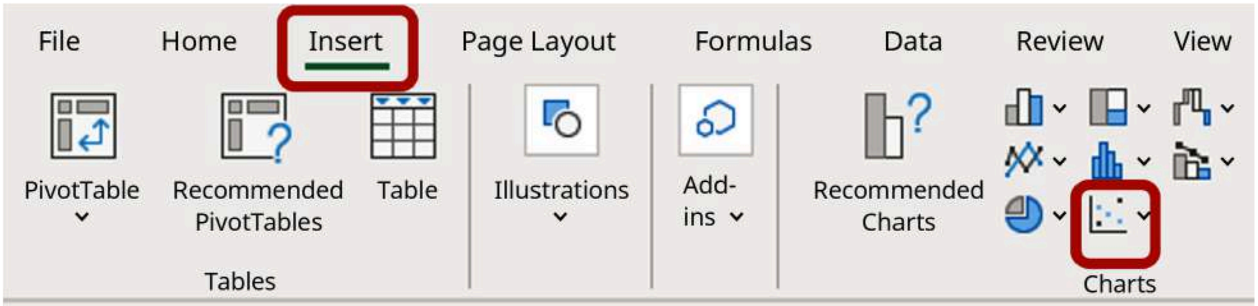


Figure 13.9 Excel Menu Showing the Scatter Plot Icon

13.7 The R Statistical Analysis Tool

By the end of this section, you will be able to:

- Create a vector of data values for the R statistical analysis tool.
- Write basic statistical commands using the R statistical analysis tool.

Commands and Vectors in R

R is a statistical analysis tool that is widely used in the finance industry. It is available as a free program and provides an integrated suite of functions for data analysis, graphing, and statistical programming. R is increasingly being used as a data analysis and statistical tool as it is an open-source language and additional features are constantly being added by the user community. The tool can be used on many different computing platforms and can be downloaded at the R Project website (https://openstax.org/r/the-R-project-website).

LINK TO LEARNING

Using the R Statistical Tool

There are many resources for learning and using the R statistical tool, including the following:

How to install R on different computer operating systems (https://openstax.org/r/how-to-install)

Introduction to using R (https://openstax.org/r/introduction-to-using-R)

How to import and export data using R (https://openstax.org/r/how-to-import-and-export)

Frequently asked questions (FAQ) on using R (https://openstax.org/r/frequently-asked-questions)

Once you have installed and started R on your computer, at the bottom of the R console, you should see the symbol >, which indicates that R is ready to accept commands.

```
Type 'demo()' for some demos, 'help()' for on-line help, or 'help.start()' for an HTML
browser interface to help. Type 'q()' to quit R.

    >
```

R is a command-driven language, meaning that the user enters commands at the prompt, which R then executes one at a time. R can also execute a program containing multiple commands. There are ways to add a graphic user interface (GUI) to R. An example of a GUI tool for R is RStudio (https://openstax.org/r/RStudio).

The R command line can be used to perform any numeric calculation, similar to a handheld calculator. For example, to evaluate the expression $10 + 3 \cdot 7$, enter the following expression at the command line prompt and hit return:

```
> 10+3*7

[1] 31
```

Most calculations in R are handled via functions. For statistical analysis, there are many preestablished functions in R to calculate mean, median, standard deviation, quartiles, and so on. Variables can be named and assigned values using the assignment operator <-. For example, the following R commands assign the value of 20 to the variable named *x* and assign the value of 30 to the variable named *y*:

```
> x <- 20

> y <- 30
```

These variable names can be used in any calculation, such as multiplying *x* by *y* to produce the result 600:

```
> x*y

[1] 600
```

The typical method for using functions in statistical applications is to first create a vector of data values. There are several ways to create vectors in R. For example, the *c* function is often used to combine values into a vector. The following R command will generate a vector called *salaries* that contains the data values 40,000, 50,000, 75,000, and 92,000:

```
> salaries <- c(40000, 50000, 75000, 92000)
```

This vector *salaries* can then be used in statistical functions such as mean, median, min, max, and so on, as shown:

```
> mean(salaries)

[1] 64250

> median(salaries)

[1] 62500

> min(salaries)

[1] 40000

> max(salaries)

[1] 92000
```

Another option for generating a vector in R is to use the *seq* function, which will automatically generate a sequence of numbers. For example, we can generate a sequence of numbers from 1 to 5, incremented by 0.5, and call this vector *example1*, as follows:

```
> example1 <- seq(1, 5, by=0.5)
```

If we then type the name of the vector and hit enter, R will provide a listing of numeric values for that vector name.

```
> salaries

[1] 40000 50000 75000 92000

> example1

[1] 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
```

Often, we are interested in generating a quick statistical summary of a data set in the form of its mean, median, quartiles, min, and max. The R command called *summary* provides these results.

```
> summary(salaries)

Min. 1st Qu. Median Mean 3rd Qu. Max.

40000 47500 62500 64250 79250 92000
```

For measures of spread, R includes a command for standard deviation, called *sd*, and a command for variance, called *var*. The standard deviation and variance are calculated with the assumption that the data set was collected from a sample.

```
> sd(salaries)

[1] 23641.42

> var(salaries)

[1] 558916667
```

To calculate a weighted mean in R, create two vectors, one of which contains the data values and the other of which contains the associated weights. Then enter the R command *weighted.mean(values, weights)*.

The following is an example of a weighted mean calculation in R:
Assume your portfolio contains 1,000 shares of XYZ Corporation, purchased on three different dates, as shown in Table 13.14. Calculate the weighted mean of the purchase price, where the weights are based on the number of shares in the portfolio.

Date Purchased	Purchase Price ($)	Number of Shares Purchased
January 17	78	200
February 10	122	300
March 23	131	500
Total		**1,000**

Table 13.14 Portfolio of XYZ Shares

Here is how you would create two vectors in R: the *price* vector will contain the purchase price, and the *shares* vector will contain the number of shares. Then execute the R command *weighted.mean(price, shares)*, as follows:

```
> price <- c(78, 122, 131)

> shares <- c(200, 300, 500)

> weighted.mean(price, shares)

[1] 117.7
```

A list of common R statistical commands appears in Table 13.15.

R Command	Result
mean( )	Calculates the arithmetic mean
median( )	Calculates the median
min( )	Calculates the minimum value
max( )	Calculates the maximum value
weighted.mean( )	Calculates the weighted mean
sum( )	Calculates the sum of values
summary( )	Calculates the mean, median, quartiles, min, and max
sd( )	Calculates the sample standard deviation
var( )	Calculates the sample variance
IQR( )	Calculates the interquartile range
barplot( )	Plots a bar chart of non-numeric data
boxplot( )	Plots a boxplot of numeric data
hist( )	Plots a histogram of numeric data
plot( )	Plots various graphs, including a scatter plot
freq( )	Creates a frequency distribution table

Table 13.15 List of Common R Statistical Commands

Graphing in R

There are many statistical applications in R, and many graphical representations are possible, such as bar graphs, histograms, time series plots, scatter plots, and others. The basic command to create a plot in R is the plot command, *plot(x, y)*, where *x* is a vector containing the *x*-values of the data set and *y* is a vector containing the *y*-values of the data set.

The general format of the command is as follows:

```
>plot(x, y, main="text for title of graph", xlab="text for x-axis label", ylab="text
for y-axis label")
```

For example, we are interested in creating a scatter plot to examine the correlation between the value of the S&P 500 and Nike stock prices. Assume we have the data shown in Table 13.13, collected over a one-year time period.

Note that data can be read into R from a text file or Excel file or from the clipboard by using various R commands. Assume the values of the S&P 500 have been loaded into the vector *SP500* and the values of Nike stock prices have been loaded into the vector *Nike*. Then, to generate the scatter plot, we can use the following R command:

```
>plot(SP500, Nike, main="Scatter Plot of Nike Stock Price vs. S&P 500", xlab="S&P
500", ylab="Nike Stock Price")
```

As a result of these commands, R provides the scatter plot shown in Figure 13.10. This is the same data that was used to generate the scatter plot in Figure 13.8 in Excel.

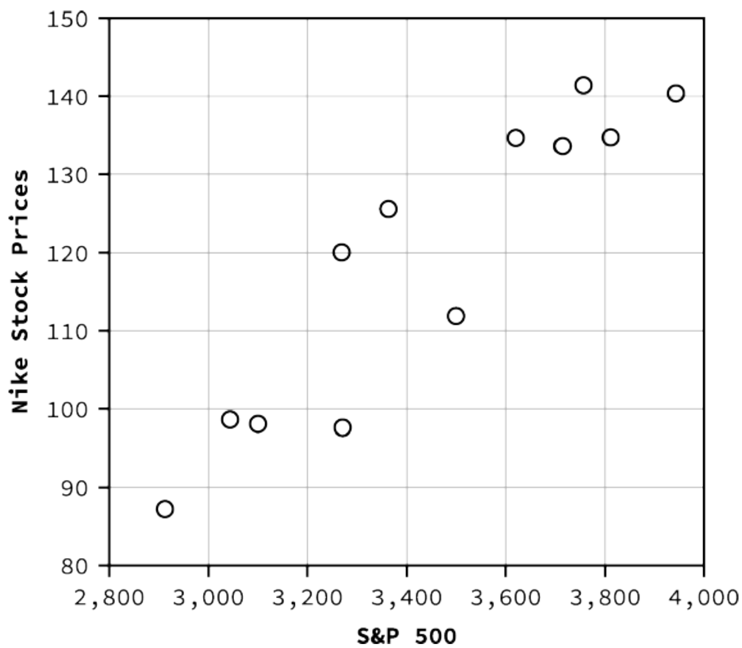


Figure 13.10 Scatter Plot Generated by R for Nike Stock Price versus S&P 500

Summary

13.1 Measures of Center

Several measurements are used to provide the average of a data set, including mean, median, and mode. The terms *mean* and *average* are often used interchangeably. To calculate the mean for a set of numbers, add the numbers together and then divide the sum by the number of data values. The geometric mean redistributes not the sum of the values but the product by multiplying all of the individual values and then redistributing them in equal portions such that the total product remains the same. To calculate the median for a set of numbers, order the data from smallest to largest and identify the middle data value in the ordered data set.

13.2 Measures of Spread

The standard deviation and variance are measures of the spread of a data set. The standard deviation is small when the data values are all concentrated close to the mean, exhibiting little variation or spread. The standard deviation is larger when the data values are more spread out from the mean, exhibiting more variation. The formula used to calculate the standard deviation depends on whether the data represents a sample or a population, as the formulas for the sample standard deviation and the population standard deviation are slightly different.

13.3 Measures of Position

Several measures are used to indicate the position of a data value in a data set. One measure of position is the *z*-score for a particular measurement. The *z*-score indicates how many standard deviations a particular measurement is above or below the mean. Other measures of position include quartiles and percentiles. Quartiles are special percentiles. The first quartile, Q_1, is the same as the 25th percentile, and the third quartile, Q_3, is the same as the 75th percentile. The median, M, is called both the second quartile and the 50th percentile. To calculate quartiles and percentiles, the data must be ordered from smallest to largest. Quartiles divide ordered data into quarters. Percentiles divide ordered data into hundredths.

13.4 Statistical Distributions

A frequency distribution provides a method of organizing and summarizing a data set and allows us to organize and tabulate the data in a summarized way. Once a frequency distribution is generated, it can be used to create graphs to help facilitate an interpretation of the data set. The normal distribution has two parameters, or numerical descriptive measures: the mean, μ, and the standard deviation, σ. The exponential distribution is often concerned with the amount of time until some specific event occurs.

13.5 Probability Distributions

A probability distribution is a mathematical function that assigns probabilities to various outcomes. In many financial situations, we are interested in determining the expected value of the return on a particular investment or the expected return on a portfolio of multiple investments. When analyzing distributions that follow a normal distribution, probabilities can be calculated by finding the area under the graph of the normal curve.

13.6 Data Visualization and Graphical Displays

Data visualization refers to the use of graphical displays to summarize a data set to help to interpret patterns and trends in the data. *Univariate data* refers to observations recorded for a single characteristic or attribute, such as salaries or blood pressure measurements. When graphing univariate data, we can choose from among several types of graphs. The type of graph to be used for a certain data set will depend on the nature of the data and the purpose of the graph. Examples of graphs for univariate data include line graphs, bar graphs, and histograms. *Bivariate data* refers to paired data where each value of one variable is paired with a value of a second variable. Examples of graphs for bivariate data include time series graphs and scatter plots.

13.7 The R Statistical Analysis Tool

R is an open-source statistical analysis tool that is widely used in the finance industry. It provides an integrated suite of functions for data analysis, graphing, and statistical programming. R is increasingly being used as a data analysis and statistical tool as it is an open-source language, and additional features are constantly being added by the user community. This tool can be used on many different computing platforms and can be downloaded at The R Project for Statistical Computing (https://openstax.org/r/The-R-Project).

Key Terms

arithmetic mean a measure of center of a data set, calculated by adding up the data values and dividing the sum by the number of data values

bar graph a chart that presents categorical data in a summarized form based on frequency or relative frequency

bivariate data paired data in which each value of one variable is paired with a value of a second variable

data visualization the use of graphical displays, such as bar charts, histograms, and scatter plots, to help interpret patterns and trends in a data set

empirical rule a rule that provides the percentages of data values falling within one, two, and three standard deviations from the mean for a bell-shaped (normal) distribution

expected value a weighted average of the values of a variable where the weights are the associated probabilities

exponential distribution a continuous probability distribution that is useful for calculating probabilities within the time between events

frequency distribution a method of organizing and summarizing a data set that provides the frequency with which each value in the data set occurs

geometric mean a measure of center of a data set, calculated by multiplying the data values and then raising the product to the exponent $\frac{1}{n}$, where n is the number of data values

histogram a graphical display of continuous data showing class intervals on the horizontal axis and frequency or relative frequency on the vertical axis

interquartile range (IQR) a number that indicates the spread of the middle half, or middle 50%, of the data; the difference between the third quartile (Q_3) and the first quartile (Q_1)

median the middle value in an ordered data set

mode the most frequently occurring data value in a data set

normal distribution a bell-shaped distribution curve that is used to model many measurements, including IQ scores, salaries, heights, weights, blood pressures, etc.

outliers data values that are significantly different from the other data values in a data set

percentiles numbers that divide an ordered data set into hundredths; often used to indicate position of a data value in a data set

population data data representing all the outcomes or measurements that are of interest

portfolio a collection of financial investments, such as stocks, bonds, mutual funds, certificates of deposit, etc.

probability distribution a mathematical function that assigns probabilities to various outcomes

quartiles numbers that divide an ordered data set into quarters; the second quartile is the same as the median

sample data data representing outcomes or measurements collected from a subset or part of a population

scatter plot (or scatter diagram) a graphical display that shows the relationship between a dependent variable and an independent variable

standard deviation a measure of the spread of a data set that indicates how far a typical data value is from the mean

time series graph a graphical display used to show measurement data plotted versus time, where time is displayed on the horizontal axis

variance the measure of the spread of data values calculated as the square of the standard deviation

weighted mean a measure of center of a data set in which each data value has a corresponding weighting

***x*-axis** the horizontal axis in a rectangular coordinate system

***y*-axis** the vertical axis in a rectangular coordinate system

***z*-score (or *z*-value)** a measure of the position of a data value in the data set, calculated by subtracting the mean from the data value and then dividing the difference by the standard deviation

CFA Institute

This chapter supports some of the Learning Outcome Statements (LOS) in this CFA® Level I Study Session (https://openstax.org/r/cfa-level1-study-session). Reference with permission of CFA Institute.

Multiple Choice

1. A data set of salaries contains an outlier salary. The best measure of center to use for this data set is the ________.

a. mean
b. median
c. mode
d. standard deviation

2. A portfolio includes shares of United Airlines stock that were purchased at different times and different prices. Which measure is best to determine the average cost of the shares of the stock?

a. mean
b. median
c. weighted mean
d. standard deviation

3. Standard deviation is a measure of the ________.

a. center of a data set
b. position of a data value in a data set
c. area under a normal curve
d. spread of a distribution

4. How are standard deviation and variance related?

a. The two measures are equal to one another.
b. Variance is the square root of the standard deviation.
c. Standard deviation is the square root of the variance.
d. The two squared measures are equal to one another.

5. Which of the following is the best definition of a *z*-score?

a. the distance of a data value from the mean
b. the number of standard deviations that a data value is from the mean
c. the distance of a data value from the mean divided by the sample size
d. the number of quartiles that a data value is from the mean

6. The results of a standardized test indicate that you are in the 85th percentile. What is the best interpretation of this result?

a. You scored in the top 85% of all students taking the test.

b. You scored in the top 15% of all students taking the test.
c. Your score on the test is 85 when measured on a scale from 0 to 100.
d. You scored in the bottom 15% of all students taking the test.

7. The interquartile range is _______.
a. the middle 50% of a data set
b. the upper 50% of a data set
c. the lower 50% of a data set
d. equal to the median

8. In a frequency distribution table, the sum of the relative frequencies must be equal to _______.
a. the sample size
b. 1, or 100%
c. zero
d. the standard deviation of the distribution

9. A change in the standard deviation of a normal distribution will result in _______.
a. a change in the location of the peak of the curve
b. a change in the area under the curve
c. a change in the shape of the curve
d. a change that shifts the graph to the left or the right

10. When calculating an expected value, _______.
a. the result should always be 1
b. the result should always be a positive value
c. the result should always be a negative value
d. the result can be a positive or negative value

11. The area under a normal curve between a *z*-score of -2 and a *z*-score of +2 is _______.
a. 0.68
b. 0.95
c. 0.997
d. dependent on the mean and standard deviation

12. A scatter plot is a visualization for _______.
a. univariate data only
b. bivariate data only
c. either univariate or bivariate data
d. test scores

13. Which of the following is NOT a benefit of using the R statistical analysis tool?
a. Additional features are constantly being added by the user community.
b. It can be used on many computer platforms, including Mac, Windows, and Linux.
c. It is free to download.
d. Users pay an annual subscription fee.

Review Questions

1. Explain the considerations that determine whether the mean or the median is the best measure of central tendency for a data set.

2. Explain the difference between a mean and a weighted mean.
3. Explain why the standard deviation of a data set cannot be a negative value.
4. Explain what a negative *z*-score, a positive *z*-score, and a *z*-score of zero imply.
5. Explain how quartiles can be used to detect outliers in a data set.

Problems

1. You purchased 1,000 shares of a stock for $12 per share. Then, two months later, you purchased an additional 500 shares of the same stock at $9 per share. Calculate the weighted mean of the purchase price for the total of 1,500 shares.
2. You score a 60 on a biology test. The mean test grade is 70, and the standard deviation is 5. Calculate and interpret your corresponding *z*-score.
3. You score a 60 on a biology test. The mean test grade is 70, and the standard deviation is 5. What percentile does your grade correspond to?
4. A fast food restaurant has measured service time for customers waiting in line, and the service time follows an exponential distribution with a mean waiting time of 1.9 minutes. The restaurant has a guarantee that if customers wait in line for more than 5 minutes, their meal is free. What is the probability that a customer will receive a free meal?
5. The total value of your portfolio consists of approximately 65% stock assets, 25% bonds, and 10% cash equivalents. Historical returns have shown that stocks provide a return of 12%, bonds provide a return of 3.5%, and cash savings provide a return of 1.5%. What is the expected value of the return on this portfolio?
6. The distribution of the average annual return of the S&P 500 over a 50-year time period follows a normal distribution with a mean rate of return of 10.5% and a standard deviation of 14.3%. What is the probability that an average annual return will fall between -3.8% and 24.8%?
7. Write a short R program to find the expected return for the data set in Table 13.16.

Historical Return on United Airlines Stock	Associated Probability
12%	15%
5%	35%
2%	25%
-5%	14%
-10%	11%

Table 13.16

Video Activity

Normal Distribution Stock Return Calculations

Click to view content (https://openstax.org/r/stock-return)

1. Assume the return on stocks follows a normal distribution. Is it more likely that a stock will return between -1 and +1 standard deviations from the mean or between -2 and +2 standard deviations from the mean? Why?

2. Would an investor be likely to prefer a stock that has a smaller standard deviation for annual stock returns or one with a larger standard deviation for annual stock returns? Why?

Portfolio Weights

[Click to view content (https://openstax.org/r/port-weights)](https://openstax.org/r/port-weights)

3. What are the reasons for calculating portfolio weights? What useful information does this provide to the investor?
4. What are the advantages and disadvantages of the equal weighting approach and the market cap weighting approach for portfolio allocation strategy?

14 Regression Analysis in Finance

Figure 14.1 Regression analysis is used in financial decision-making. (credit: modification of “Stock exchange” by Jack Sem/flickr, CC BY 2.0)

Chapter Outline

Why It Matters

Correlation and regression analysis are used extensively in finance applications. Correlation analysis allows the determination of a statistical relationship between two numeric quantities. Regression analysis can be used to predict one quantity based on a second quantity, assuming there is a significant correlation between the two quantities. For example, in finance, we use regression analysis to calculate the beta coefficient of a stock, which represents the volatility of the stock versus overall market volatility, with volatility being a measure of risk.

A business may want to establish a correlation between the amount the company spent on advertising versus its recorded sales. If a strong enough correlation is established, then the business manager can predict sales based on the amount spent on advertising for a given time period.

Finance professionals often use correlation analysis to predict future trends and mitigate risk in a stock portfolio. For example, if two investments are strongly correlated, an investor might not want to have both investments in a certain portfolio since the two investments would tend to move in the same directions during up markets or down markets. To diversify a portfolio, an investor might seek investments that are not strongly correlated with one another.

Regression analysis can be used to establish a mathematical equation that relates a dependent variable (such as sales) to an independent variable (such as advertising expenditure). In this discussion, the focus will be on analyzing the relationship between one dependent variable and one independent variable, where the relationship can be modeled using a linear equation. This type of analysis is called *linear regression*.

14.1 Correlation Analysis

Learning Outcomes

By the end of this section, you will be able to:

- Calculate a correlation coefficient.
- Interpret a correlation coefficient.
- Test for the significance of a correlation coefficient.

Calculate a Correlation Coefficient

In correlation analysis, we study the relationship between bivariate data, which is data collected on two variables where the data values are paired with one another.

Correlation is the measure of association between two numeric variables. For example, we may be interested to know if there is a correlation between bond prices and interest rates or between the age of a car and the value of the car. To investigate the correlation between two numeric quantities, the first step is to create a scatter plot that will graph the (*x, y*) ordered pairs. The independent, or explanatory, quantity is labeled as the *x*-variable, and the dependent, or response, quantity is labeled as the *y*-variable.

For example, we may be interested to know if the price of Nike stock is correlated with the value of the S&P 500 (Standard & Poor's 500 stock market index). To investigate this, monthly data can be collected for Nike stock prices and value of the S&P 500 for a period of time, and a scatter plot can be created and examined. A **scatter plot**, or **scatter diagram**, is a graphical display intended to show the relationship between two variables. The setup of the scatter plot is that one variable is plotted on the horizontal axis and the other variable is plotted on the vertical axis. Each pair of data values is considered as an (*x, y*) point, and the various points are plotted on the diagram. A visual inspection of the plot is then made to detect any patterns or trends on the scatter diagram. Table 14.1 shows the relationship between the Nike stock price and its S&P value over a one-year time period.

To assess linear correlation, the graphical trend of the data points is examined on the scatter plot to determine if a straight-line pattern exists. If a linear pattern exists, the correlation may indicate either a positive or a negative correlation. A positive correlation indicates that as the independent variable increases, the dependent variable tends to increase as well, or, as the independent variable decreases, the dependent variable tends to decrease (the two quantities move in the same direction). A negative correlation indicates that as the independent variable increases, the dependent variable decreases, or, as the independent variable decreases, the dependent variable increases (the two quantities move in opposite directions). If there is no relationship or association between the two quantities, where one quantity changing does not affect the other quantity, we conclude that there is no correlation between the two variables.

Date	S&P 500	Nike Stock Price
4/1/2020	2,912.43	87.18
5/1/2020	3,044.31	98.58
6/1/2020	3,100.29	98.05

Table 14.1 **Nike Stock Price ($) and Value of S&P 500 over a One-Year Time Period** (source: Yahoo! Finance)

Date	S&P 500	Nike Stock Price
7/1/2020	3,271.12	97.61
8/1/2020	3,500.31	111.89
9/1/2020	3,363.00	125.54
10/1/2020	3,269.96	120.08
11/1/2020	3,621.63	134.70
12/1/2020	3,756.07	141.47
1/1/2021	3,714.24	133.59
2/1/2021	3,811.15	134.78
3/1/2021	3,943.34	140.45
3/12/2021	3,943.34	140.45

Table 14.1 Nike Stock Price ($) and Value of S&P 500 over a One-Year Time Period (source: Yahoo! Finance)

From the scatter plot in the Nike stock versus S&P 500 example (see Figure 14.2), we note that the trend reflects a positive correlation in that as the value of the S&P 500 increases, the price of Nike stock tends to increase as well.

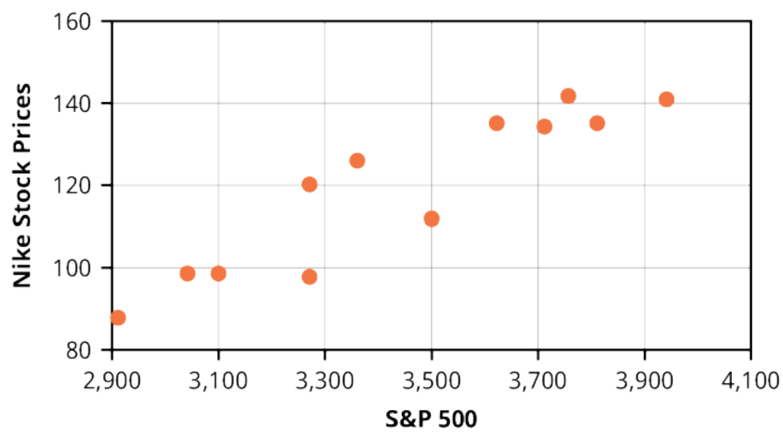


Figure 14.2 Scatter Plot of Nike Stock Price ($) and Value of S&P 500 (data source: Yahoo! Finance)

When inspecting a scatter plot, it may be difficult to assess a correlation based on a visual inspection of the graph alone. A more precise assessment of the correlation between the two quantities can be obtained by calculating the numeric correlation coefficient (referred to using the symbol r).

The **correlation coefficient**, which was developed by statistician Karl Pearson in the early 1900s, is a measure of the strength and direction of the correlation between the independent variable x and the dependent variable y.

The formula for r is shown below; however, technology, such as Excel or the statistical analysis program R, is typically used to calculate the correlation coefficient.

$$r = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{\sqrt{n\sum x^2 - \left(\sum x\right)^2}\sqrt{n\sum y^2 - \left(\sum y\right)^2}}$$

where *n* refers to the number of data pairs and the symbol $\sum x$ indicates to sum the *x*-values.

Table 14.2 provides a step-by-step procedure on how to calculate the correlation coefficient *r*.

Step	Representation in Symbols
1. Calculate the sum of the *x*-values.	$\sum x$
2. Calculate the sum of the *y*-values.	$\sum y$
3. Multiply each *x*-value by the corresponding *y*-value and calculate the sum of these *xy* products.	$\sum xy$
4. Square each *x*-value and then calculate the sum of these squared values.	$\sum x^2$
5. Square each *y*-value and then calculate the sum of these squared values.	$\sum y^2$
6. Determine the value of *n,* which is the number of data pairs.	*n*
7. Use these results to then substitute into the formula for the correlation coefficient.	$r = \frac{n\sum \text{xy} - (\sum x)(\sum y)}{\sqrt{n\sum x^2 - (\sum x)^2}\sqrt{n\sum y^2 - (\sum y)^2}}$

Table 14.2 Steps for Calculating the Correlation Coefficient

Note that since *r* is calculated using sample data, *r* is considered a sample statistic used to measure the strength of the correlation for the two population variables. Sample data indicates data based on a subset of the entire population.

Given the complexity of this calculation, Excel or other software is typically used to calculate the correlation coefficient.

The Excel command to calculate the correlation coefficient uses the following format:

```
=CORREL(A1:A10, B1:B10)
```

where A1:A10 are the cells containing the *x*-values and B1:B10 are the cells containing the *y*-values.

Download the spreadsheet file (https://openstax.org/r/excel_exhibits) containing key Chapter 14 Excel exhibits.

Interpret a Correlation Coefficient

Once the value of *r* is calculated, this measurement provides two indicators for the correlation:

a. the strength of the correlation based on the *value* of *r*
b. the direction of the correlation based on the *sign* of *r*

The *value* of *r* gives us this information:

- The value of *r* is always between -1 and $+1$: $-1 \leq r \leq 1$.
- The size of the correlation *r* indicates the strength of the linear relationship between the two variables. Values of *r* close to -1 or to $+1$ indicate a stronger linear relationship.
- If $r = 0$, there is no linear relationship between the two variables (no **linear correlation**).
- If $r = 1$, there is perfect positive correlation.
- If $r = -1$, there is perfect negative correlation. In both of these cases, all the original data points lie on a straight line.

The *sign* of *r* gives us this information:

- A positive value of *r* means that when *x* increases, *y* tends to increase, and when *x* decreases, *y* tends to decrease (*positive correlation*).
- A negative value of *r* means that when *x* increases, *y* tends to decrease, and when *x* decreases, *y* tends to increase (*negative correlation*).

LINK TO LEARNING

Correlation in Finance Applications

This video on correlation concepts (https://openstax.org/r/video_correlation) discusses them with a specific focus on finance applications.

The Excel command used to find the value of the correlation coefficient for the Nike stock versus S&P 500 example (refer back to Table 14.1) is

```
=CORREL(B2:B14,C2:C14)
```

In this example, the value of *r* is calculated by Excel to be $r = 0.928$.

Since this is a positive value close to 1, we conclude that the relationship between Nike stock and the value of the S&P 500 over this time period represents a strong, positive correlation.

The correlation coefficient *r* can also be determined using the statistical capability on the financial calculator:

- Step 1 is to enter the data in the calculator (using the `[DATA]` function that is located above the `7` key).
- Step 2 is to access the statistical results provided by the calculator (using the `[STAT]` function that is located above the `8` key) and scroll to the correlation coefficient results.

Follow the steps in Table 14.3 for calculating the correlation data for the data set of Nike stock price and value of the S&P 500 shown previously.

Step	Description	Enter	Display	
1	Enter `[DATA]` entry mode	`2ND [DATA]`	X01	0.00
2	Clear any previous data	`2ND [CLR WORK]`	X01	0.00
3	Enter first *x*-value of 2912.43	2912.43 `ENTER`	X01 =	2,912.43
4	Move to next data entry	↓	Y01 =	1.00
5	Enter first *y*-value of 87.18	87.18 `ENTER`	Y01 =	87.18
6	Move to next data entry	↓	X02	0.00
7	Enter second *x*-value of 3044.31	3044.31 `ENTER`	X02 =	3,044.31
8	Move to next data entry	↓	Y02 =	1.00
9	Enter second *y*-value of 98.58	98.58 `ENTER`	Y02 =	98.58
10	Move to next data entry	↓	X03	0.00
11	Continue to enter remaining data values			
12	Enter `[STAT]` mode	`2ND [STAT]`		

Table 14.3 Calculator Steps for Finding the Relationship between Nike Stock Price and Value of S&P 500[1]

1 The specific financial calculator in these examples is the Texas Instruments BA II Plus TM Professional model, but you can use other financial calculators for these types of calculations.

Step	Description	Enter	Display	
13	Press [SET] until LIN appears	2ND [SET]	LIN	
14	Move to 1st statistical result	↓	$n =$	13.00
15	Move to next statistical result	↓	$\overline{x} =$	3,480.86
16	Continue to scroll down until the value of *r* is displayed	↓	$r =$	0.93

Table 14.3 Calculator Steps for Finding the Relationship between Nike Stock Price and Value of S&P 500[1]

From the statistical results shown on the calculator display, the correlation coefficient *r* is 0.93, which indicates that the relationship between Nike stock and the value of the S&P 500 over this time period represents a strong, positive correlation.

Note: A strong correlation does not suggest that *x* causes *y* or *y* causes *x*. We must remember that *correlation does not imply causation.*

Test a Correlation Coefficient for Significance

The correlation coefficient, *r*, tells us about the strength and direction of the linear relationship between *x* and *y*. The sample data are used to compute *r*, the correlation coefficient for the sample. If we had data for the entire population (that is, all measurements of interest), we could find the population correlation coefficient, which is labeled as the Greek letter *ρ* (pronounced "rho"). But because we have only sample data, we cannot calculate the population correlation coefficient. The sample correlation coefficient, *r*, is our estimate of the unknown population correlation coefficient.

- *ρ* = population correlation coefficient (unknown)
- *r* = sample correlation coefficient (known; calculated from sample data)

An important step in the correlation analysis is to determine if the correlation is significant. By this, we are asking if the correlation is strong enough to allow meaningful predictions for *y* based on values of *x*. One method to test the significance of the correlation is to employ a hypothesis test. The hypothesis test lets us decide whether the value of the population correlation coefficient *ρ* is close to zero or significantly different from zero. We decide this based on the sample correlation coefficient *r* and the sample size *n*.

If the test concludes that the correlation coefficient is significantly different from zero, we say that the correlation coefficient is significant.

- Conclusion: There is sufficient evidence to conclude that there is a significant linear relationship between *x* and *y* variables because the correlation coefficient is significantly different from zero.
- What the conclusion means: There is a significant linear relationship between the *x* and *y* variables. If the test concludes that the correlation coefficient is not significantly different from zero (it is close to zero), we say that the correlation coefficient is not significant.

A hypothesis test can be performed to test if the correlation is significant. A hypothesis test is a statistical method that uses sample data to test a claim regarding the value of a population parameter. In this case, the hypothesis test will be used to test the claim that the population correlation coefficient *ρ* is equal to zero.

Use these hypotheses when performing the hypothesis test:

- Null hypothesis: H_0: $\rho = 0$
- Alternate hypothesis: H_a: $\rho \neq 0$

The hypotheses can be stated in words as follows:

- Null hypothesis H_0: The population correlation coefficient *is not* significantly different from zero. There *is not* a significant linear relationship (correlation) between *x* and *y* in the population.

- Alternate hypothesis H_a: The population correlation coefficient is significantly different from zero. There *is* a significant linear relationship (correlation) between *x* and *y* in the population.

A quick shorthand way to test correlations is the relationship between the sample size and the correlation. If $|\, r \,| \; \geq \; \frac{2}{\sqrt{n}}$, then this implies that the correlation between the two variables demonstrates that a linear relationship exists and is statistically significant at approximately the 0.05 level of significance. As the formula indicates, there is an inverse relationship between the sample size and the required correlation for significance of a linear relationship. With only 10 observations, the required correlation for significance is 0.6325; for 30 observations, the required correlation for significance decreases to 0.3651; and at 100 observations, the required level is only 0.2000.

NOTE:

- If *r* is significant and the scatter plot shows a linear trend, the line can be used to predict the value of *y* for values of *x* that are within the domain of observed *x*-values.
- If *r* is not significant OR if the scatter plot does not show a linear trend, the line should not be used for prediction.
- If *r* is significant and the scatter plot shows a linear trend, the line may *not* be appropriate or reliable for prediction *outside* the domain of observed *x*-values in the data.

THINK IT THROUGH

Determining If a Correlation Is Significant

Suppose that the chief financial officer (CFO) of a corporation is investigating the correlation between stock prices and unemployment rate over a period of 10 years and finds the correlation coefficient to be -0.68. There are 10 (*x, y*) data points in the data set. Should the CFO conclude that the correlation is significant for the relationship between stock prices and unemployment rate based on a level of significance of 0.05?

Solution:

When using a level of significance of 0.05, if $|\, r \,| \; \geq \; \frac{2}{\sqrt{n}}$, then this implies that the correlation between the two variables demonstrates a linear relationship that is statistically significant at approximately the 0.05 level of significance. In this example, we check if $|-0.68|$ is greater than or equal to $\frac{2}{\sqrt{n}}$ where $n = 10$. Since $\frac{2}{\sqrt{10}}$ is approximately 0.632, this indicates that the absolute value of *r* of -0.68 is greater than $\frac{2}{\sqrt{n}}$, and thus the correlation is deemed as significant.

Correlations may be helpful in visualizing the data, but they are not appropriately used to explain a relationship between two variables. Perhaps no single statistic is more misused than the correlation coefficient. Citing correlations between health conditions and everything from place of residence to eye color have the effect of implying a cause-and-effect relationship. This simply cannot be accomplished with a correlation coefficient. The correlation coefficient is, of course, innocent of this misinterpretation. It is the duty of analysts to use a statistic that is designed to test for cause-and-effect relationships and to report only those results, if they are intending to make such a claim. The problem is that passing this more rigorous test is difficult, therefore lazy and/or unscrupulous researchers fall back on correlations when they cannot make their case legitimately.

14.2 Linear Regression Analysis

Learning Outcomes

By the end of this section, you will be able to:

- Analyze a regression using the method of least squares and residuals.
- Test the assumptions for linear regression.

Method of Least Squares and Residuals

Once the correlation coefficient has been calculated and a determination has been made that the correlation is significant, typically a regression model is then developed. In this discussion we will focus on linear regression, where a straight line is used to model the relationship between the two variables. Once a straight-line model is developed, this model can then be used to predict the value of the dependent variable for a specific value of the independent variable.

Recall from algebra that the equation of a straight line is given by

$$y = mx + b$$

where *m* is the slope of the line and *b* is the *y*-intercept of the line.

The slope measures the steepness of the line, and the *y*-intercept is that point on the *y*-axis where the graph crosses, or intercepts, the *y*-axis.

In linear regression analysis, the equation of the straight line is written in a slightly different way using the model

$$\hat{y} = a + bx$$

In this format, *b* is the slope of the line, and *a* is the *y*-intercept. The notation $\hat{y}$ is called *y-hat* and is used to indicate a predicted value of the dependent variable *y* for a certain value of the independent variable *x*.

If a line extends uphill from left to right, the slope is a positive value, and if the line extends downhill from left to right, the slope is a negative value. Refer to Figure 14.3.

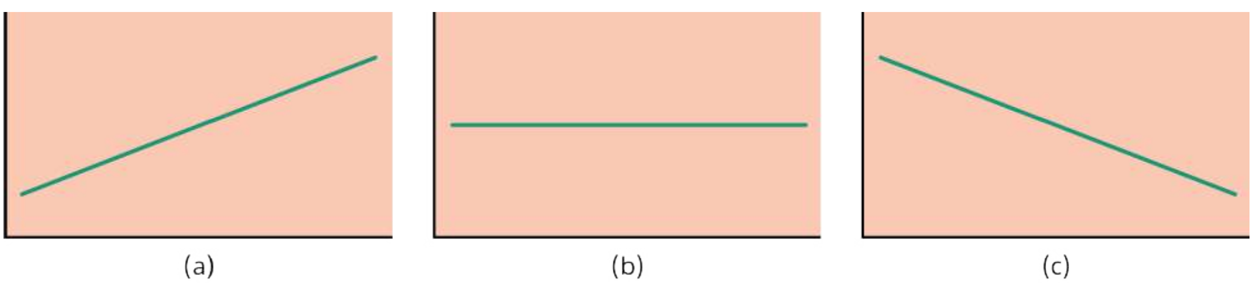


Figure 14.3 Three Possible Graphs of $\hat{y} = a + bx$ (a) If $b > 0$, the line slopes upward to the right. (b) If $b = 0$, the line is horizontal. (c) If $b < 0$, the line slopes downward to the right.

When generating the equation of a line in algebra using $y = mx + b$, two (*x, y*) points were required to generate the equation. However, in regression analysis, all (*x, y*) points in the data set will be utilized to develop the linear regression model.

The first step in any regression analysis is to create the scatter plot. Then proceed to calculate the correlation coefficient *r*, and check this value for significance. If we think that the points show a linear relationship, we would like to draw a line on the scatter plot. This line can be calculated through a process called linear regression. However, we only calculate a regression line if one of the variables helps to explain or predict the other variable. If *x* is the independent variable and *y* the dependent variable, then we can use a regression line to predict *y* for a given value of *x.*

As an example of a regression equation, assume that a correlation exists between the monthly amount spent on advertising and the monthly revenue for a Fortune 500 company. After collecting (*x, y*) data for a certain time period, the company determines the regression equation is of the form

$$\hat{y} = 9{,}376.7 + 61.8x$$

where *x* represents the monthly amount spent on advertising (in thousands of dollars) and $\hat{y}$ represents the monthly revenues for the company (in thousands of dollars).

A scatter plot of the (*x, y*) data is shown in Figure 14.4.

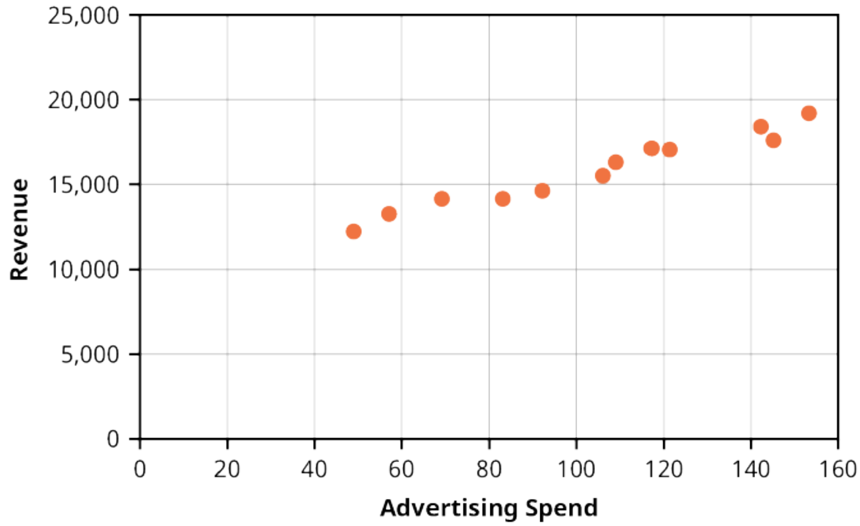


Figure 14.4 Scatter Plot of Revenue versus Advertising for a Fortune 500 Company ($000s)

The Fortune 500 company would like to predict the monthly revenue if its executives decide to spend $150,000 in advertising next month. To determine the estimate of monthly revenue, let $x = 150$ in the regression equation and calculate a corresponding value for $\hat{y}$:

$$\begin{aligned}\hat{y} &= 9{,}376.7 + 61.8x \\ \hat{y} &= 9{,}376.7 + 61.8(150) \\ \hat{y} &= 18{,}646.7\end{aligned}$$

This predicted value of *y* indicates that the anticipated revenue would be $18,646,700, given the advertising spend of $150,000.

Notice that from past data, there may have been a month where the company actually did spend $150,000 on advertising, and thus the company may have an actual result for the monthly revenue. This actual, or observed, amount can be compared to the **prediction** from the linear regression model to calculate a residual.

A **residual** is the difference between an observed *y*-value and the predicted *y*-value obtained from the linear regression equation. As an example, assume that in a previous month, the actual monthly revenue for an advertising spend of $150,000 was $19,200,000, and thus $y = 19,200$. The residual for this data point can be calculated as follows:

$$\begin{aligned}\text{Residual} &= (\text{observed } y\text{-value}) - (\text{predicted } y\text{-value}) \\ \text{Residual} &= y - \hat{y} \\ \text{Residual} &= 19{,}200 - 18{,}646.7 = 553.3\end{aligned}$$

Notice that residuals can be positive, negative, or zero. If the observed *y*-value exactly matches the predicted *y*-value, then the residual will be zero. If the observed *y*-value is greater than the predicted *y*-value, then the residual will be a positive value. If the observed *y*-value is less than the predicted *y*-value, then the residual will be a negative value.

When formulating the linear regression line of best fit to the points on the scatter plot, the mathematical analysis generates a linear equation where the sum of the squared residuals is minimized. This analysis is referred to as the **method of least squares**. The result is that the analysis generates a linear equation that is the "best fit" to the points on the scatter plot, in the sense that the line minimizes the differences between the predicted values and observed values for *y*.

THINK IT THROUGH

Calculating a Residual

Suppose that the chief financial officer of a corporation has created a linear model for the relationship between the company stock and interest rates. When interest rates are at 5%, the company stock has a value of $94. Using the linear model, when interest rates are at 5%, the model predicts the value of the company stock to be $99. Calculate the residual for this data point.

Solution:

A residual is the difference between an observed *y*-value and the predicted *y*-value obtained from the linear regression equation

$$\begin{aligned} \text{Residual} &= (\text{observed } y\text{-value}) - (\text{predicted } y\text{-value}) \\ \text{Residual} &= y - \hat{y} \\ \text{Residual} &= 94 - 99 = -5 \end{aligned}$$

The goal in the regression analysis is to determine the coefficients *a* and *b* in the following regression equation:

$$\hat{y} = a + bx$$

Once the (*x, y*) has been collected, the slope (*b*) and *y*-intercept (*a*) can be calculated using the following formulas:

$$b = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{n\sum x^2 - \left(\sum x\right)^2}$$

$$a = \frac{\sum y}{n} - b\frac{\sum x}{n}$$

where *n* refers to the number of data pairs and $\sum x$ indicates sum of the *x*-values.

Notice that the formula for the *y*-intercept requires the use of the slope result (*b*), and thus the slope should be calculated first and the *y*-intercept should be calculated second.

When making predictions for *y*, it is always important to plot a scatter diagram first. If the scatter plot indicates that there is a linear relationship between the variables, then it is reasonable to use a best-fit line to make predictions for *y,* given *x* within the domain of *x*-values in the sample data, *but not necessarily for* x*-values outside that domain*.

Note: Computer spreadsheets, statistical software, and many calculators can quickly calculate the best-fit line and create the graphs. The calculations tend to be tedious if done by hand.

Assumptions for Linear Regression

Testing the significance of the correlation coefficient requires that certain assumptions about the data are satisfied. The premise of this test is that the data are a sample of observed points taken from a larger population. We have not examined the entire population because it is not possible or feasible to do so. We are examining the sample to draw a conclusion about whether the linear relationship that we see between *x* and *y* in the sample data provides strong enough evidence that we can conclude that there is a linear relationship between x and y in the population.

The regression line equation that we calculate from the sample data gives the best-fit line for our particular sample. We want to use this best-fit line for the sample as an estimate of the best-fit line for the population (Figure 14.5). Examining the scatter plot and testing the significance of the correlation coefficient helps us determine if it is appropriate to do this.

These are the assumptions underlying the test of significance:

1. There is a linear relationship in the population that models the average value of y for varying values of x. In other words, the expected value of y for each particular value lies on a straight line in the population. (We do not know the equation for the line for the population. Our regression line from the sample is our best estimate of this line in the population.)
2. The y-values for any particular x-value are normally distributed about the line. This implies that there are more y-values scattered closer to the line than are scattered farther away. Assumption (1) implies that these normal distributions are centered on the line: the means of these normal distributions of y-values lie on the line.
3. The standard deviations of the population y-values about the line are equal for each value of x. In other words, each of these normal distributions of y-values has the same shape and spread about the line.
4. The residual errors are mutually independent (no pattern).
5. The data are produced from a well-designed, random sample or randomized experiment.

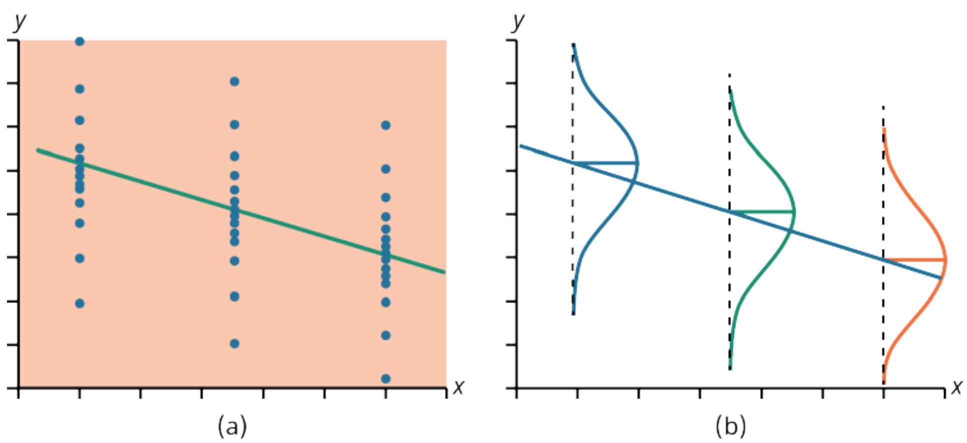


Figure 14.5 Best-Fit Line The y-values for each x-value are normally distributed about the line with the same standard deviation. For each x-value, the mean of the y-values lies on the regression line. More y-values lie near the line than are scattered further away from the line.

14.3 Best-Fit Linear Model

Learning Outcomes

By the end of this section, you will be able to:

- Calculate the slope and y-intercept for a linear regression model using technology.
- Interpret and apply the slope and y-intercepts.

Calculate the Slope and y-Intercept for a Linear Regression Model Using Technology

Once a correlation has been deemed as significant, a **best-fit linear regression model** is developed. The goal in the regression analysis is to determine the coefficients a and b in the following regression equation:

$$\hat{y} = a + bx$$

The slope (b) and y-intercept (a) can be calculated using the following formulas:

$$b = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{n\sum x^2 - \left(\sum x\right)^2}$$
$$a = \frac{\sum y}{n} - b\frac{\sum x}{n}$$

These formulas can be quite cumbersome, especially for a significant number of data pairs, and thus technology is often used (such as Excel, a calculator, R statistical software, etc.).

Using Excel: To calculate the slope and *y*-intercept of the linear model, start by entering the (*x, y*) data in two columns in Excel. Then the Excel commands =SLOPE and =INTERCEPT can be used to calculate the slope and intercept, respectively.

The following data set will be used as an example: the monthly amount spent on advertising and the monthly revenue for a Fortune 500 company for 12 months (data is shown in Table 14.4).

Month	Advertising Expenditure	Revenue
Jan	49	12,210
Feb	145	17,590
Mar	57	13,215
Apr	153	19,200
May	92	14,600
Jun	83	14,100
Jul	117	17,100
Aug	142	18,400
Sep	69	14,100
Oct	106	15,500
Nov	109	16,300
Dec	121	17,020

Table 14.4 Revenue versus Advertising for Fortune 500 Company ($000s)

To calculate the slope of the regression model, use the Excel command

```
=SLOPE(y-data range, x-data range)
```

It's important to note that this Excel command expects that the *y*-data range is entered first and the *x*-data range is entered second. Since revenue depends on amount spent on advertising, revenue is considered the *y*-variable and amount spent on advertising is considered the *x*-variable. Notice the *y*-data is contained in cells C2 through C13 and the *x*-data is contained in cells B2 through B13. Thus the Excel command for slope would be entered as

```
=SLOPE(C2:C13, B2:B13)
```

In the same way, the Excel command to calculate the *y*-intercept of the regression model is

```
=INTERCEPT(y-data range, x-data range)
```

For the data set shown in the above table, the Excel command would be

```
=INTERCEPT(C2:C13, B2:B13)
```

The results are shown in Figure 14.6, where

$$\text{slope } b = 61.8$$
$$\text{intercept } a = 9{,}376.7$$

	A	B	C
1	**Month**	**Advertising Expenditure**	**Revenue**
2	Jan	49	12,210
3	Feb	145	17,590
4	Mar	57	13,215
5	Apr	153	19,200
6	May	92	14,600
7	Jun	83	14,100
8	Jul	117	17,100
9	Aug	142	18,400
10	Sep	69	14,100
11	Oct	106	15,500
12	Nov	109	16,300
13	Dec	121	17,020
14			
15		**=SLOPE(C2:C13,B2:B13)**	**=INTERCEPT(C2:C13,B2:B13)**
16		**61.8**	**9,376.7**

Figure 14.6 Revenue versus Advertising for Fortune 500 Company ($000s) Showing Slope and *y*-Intercept Calculation in Excel

Based on this, the regression equation can be written as

$$\hat{y} = a + bx$$
$$\hat{y} = 9{,}376.7 + 61.8x$$

where *x* represents the amount spent on advertising (in thousands of dollars) and *y* represents the amount of revenue (in thousands of dollars).

Using a Financial Calculator

The financial calculator provides the slope and *y*-intercept for the linear regression model once the (*x, y*) data is inputted into the calculator.

Follow the steps in Table 14.5 for calculating the slope and *y*-intercept for the data set of amounts spent on advertising and revenue shown previously.

Step	Description	Enter	Display	
1	Enter `[DATA]` entry mode	`2ND [DATA]`	X01	0.00
2	Clear any previous data	`2ND [CLR WORK]`	X01	0.00
3	Enter first *x*-value of 49	49 `ENTER`	X01 =	49.00
4	Move to next data entry	↓	Y01 =	1.00

Table 14.5 Calculator Steps for the Slope and y-Intercept

Step	Description	Enter	Display	
5	Enter first *y*-value of 12210	12210 ENTER	Y01 =	12,210.00
6	Move to next data entry	↓	X02	0.00
7	Enter second *x*-value of 145	145 ENTER	X02 =	145.00
8	Move to next data entry	↓	Y02 =	1.00
9	Enter second *y*-value of 17590	17590ENTER	Y02 =	17,590.00
10	Move to next data entry	↓	X03	0.00
11	Continue to enter remaining data values			
12	Enter [STAT] mode	2ND [STAT]		
13	Press [SET] until LIN appears	2ND [SET]	LIN	
14	Move to 1st statistical result	↓	$n =$	12.00
15	Move to next statistical result	↓	$\overline{x} =$	103.58
16	Continue to scroll down until the value of *a* is displayed	↓	$a =$	9,376.70
17	Continue to scroll down until the value of *b* is displayed	↓	$b =$	61.80

Table 14.5 Calculator Steps for the Slope and y-Intercept

From the statistical results shown on the calculator display, the slope *b* is 61.8 and the *y*-intercept *a* is 9,367.7.

Based on this, the regression equation can be written as

$$\begin{aligned}\hat{y} &= a + bx \\ \hat{y} &= 9{,}376.7 + 61.8x\end{aligned}$$

Interpret and Apply the Slope and *y*-Intercept

The slope of the line, *b*, describes how changes in the variables are related. It is important to interpret the slope of the line in the context of the situation represented by the data. You should be able to write a sentence interpreting the slope in plain English.

Interpretation of the Slope

The slope of the best-fit line tells us how the dependent variable (*y*) changes for every one unit increase in the independent (*x*) variable, on average.

In the previous example, the linear regression model for the monthly amount spent on advertising and the monthly revenue for a Fortune 500 company for 12 months was generated as follows:

$$\begin{aligned}\hat{y} &= a + bx \\ \hat{y} &= 9,376.7 + 61.8x\end{aligned}$$

Since the slope was determined to be 61.8, the company can interpret this to mean that for every $1,000 dollars spent on advertising, on average, this will result in an increase in revenues of $61,800.

The intercept of the regression equation is the corresponding *y*-value when.

Interpretation of the Intercept

The intercept of the best-fit line tells us the expected mean value of *y* in the case where the *x*-variable is equal to zero.

However, in many scenarios it may not make sense to have the *x*-variable equal zero, and in these cases, the intercept does not have any meaning in the context of the problem. In other examples, the *x*-value of zero is outside the range of the *x*-data that was collected. In this case, we should not assign any interpretation to the *y*-intercept.

In the previous example, the range of data collected for the *x*-variable was from $49 to $153 spent per month on advertising. Since this interval does not include an *x*-value of zero, we would not provide any interpretation for the intercept.

14.4 Regression Applications in Finance

Learning Outcomes

By the end of this section, you will be able to:

- Calculate the regression model for a single independent variable as applied to financial forecasting.
- Extract measures of slope and intercept from regression analysis in financial applications.

Regression Model for a Single Independent Variable

Regression analysis is used extensively in finance-related applications. Many typical applications involve determining if there is a correlation between various stock market indices such as the S&P 500, the Dow Jones Industrial Average (DJIA), and the Russell 2000 index.

As an example, suppose we would like to determine if there is a correlation between the Russell 2000 index and the DJIA. Does the value of the Russell 2000 index depend on the value of the DJIA? Is it possible to predict the value of the Russell 2000 index for a certain value of the DJIA? We can explore these questions using regression analysis.

Table 14.6 shows a summary of monthly closing prices of the DJIA and the Russell 2000 for a 12-month time period. We consider the DJIA to be the independent variable and the Russell 2000 index to be the dependent variable.

Monthly Close	DJIA	Russell 2000
1-Apr-21	34,200.67	2,262.67
1-Mar-21	32,981.55	2,220.52
1-Feb-21	30,932.37	2,201.05
1-Jan-21	29,982.62	2,073.64
1-Dec-20	30,606.48	1,974.86
1-Nov-20	29,638.64	1,819.82
1-Oct-20	26,501.60	1,538.48
1-Sep-20	27,781.70	1,507.69
1-Aug-20	28,430.05	1,561.88
1-Jul-20	26,428.32	1,480.43
1-Jun-20	25,812.88	1,441.37
1-May-20	25,383.11	1,394.04

Table 14.6 **Monthly Closing Prices of the DJIA and the Russell 2000 for a 12-Month Time Period** (source: Yahoo! Finance)

The first step is to create a scatter plot to determine if the data points appear to follow a linear pattern. The scatter plot is shown in Figure 14.7. The scatter plot clearly shows a linear pattern; the next step is to calculate the correlation coefficient and determine if the correlation is significant.

- Using the Excel command =CORREL, the correlation coefficient is calculated to be 0.947. This value of the correlation coefficient is significant using the test for significance referenced earlier in Correlation Analysis.
- Using the Excel commands =SLOPE and =INTERCEPT, the value of the slope and *y*-intercept are calculated as 0.11 and $-1{,}496.34$, respectively, when rounded to two decimal places.

The Excel output is shown below:

```
=CORREL(C3:C14,B3:B14): 0.947

=SLOPE(C3:C14,B3:B14): 0.113

=INTERCEPT(C3:C14,B3:B14): -1,496.340
```

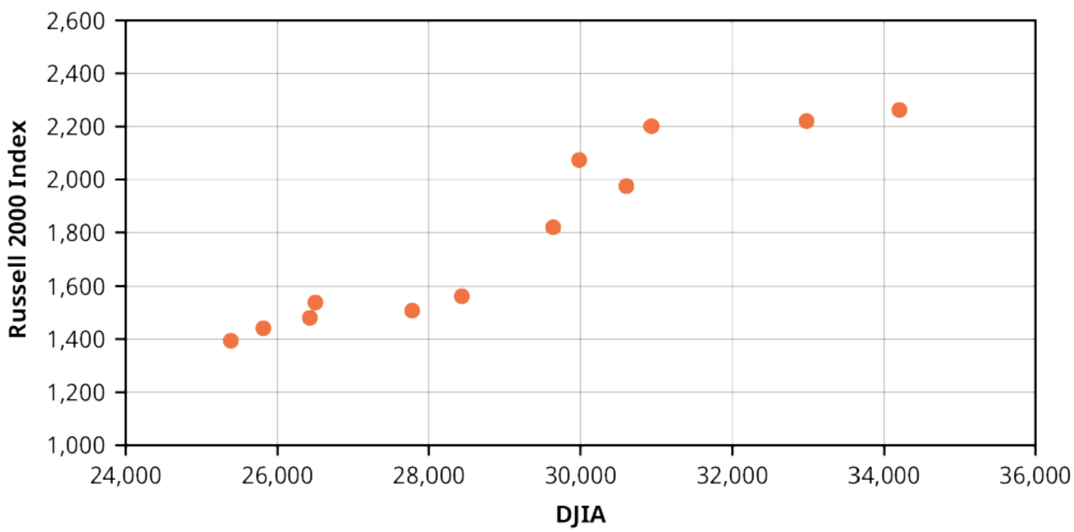


Figure 14.7 Scatter Plot for Monthly Closing Prices of the DJIA versus the Russell 2000 for a 12-Month Time Period (data source: Yahoo! Finance)

Based on these results, the corresponding linear regression model is

$$\begin{aligned}\hat{y} &= a + bx \\ \hat{y} &= -1{,}496.34 + 0.11x\end{aligned}$$

Assume the DJIA has reached a value of 32,000. Predict the corresponding value of the Russell 2000 index. To determine this, substitute the value of the independent variable, $x = 32{,}000$ (this is the given value of the DJIA), and calculate the corresponding value for the dependent variable, which is the predicted value for the Russell 2000 index:

$$\begin{aligned}\hat{y} &= -1{,}496.34 + 0.11(32{,}000) \\ \hat{y} &= 2{,}023.66\end{aligned}$$

Thus the predicted value for the Russell 2000 index is approximately 2,024 when the DJIA reached a value of 32,000.

Measures of Slope and Intercept from Regression Analysis

An important application of regression analysis is to determine the systematic risk for a particular stock, which is referred to as **beta**. A stock's beta is a measure of the volatility of the stock compared to a benchmark such as the S&P 500 index. If a stock has more volatility compared to the benchmark, then the stock will have a beta greater than 1.0. If a stock has less volatility compared to the benchmark, then the stock will have a beta less than 1.0.

Beta can be determined as the slope of the regression line when the stock returns are plotted versus the returns for the benchmark, such as the S&P 500. As an example, consider the calculation for beta of Nike stock based on monthly returns of Nike stock versus monthly returns for the S&P 500 over the time period from May 2020 to March 2021. The monthly return data is shown in Table 14.7.

Date	S&P 500	S&P Monthly Return (%)	Nike Stock Price ($)	Nike Monthly Return (%)
4/1/2020	2,912.43	N/A	87.18	N/A
5/1/2020	3,044.31	0.05	98.58	0.13
6/1/2020	3,100.29	0.02	98.05	-0.01
7/1/2020	3,271.12	0.06	97.61	0.00
8/1/2020	3,500.31	0.07	111.89	0.15
9/1/2020	3,363.00	-0.04	125.54	0.12
10/1/2020	3,269.96	-0.03	120.08	-0.04
11/1/2020	3,621.63	0.11	134.70	0.12
12/1/2020	3,756.07	0.04	141.47	0.05
1/1/2021	3,714.24	-0.01	133.59	-0.06
2/1/2021	3,811.15	0.03	134.78	0.01
3/1/2021	3,943.34	0.03	140.45	0.04
3/12/2021	3,943.34	0.00	140.45	0.00

Table 14.7 **Monthly Returns of Nike Stock versus Monthly Returns for the S&P 500** (source: Yahoo! Finance)

The scatter plot that graphs S&P monthly return versus Nike monthly return is shown in Figure 14.8.

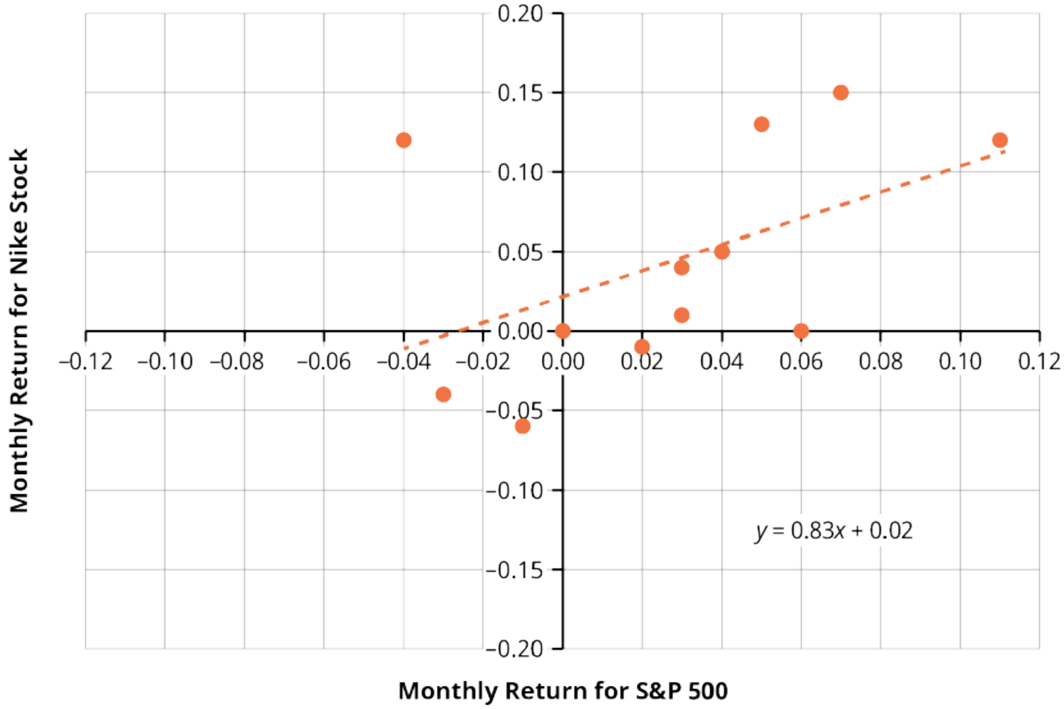


Figure 14.8 Scatter Plot of Monthly Returns of Nike Stock versus Monthly Returns for the S&P 500 ($) (data source: Yahoo! Finance)

The slope of the regression line is 0.83, obtained by using the =SLOPE command in Excel.

```
=SLOPE (E4:E15,C4:C15)

=0.830681658
```

This indicates the value of beta for Nike stock is 0.83, which indicates that Nike stock had lower volatility versus the S&P 500 for the time period of interest.

14.5 Predictions and Prediction Intervals

Learning Outcomes

By the end of this section, you will be able to:

- Calculate predictions for the dependent variable using the regression model.
- Generate prediction intervals based on a prediction for the dependent variable.

Predicting the Dependent Variable Using the Regression Model

A key aspect of generating the linear regression model is to use the model for predictions, provided the correlation is significant. To generate predictions or forecasts using the linear regression model, substitute the value of the independent variable (*x*) in the regression equation and solve the equation for the dependent variable (*y*).

In a previous example, the linear regression equation was generated to relate the amount of monthly revenue for a Fortune 500 company to the amount of monthly advertising spend. From the previous example, it was determined that the regression equation can be written as

$$\begin{aligned} \hat{y} &= a + bx \\ \hat{y} &= 9{,}376.7 + 61.8x \end{aligned}$$

where *x* represents the amount spent on advertising (in thousands of dollars) and *y* represents the amount of revenue (in thousands of dollars).

Let’s assume the Fortune 500 company would like to predict the monthly revenue for a month where it plans to spend $80,000 for advertising. To determine the estimate of monthly revenue, let $x = 80$ in the regression equation and calculate a corresponding value for ŷ:

$$\begin{aligned}\hat{y} &= 9{,}376.7 + 61.8x \\ \hat{y} &= 9{,}376.7 + 61.8(80) \\ \hat{y} &= 14{,}320.70\end{aligned}$$

This predicted value of *y* indicates that the forecasted revenue would be $14,320,700, assuming an advertising spend of $80,000.

- Excel can provide this forecasted value directly using the =FORECAST command.
- To use this command, enter the value of the independent variable *x*, followed by the cell range for the *y*-data and the cell range for the *x*-data, as follows: =`FORECAST(X_VALUE, Range of Y-DATA, Range of X-DATA)`
- Using this Excel command, the forecasted value for the revenue is $14,320.52 when the advertising spend is $80 (in thousands of dollars) (see Figure 14.9). (Note: The discrepancy in the more precise Excel result and the formula result is due to rounding in interim calculations.)

	A	B	C
1	**Month**	**Advertising Expenditure**	**Revenue**
2	Jan	49	12,210
3	Feb	145	17,590
4	Mar	57	13,215
5	Apr	153	19,200
6	May	92	14,600
7	Jun	83	14,100
8	Jul	117	17,100
9	Aug	142	18,400
10	Sep	69	14,100
11	Oct	106	15,500
12	Nov	109	16,300
13	Dec	121	17,020
14			
15		**=FORECAST(80,C2:C13,B2:B13]**	**14,320.52**

Figure 14.9 Revenue versus Advertising for Fortune 500 Company ($000s) Showing FORECAST Command in Excel

A word of caution when predicting values for *y*: it is generally recommended to only predict values for *y* using values of *x* that are in the original range of the data collection.

As an example, assume we have developed a linear model to predict the height of male children based on their age. We have collected data for the age range from $x = 3$ years old to $x = 10$ years old, and we have confirmed that the scatter plot shows a linear trend and that the correlation is significant.

It would be erroneous to use this model to predict the height of a 25-year-old male since $x = 25$ is outside the range of the *x*-data, which was from 3 to 10 years old. The reason this is not recommended is that a linear pattern cannot be assumed to continue beyond the *x*-value of 10 years old unless some data collection has occurred at ages greater than 10 to confirm that the linear pattern is consistent for *x*-values beyond 10 years old.

Generating Prediction Intervals

One important value of an estimated regression equation is its ability to predict the effects on *y* of a change in one or more values of the independent variables. The value of this is obvious. Careful policy cannot be made without estimates of the effects that may result. Indeed, it is the desire for particular results that drive the formation of most policy. Regression models can be, and have been, invaluable aids in forming such policies.

Remember that point estimates do not carry a particular level of probability, or level of confidence, because points have no "width" above which there is an area to measure. There are actually two different approaches to the issue of developing estimates of changes in the independent variable (or variables) on the dependent variable. The first approach wishes to measure the expected mean value of *y* from a specific change in the value of *x*.

The second approach to estimate the effect of a specific value of *x* on *y* treats the event as a single experiment: you choose *x* and multiply it times the coefficient, and that provides a single estimate of *y*. Because this approach acts as if there were a single experiment, the variance that exists in the parameter estimate is larger than the variance associated with the expected value approach.

The conclusion is that we have two different ways to predict the effect of values of the independent variable(s) on the dependent variable, and thus we have two different intervals. Both are correct answers to the question being asked, but there are two different questions. To avoid confusion, the first case where we are asking for the expected value of the mean of the estimated *y* is called a *confidence interval*. The second case, where we are asking for the estimate of the impact on the dependent variable *y* of a single experiment using a value of *x,* is called the *prediction interval*.

The prediction interval for an individual *y* for $x = x_p$ can be calculated as

$$\hat{y} = \pm\, t_{\alpha/2}\, s_e \sqrt{1 + \frac{1}{n} + \frac{\left(x_p - \overline{x}\right)^2}{s_x}}$$

where s_e is the standard deviation of the error term, s_x is the standard deviation of the *x*-variable, and $t_{\alpha/2}$ is the critical value of the t-distribution at the $1 - \alpha$ confidence level.

Tabulated values of the t-distribution are available in online references such as the Engineering Statistics Handbook (https://openstax.org/r/engineering_handbook). The mathematical computations for prediction intervals are complex, and usually the calculations are performed using software. The formula above can be implemented in Excel to create a 95% prediction interval for the forecast for monthly revenue when $x = \$80{,}000$ is spent on monthly advertising. Figure 14.10 shows the detailed calculations in Excel to arrive at a 95% prediction interval of (13,270.95, 15,370.09) for the monthly revenue. (The commands refer to the Excel data table shown in Figure 14.9.)

	E	F	G	H
1	**Calculations for 95% Prediction Interval**			
2	**Measurement**	**Symbol**	**Value**	**Excel Command**
3	Sample size	*n*	12	=COUNT(C2:C13)
4	Degrees of freedom	df	10	=G3 - 2
5	X-bar		103.583333	=AVERAGE(B2:B13)
6	Standard error	S_e	443.92908	=STEYX(C2:C13,B2:B13)
7	Squared deviations of *x*	SS_x	13,054.917	=DEVSQ(B2:B13)
8	Value of *x* for prediction	*x*	80	NA
9	Forecasted value of *y*		14,320.520	=FORECAST(80,C2:C13,B2:B13)
10	Value of t-distribution		2.22813885	=ABS(T.INV(0.025,G4))
11	Margin of error	E	1,049.573	=G10*G6*SQRT(1+1/G3+(G8-G5)^2/G7)
12				
13	**Lower Bound**		**13,270.946**	=G9-G11
14	**Upper Bound**		**15,370.093**	=G9+G11

Figure 14.10 Calculations for 95% Prediction Interval for Monthly Revenue

This prediction interval can be interpreted as follows: there is 95% confidence that when the amount spent on monthly advertising is $80,000, the corresponding monthly revenue will be between $13,270.95 and $15,370.09.

Various computer regression software packages provide programs within the regression functions to provide answers to inquiries of estimated predicted values of *y* given various values chosen for the *x*-variable(s). For example, the statistical program R provides these prediction intervals directly. It is important to know just which interval is being tested in the computer package because the difference in the size of the standard deviations will change the size of the interval estimated. This is shown in Figure 14.11.

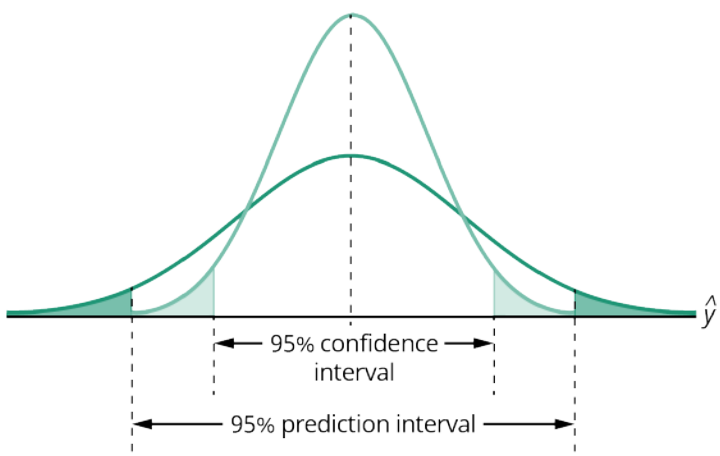


Figure 14.11 Prediction and Confidence Intervals for Regression Equation at 95% Confidence Level

Figure 14.11 shows visually the difference the standard deviation makes in the size of the estimated intervals. The confidence interval, measuring the expected value of the dependent variable, is smaller than the prediction interval for the same level of confidence. The expected value method assumes that the experiment is conducted multiple times rather than just once, as in the other method. The logic here is similar, although not identical, to that discussed when developing the relationship between the sample size and the confidence interval using the central limit theorem. There, as the number of experiments increased, the distribution narrowed, and the confidence interval became tighter around the expected value of the mean.

It is also important to note that the intervals around a point estimate are highly dependent upon the range of data used to estimate the equation, regardless of which approach is being used for prediction. Remember that all regression equations go through the point of means—that is, the mean value of *y* and the mean values of all independent variables in the equation. As the value of *x* gets further and further from the (*x, y*) point corresponding to the mean value of *x* and the mean value of *y*, the width of the estimated interval around the point estimate increases. Choosing values of *x* beyond the range of the data used to estimate the equation poses an even greater danger of creating estimates with little use, very large intervals, and risk of error. Figure 14.12 shows this relationship.

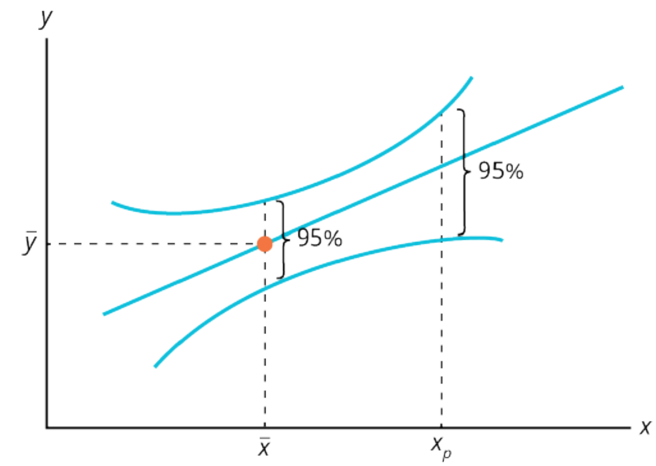


Figure 14.12 Confidence Interval for an Individual Value of *x*, X_p, at 95% Confidence Level

Figure 14.12 demonstrates the concern for the quality of the estimated interval, whether it is a prediction interval or a confidence interval. As the value chosen to predict *y*, X_p in the graph, is further from the central weight of the data, $\overline{X}$, we see the interval expand in width even while holding constant the level of confidence. This shows that the precision of any estimate will diminish as one tries to predict beyond the largest weight of the data and most certainly will degrade rapidly for predictions beyond the range of the data. Unfortunately, this is just where most predictions are desired. They can be made, but the width of the confidence interval may be so large as to render the prediction useless.

14.6 Use of R Statistical Analysis Tool for Regression Analysis

Learning Outcomes

By the end of this section, you will be able to:

- Generate correlation coefficients using the R statistical tool.
- Generate linear regression models using the R statistical tool.

Generate Correlation Coefficients Using the R Statistical Tool

R is an open-source statistical analysis tool that is widely used in the finance industry. R is available as a free program and provides an integrated suite of functions for data analysis, graphing, and statistical programming. R provides many functions and capabilities for regression analysis.

Recall that most calculations in R are handled via functions.

The typical method for using functions in statistical applications is to first create a vector of data values. There are several ways to create vectors in R. For example, the c function is often used to combine values into a vector. For example, this R command will generate a vector called salaries, containing the data values 40,000, 50,000, 75,000, and 92,000:

```
> salaries <- c(40000, 50000, 75000, 92000)
```

To calculate the correlation coefficient *r*, we use the R command called *cor*.

As an example, consider the data set in Table 14.8, which tracks the return on the S&P 500 versus return on Coca-Cola stock for a seven-month time period.

Month	S&P 500 Monthly Return (%)	Coca-Cola Monthly Return (%)
Jan	8	6
Feb	1	0
Mar	0	-2
Apr	2	1
May	-3	-1
Jun	7	8
Jul	4	2

Table 14.8 Monthly Returns of Coca-Cola Stock versus Monthly Returns for the S&P 500

Create two vectors in R, one vector for the S&P 500 returns and a second vector for Coca-Cola returns:

```
> SP500 <- c(8,1,0,2,-3,7,4)

> CocaCola <- c(6,0,-2,1,-1,8,2)
```

The R command called *cor* returns the correlation coefficient for the *x*-data vector and *y*-data vector:

```
> cor(SP500, CocaCola)
```

Generate Linear Regression Models Using the R Statistical Tool

To create a linear model in R, assuming the correlation is significant, the command *lm* (for linear model) will provide the slope and *y*-intercept for the linear regression equation.

The format of the R command is

```
lm(dependent_variable_vector ~ independent_variable_vector)
```

Notice the use of the tilde symbol as the separator between the dependent variable vector and the independent variable vector.

We use the returns on Coca-Cola stock as the dependent variable and the returns on the S&P 500 as the independent variable, and thus the R command would be

```
> lm(CocaCola ~ SP500)

Call:

lm(formula = CocaCola ~ SP500)

Coefficients:

(Intercept) SP500

-0.3453 0.8641
```

The R output provides the value of the *y*-intercept as -0.3453 and the value of the slope as 0.8641. Based on this, the linear model would be

$$\begin{aligned}\hat{y} &= a + bx \\ \hat{y} &= -0.3453 + 0.8641x\end{aligned}$$

where *x* represents the value of S&P 500 return and *y* represents the value of Coca-Cola stock return.

The results can also be saved as a formula and called "model" using the following R command. To obtain more detailed results for the linear regression, the *summary* command can be used, as follows:

```
> model <- lm(CocaCola ~ SP500)

> summary(model)

Call:

lm(formula = CocaCola ~ SP500)

Residuals:

1 2 3 4 5 6 7

-0.5672 -0.5188 -1.6547 -0.3828 1.9375 2.2969 -1.1109

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) -0.3453 0.7836 -0.441 0.67783

SP500 0.8641 0.1734 4.984 0.00416 **

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.658 on 5 degrees of freedom
```

```
Multiple R-squared: 0.8325, Adjusted R-squared: 0.7989

F-statistic: 24.84 on 1 and 5 DF, p-value: 0.004161
```

In this output, the *y*-intercept and slope is given, as well as the residuals for each *x*-value. The output includes additional statistical details regarding the regression analysis.

Predicted values and prediction intervals can also be generated within R.

First, we can create a structure in R called a data frame to hold the values of the independent variable for which we want to generate a prediction. For example, we would like to generate the predicted return for Coca-Cola stock, given that the return for the S&P 500 is 6.

We use the R command called *predict*.

To generate a prediction for the linear regression equation called *model*, using the data frame where the value of the S&P 500 is 6, the R commands will be

```
> a <- data.frame(SP500=6)

> predict(model, a)

1

4.839062
```

The output from the *predict* command indicates that the predicted return for Coca-Cola stock will be 4.8% when the return for the S&P 500 is 6%.

We can extend this analysis to generate a 95% prediction interval for this result by using the following R command, which adds an option to the *predict* command to generate a prediction interval:

```
> predict(model,a, interval="predict")

fit lwr upr

1 4.839062 0.05417466 9.62395
```

Thus the 95% prediction interval for Coca-Cola return is (0.05%, 9.62%) when the return for the S&P 500 is 6%.

Summary

14.1 Correlation Analysis

Correlation is the measure of association between two numeric variables. A correlation coefficient called *r* is used to assess the strength and direction of the correlation. The value of *r* is always between -1 and $+1$. The size of the correlation *r* indicates the strength of the linear relationship between the two variables. Values of *r* close to -1 or to $+1$ indicate a stronger linear relationship. A positive value of *r* means that when *x* increases, *y* tends to increase and when *x* decreases, *y* tends to decrease (positive correlation). A negative value of *r* means that when *x* increases, *y* tends to decrease and when *x* decreases, *y* tends to increase (negative correlation).

14.2 Linear Regression Analysis

Linear regression analysis uses a straight-line fit to model the relationship between the two variables. Once a straight-line model is developed, this model can then be used to predict the value of the dependent variable for a specific value of the independent variable. Two parameters are calculated for the linear model, the slope of the best-fit line and the *y*-intercept of the best-fit line. The method of least squares is used to generate these parameters; this method is based on minimizing the squared differences between the predicted values and observed values for *y*.

14.3 Best-Fit Linear Model

Once a correlation has been deemed significant, a linear regression model is developed. The goal in the regression analysis is to determine the coefficients *a* and *b* in the following regression equation: $\hat{y} = a + bx$. Typically some technology, such as Excel, R statistical tool, or a calculator, is used to generate the coefficients *a* and *b* since manual calculations are cumbersome.

14.4 Regression Applications in Finance

Regression analysis is used extensively in finance-related applications. Many typical applications involve determining if there is a correlation between various stock market indices such as the S&P 500, the DJIA, and the Russell 2000 index. The procedure is to first generate a scatter plot to determine if a visual trend is observed, then calculate a correlation coefficient and check for significance. If the correlation coefficient is significant, a linear model can then be generated and used for predictions.

14.5 Predictions and Prediction Intervals

A key aspect of generating the linear regression model is to then use the model for predictions, provided that the correlation is significant. To generate predictions or forecasts using the linear regression model, substitute the value of the independent variable (*x*) in the regression equation and solve the equation for the dependent variable (*y*). When making predictions using the linear model, it is generally recommended to only predict values for *y* using values of *x* that are in the original range of the data collection.

14.6 Use of R Statistical Analysis Tool for Regression Analysis

R is an open-source statistical analysis tool that is widely used in the finance industry and can be found online (https://openstax.org/r/finance_industry). R provides an integrated suite of functions for data analysis, graphing, and correlation and regression analysis. R is increasingly being used as a data analysis and statistical tool because it is an open-source language and additional features are constantly being added by the user community. The tool can be used on many different computing platforms.

Key Terms

best-fit linear regression model an equation of the form $\hat{y} = a + bx$ that provides the best-fit straight line to the (*x*, *y*) data points

beta the measure of the volatility of a stock as compared to a benchmark such as the S&P 500 index

correlation the measure of association between two numeric variables

correlation coefficient a measure of the strength and direction of the linear relationship between two variables

linear correlation a measure of the association between two variables that exhibit an approximate straight-line fit when plotted on a scatter plot

method of least squares a mathematical method to generate a linear equation that is the "best fit" to the points on the scatter plot in the sense that the line minimizes the differences between the predicted values and observed values for *y*

prediction a forecast for the dependent variable based on a specific value of the independent variable generated using the linear model

residual the difference between an observed *y*-value and the predicted *y*-value obtained from the linear regression equation

scatter plot (scatter diagram) graphical display that shows values of the independent variable plotted on the *x*-axis and values of the dependent variable plotted on the *y*-axis

Multiple Choice

1. Two correlation coefficients are compared: Correlation Coefficient A is 0.83. Correlation Coefficient B is -0.91. Which correlation coefficient represents the stronger linear relationship?
  a. Correlation Coefficient A
  b. Correlation Coefficient B
  c. equal strength
  d. not enough information to determine

2. A data set containing 10 pairs of (x, y) data points is analyzed, and the correlation coefficient is calculated to be 0.58. Does this value of $r = 0.58$ indicate a significant or nonsignificant correlation?
  a. significant
  b. nonsignificant
  c. neither significant nor nonsignificant
  d. not enough information to determine

3. A linear regression model is developed, and for $x = 10$, the corresponding predicted *y*-value is 22.7. The actual observed value for $x = 10$ is $y = 31.3$. Is the residual for this data point positive, negative, or zero?
  a. positive
  b. negative
  c. zero
  d. not enough information to determine

4. A linear model is developed for the relationship between salary of finance professionals and years of experience. The data was collected based on years of experience ranging from 1 to 15. Assuming the correlation is significant, should the linear model be used to predict the salary for a person with 25 years of experience?
  a. It is acceptable to predict the salary for a person with 25 years of experience.
  b. A linear model cannot be created for these two variables.
  c. It is not recommended to predict the salary for a person with 25 years of experience.
  d. There is not enough information to determine the answer.

5. Which of the following is the best interpretation for the slope of the linear regression model?
  a. The slope is the expected mean value of *y* when the *x*-variable is equal to zero.
  b. The slope indicates the change in *y* for every unit increase in *x*.

c. The slope indicates the strength of the linear relationship between *x* and *y*.
d. The slope indicates the direction of the linear relationship between *x* and *y*.

6. A linear model is developed for the relationship between the annual salary of finance professionals and years of experience, and the following is the linear model $\hat{y} = 55{,}000 + 1{,}000x$. Which is the correct interpretation of this linear model?
a. $\text{slope} = 55{,}000$, $y\text{-intercept} = 1{,}000$
b. $\text{slope} = 55$, $y\text{-intercept} = 1{,}000$
c. $\text{slope} = 1{,}000$, $y\text{-intercept} = 55$
d. $\text{slope} = 1{,}000$, $y\text{-intercept} = 55{,}000$

7. Which of the following is the correct sequence of steps needed to create a linear regression model?
a. create scatter plot, calculate correlation coefficient, check for significance, create linear model
b. create linear model, calculate correlation coefficient, check for significance, create scatter plot
c. check for significance, create linear model, calculate correlation coefficient, create scatter plot
d. create scatter plot, check for significance, create linear model, calculate correlation coefficient

8. A linear model is developed for the relationship between the annual salary of finance professionals and years of experience, and the linear model is: $\hat{y} = 55{,}000 + 1{,}000x$. The correlation is determined to be significant. Predict the salary for a finance professional with 7 years of experience.
a. $55,010
b. $60,000
c. $62,000
d. $125,000

9. As predictions are made for *x*-values that are further and further away from the mean of *x*, which is true about the prediction intervals for these *x*-values?
a. The prediction intervals will become smaller.
b. The prediction intervals will become larger.
c. The prediction intervals will remain the same.
d. There is not enough information to determine the answer.

10. Which of the following is the R command to calculate the correlation coefficient *r*?
a. *correl*
b. *cor*
c. *slope*
d. *lm*

11. Which of the following is the R command to calculate the slope and *y*-intercept for a linear regression model?
a. *cor*
b. *slope*
c. *lm*
d. *intercept*

Review Questions

1. A correlation coefficient is calculated as -0.92. Provide an interpretation for this correlation coefficient.

2. Explain what a residual is and how this relates to the best-fit regression model.

3. Explain how to interpret the slope of the best-fit line.

4. Explain how to generate a prediction using a linear regression model.

5. Will the sign of the correlation coefficient always be the same as the sign of the slope of the best-fit linear regression model?

Problems

1. A Fortune 500 company is tracking revenues versus cash flow for recent years, and the data is shown in the table below. Consider cash flow to be the dependent variable. Create a scatter plot of the data set, comment on the correlation between these two variables, and comment on the correlation for this data (all dollar amounts are in thousands).

Revenues ($000s)	Cash Flow ($000s)
237	82
241	86
229	77
284	94
307	93

Table 14.9

2. A Fortune 500 company is tracking revenues versus cash flow for recent years, and the data is shown in the table below. Consider cash flow to be the dependent variable. Calculate the correlation coefficient for this data (all dollar amounts are in thousands).

Revenues ($000s)	Cash Flow ($000s)
237	82
241	86
229	77
284	94
307	93

Table 14.10

3. A chief financial officer calculates the correlation coefficient for bond prices versus interest rate as -0.71. The data set contained nine (x, y) data points. Determine if the correlation is significant or not significant at the 0.05 level of significance.

4. A Fortune 500 company is tracking revenues versus cash flow for recent years, and the data is shown in the table below. Consider cash flow to be the dependent variable. Determine the best-fit linear regression equation for this data set (all dollar amounts are in thousands).

Revenues ($000s)	Cash Flow ($000s)
237	82
241	86

Table 14.11

229	77
284	94
307	93

Table 14.11

5. A Fortune 500 company is tracking revenues versus cash flow for recent years, and the data is shown in the table below. Consider cash flow to be the dependent variable. Assume the correlation is significant. Predict the cash flow for company revenues of $250,000 (all dollar amounts are in thousands).

Revenues ($000s)	Cash Flow ($000s)
237	82
241	86
229	77
284	94
307	93

Table 14.12

6. A Fortune 500 company is tracking revenues versus cash flow for recent years, and the data is shown in the table below. Consider cash flow to be the dependent variable. Assume the correlation is significant. Predict the cash flow for company revenues of $750,000 (all dollar amounts are in thousands).

Revenues ($000s)	Cash Flow ($000s)
237	82
241	86
229	77
284	94
307	93

Table 14.13

7. A Fortune 500 company is tracking revenues versus cash flow for recent years, and the data is shown in the table below. Consider cash flow to be the dependent variable. Calculate the residual for the revenue value of $284,000 (all dollar amounts are in thousands):

Revenues ($000s)	Cash Flow ($000s)
237	82
241	86
229	77
284	94
307	93

Table 14.14

Video Activity

Simple Linear Regression

Click to view content (https://openstax.org/r/linear_regression)

1. Based on the scatter plot shown, will the correlation coefficient be a positive value or negative value? Would you estimate that the correlation is significant for the relationship between radio ads and revenue?

2. For the linear regression model for ads versus revenue, the slope is shown as 78.075. How would this slope be interpreted (that is, provide a verbal description for the meaning of the slope of 78.075)?

How to Calculate Correlation for Stocks, Bonds, and Funds

Click to view content (https://openstax.org/r/bonds_and_funds)

3. Based on the presentation shown in the video, is the FTSE 100 index correlated with the value of sterling? Or are the two measures uncorrelated? What data leads to your conclusion?

4. Based on the presentation in the video, is there a correlation between stock funds and bond funds? Why is this information important to an investor trying to design a portfolio?

15 How to Think about Investing

Figure 15.1 Investing can often provide great returns, but it can also be a risk. (credit: modification of work “E-ticker” by klip game/ Wikimedia Commons, Public Domain)

Chapter Outline

Why It Matters

Having finished her college degree and embarked on her career, Maria is now contemplating her financial future. She is considering how she might invest some of her hard-earned money. As a short-term goal, she wants to build an emergency fund so that she could cover her expenses for six months if she became ill or injured and had to take time off of work. She would also like to save money for a down payment on a home and to purchase new furniture. Although she is not yet 30 years old, Maria also knows that it is prudent to begin saving for retirement.

What should she do with her savings? Maria has some friends who have told her how successful they have been investing in stocks. Bart bragged about doubling his money in just over a year when he purchased Facebook stock, and Tiffany quickly tripled her money when she purchased shares in Netflix. But Maria also knows that her uncle lost a significant amount of money when his Boeing stock dropped from over $300 per share to under $150 within a couple of months at the beginning of 2020. Just how risky would it be to invest in stocks? What type of return might Maria expect? Are there strategies she could follow that would allow her to avoid her uncle’s fate?

15.1 Risk and Return to an Individual Asset

Learning Outcomes

By the end of this section, you will be able to:

- Compute the realized return from an individual investment.
- Compute the average return and volatility of returns from historical data.
- Describe firm-specific risk.

Measuring Historical Returns

Risk and *return* are often referred to as the two Rs of finance. Investors are interested in both risk and return because understanding one without the other is really meaningless. In terms of investment, the concept of *return* is fairly straightforward; return is the benefit, or profit, the investor expects from an expenditure. It is the reward for investing—the reason an investment is made in the first place. However, no investment is a sure thing. The return may not be what the investor was expecting. This uncertainty about what the return will be is referred to as *risk*.

We begin by looking at how to measure both risk and return when considering an individual asset, such as one stock. If your grandparents bought 100 shares of Apple, Inc. stock for you when you were born, you are interested in knowing how well that investment has done. You may even want to compare how that investment has fared to how an investment in a different stock, perhaps Disney, would have done. You are interested in measuring the historical return.

Individual Investment Realized Return

The **realized return** of an investment is the total return that occurs over a particular time period. Suppose that you purchased a share of Target (TGT) at the beginning of January 2020 for $128.74. At the end of the year, you sold the stock for $176.53, which was $47.79 more than you paid for it. This increase in value is known as a *capital gain*. As the owner of the stock, you also received $2.68 in dividends during 2020. The *total dollar return* from your investment is calculated as

$$\begin{aligned}\text{Total Dollar Return } &= \text{Dividend Income } + \text{ Capital Gain}\\ &= 2.68 + \ \$47.79 \ = \ \$50.47\end{aligned}$$

It is common to express investment returns in percentage terms rather than dollar terms. This allows you to answer the question “How much do I receive for each dollar invested?” so that you can compare investments of different sizes. The *total percent return* from your investment is

$$\begin{aligned}\text{Total Percent Return } &= \text{ Dividend Yield} + \text{Capital Gain Yield}\\ &= \frac{\$2.68}{\$128.74} + \frac{\$47.79}{\$128.74} = 0.0208 + 0.3712 = 0.3920 = 39.20\%\end{aligned}$$

The **dividend yield** is calculated by dividing the dividends you received by the initial stock price. This calculation says that for each dollar invested in TGT in 2020, you received $0.0208 in dividends. The **capital gain yield** is the change in the stock price divided by the initial stock price. This calculation says that for each dollar invested in TGT in 2020, you received $0.3712 in capital gains. Your total percent return of 39.20% means that you made $0.392 for every dollar invested when your gains from both dividends and stock price appreciation are totaled together.

THINK IT THROUGH

Calculating Return

You purchased 10 shares of 3M (MMM) stock in January 2020 for $175 per share, received dividends of $5.91

per share, and sold the stock at the end of the year for $169.72 per share. Calculate your total dollar return, your dividend yield, your capital gain yield, and your total percent yield.

Solution:

Because you purchased 10 shares, you received $\$5.91 \times 10 = \$59.10$ in dividend income. You spent $\$175.00 \times 10 = \$1{,}750.00$ to purchase the stock, and you sold it for $\$169.72 \times 10 = \$1{,}697.20$. Your total dollar return is

$$\begin{aligned}\text{Total Dollar Return} &= \text{Dividend Income} + \text{Capital Gain}\\ &= \$59.10 + (\$1{,}697.20 - \$1{,}750.00) = \$6.30\end{aligned}$$

Your dividend yield is $\frac{\$5.91}{\$175.00} = 0.0338$, or 3.38%, and your capital gain yield is $\frac{\$169.72 - \$175.00}{\$175.00} = -0.0302$, or 3.02%. Your total percent return is $3.38\% + (-3.02\%) = 0.36\%$.

Notice that you sold MMM for a price lower than what you paid for it at the beginning of the year. Your capital gain is negative, or what is often referred to as a *capital loss*. Although the price fell, you still had a positive total dollar return because of the dividend income.

Of course, investors seldom purchase a stock and then sell it exactly one year later. Assume that you purchased shares of Facebook (FB) on June 1, 2020, for $228.50 per share and sold the shares three months later for $261.90. You received no dividends. In this case, your **holding period percentage return** is calculated as

$$\frac{\$261.90 - \$228.50}{\$228.50} = 0.1462 = 14.62\%$$

This 14.62% is your return for a three-month holding period. To compare them to other investment opportunities, you need to express returns on a per-year, or *annualized*, basis. The holding period returned is converted to an **effective annual rate (EAR)** using the formula

$$\text{EAR} = (1 + \text{Holding Period Percentage Return})^m - 1$$

where *m* is the number of holding periods in a year.

There are four three-month periods in a year. So, the EAR for this investment is

$$\text{EAR} = (1 + 0.1462)^4 - 1 = 0.7260 = 72.60\%$$

What happens if you own a stock for more than one year? Your holding period return would have occurred over a period longer than a year, but the process to calculate the EAR is the same. Suppose you purchased shares of FB in May 2015, when it was selling for $79.30 per share. You held the stock until May 2020, when you sold it for $224.59. Your holding period percentage return would be $\frac{\$224.59 - \$79.30}{\$79.30} = 183.22\%$. You more than tripled your money, but it took you five years to do so. Your EAR, which will be smaller than this five-year holding period return rate, is calculated as

$$\text{EAR} = (1 + 1.8322)^{\frac{1}{5}} - 1 = 23.15\%$$

Average Annual Returns

Suppose that you purchased shares of Delta Airlines (DAL) at the beginning of 2011 for $11.19 and held the stock for 10 years before selling it for $40.21. You made $\$40.21 - \$11.19 = \$29.02$ on your investment over a 10-year period. This is a 259.34% holding period return. The EAR for this investment is

$$\text{EAR} = (1 + 2.5934)^{\frac{1}{10}} - 1 = 13.65\%$$

To calculate the EAR using the above formula, the holding period return must first be calculated. The holding period return represents the percentage return earned over the entire time the investment is held. Then the holding period return is converted to an annual percentage rate using the formula.

You can also use the basic time value of money formula to calculate the EAR on an investment. In time value of money language, the initial price paid for the investment, $11.19, is the present value. The price the stock is sold for, $40.21, is the future value. It takes 10 years for the $11.19 to grow to $40.21. Using the time value of money will result in a calculation of

$$\begin{aligned} \text{PV} \times (1+i)^n &= \text{FV} \\ 1.19 \times (1+i)^{10} &= 40.21 \\ 1+i &= 3.5934^{0.10} \\ i &= 13.65\% \end{aligned}$$

The EAR formula and the time value of money both result in a 13.65% annual return. Mathematically, the two formulas are the same; one is simply an algebraic rearrangement of the other.

If you earned 13.65% each year, compounded for 10 years, you would have converted your $11.19 per share investment to $40.21 per share. Of course, DAL stock did not increase by exactly 13.65% each year. The returns for DAL for each year are shown in Table 15.1. Some years, the return was much higher than 13.65%. In 2013, the return was almost 133%! Other years, the return was much lower than 13.65%; in fact, in the return was negative in four of the years.

Year	Return	Value of Investment ($)
		Initial investment of 11.19
2011	−0.3579	7.19
2012	0.4672	10.54
2013	1.3261	24.52
2014	0.8053	44.27
2015	0.0405	46.06
2016	−0.0135	45.44
2017	0.1623	52.81
2018	−0.0866	48.24
2019	0.2038	58.07
2020	−0.3077	40.20

Table 15.1 Yearly Returns for DAL, 2011–2020: Value of Initial Investment at Each Year End

Although an investment in DAL of $11.19 at the beginning of 2011 grew to $40.20 by the end of 2020, this growth was not consistent each year. The amount that the stock was worth at the end of each year is also shown in Table 15.1. During 2011, the return for DAL was −35.79%, resulting in the value of the investment falling to $\$11.19 \times [1 + (-0.3579)] = \$7.19$. The following year, 2012, the return for DAL was 46.72%. Therefore, the value of the investment was $\$7.19 \times 1 + (1 + 0.4672) = \$10.54$ at the end of 2012. This process continues each year that the stock is held.

The compounded annual return derived from the EAR and time value of money formulas is also known as a **geometric average return**. A geometric average return is calculated using the formula

$$\text{Geometric Average Return} = [(1+R_1) \times (1+R_2) \times \ldots \times (1+R_N)]^{\frac{1}{N}} - 1$$

where R_N is the return for each year in the time period for which the average is calculated.

The calculation of the geometric average return for DAL is shown in the right column of Table 15.2. (The slight difference in the geometric average return of 13.64% from the 13.65% derived from the EAR and time value of money calculations is due to rounding errors.)

Year	Return	1 + Return	
2011	−0.3579	0.6421	
2012	0.4672	1.4672	
2013	1.3261	2.3261	
2014	0.8053	1.8053	
2015	0.0405	1.0405	
2016	−0.0135	0.9865	
2017	0.1623	1.1623	
2018	−0.0866	0.9134	
2019	0.2038	1.2038	
2020	−0.3077	0.6923	
Arithmetic Avg	**0.2240**	**3.5928**	**Product of (1 + Return)**
Std Dev	**0.5190**	**1.1364**	**Product raised to 1/N**
		0.1364	**Geometric Average**

Table 15.2 Yearly Returns for DAL, 2011–2020, with Calculation of the Arithmetic Mean, Standard Deviation, and Geometric Mean

Looking at Table 15.2, you will notice that the geometric average return differs from the mean return. Adding each of the annual returns and dividing the sum by 10 results in a 22.4% average annual return. This 22.4% is called the **arithmetic average return**.

The geometric average return will be smaller than the arithmetic average return (unless the returns for all years are identical). This is due to the basic arithmetic of compounding. Think of a very simple example in which you invest $100 for two years. If you have a positive return of 50% the first year and a negative 50% return the second year, you will have an arithmetic average return of $\frac{0.5 + (-0.50)}{2} = 0.0\%$, but you will have a geometric average return of $[(1 + 0.5) \times (1 - 0.5)]0.5 - 1 = -13.4\%$. With a 50% positive return the first year, you ended the year with $150. The second year, you lost 50% of that balance and were left with only $75.

Another important fact when studying average returns is that the order in which you earn the returns is not important. Consider what would have occurred if the returns in the two years were reversed, so that you faced a loss of 50% in the first year of your investment and a gain of 50% in the second year of your investment. With a −50% return in the first year, you would have ended that year with only $50. Then, if that $50 earned a positive 50% return the second year, you would have a $75 balance at the end of the two-year period. A negative return of 50% followed by a positive return of 50% still results in an arithmetic average return of 0% and a geometric average return of $[(1 - 0.5) \times (1 + 0.5)]0.5 - 1 = -13.4\%$.

THINK IT THROUGH

Calculating Arithmetic and Geometric Average Return

The annual returns for CVS Health Corp. (CVS) for the 10-year period of 2011–2020 are shown in Table 15.3.

Year	Returns
2011	18.94%
2012	20.28%
2013	50.38%
2014	37.12%
2015	2.90%
2016	−17.83%
2017	−5.75%
2018	−7.04%
2019	17.26%
2020	−5.14%

Table 15.3 CVS Annual Returns, 2011–2020 (source: Yahoo! Finance)

What was the arithmetic average return during the decade? What was the geometric average return during the decade?

Solution:

See Table 15.4 for the arithmetic mean and geometric mean calculations.

	Arithmetic Average Calculation	Geometric Average Calculation	
Year	**Return**	**1 + Return**	
2011	0.1894	1.1894	
2012	0.2028	1.2028	
2013	0.5038	1.5038	
2014	0.3712	1.3712	
2015	0.0290	1.0290	
2016	−0.1783	0.8217	
2017	−0.0575	0.9425	
2018	−0.0704	0.9296	
2019	0.1726	1.1726	
2020	−0.0514	0.9486	

	Arithmetic Average Calculation	Geometric Average Calculation	
Sum of Returns	1.1112	2.4309	Product of (1 + Return)
Sum Divided by 10	0.1111	1.0929	Raise Product to 1/10
Arithmetic Average	11.11%	0.0929	Subtract 1
		9.29%	Geometric Average

Table 15.4 Yearly Returns for CVS, 2011–2020

The arithmetic average return for CVS was 11.11%, and the geometric average return was 9.29%.

Both the arithmetic average return and the geometric average return are “correct” calculations. They simply answer different questions. The geometric average tells you what you actually earned per year on average, compounded annually. It is useful for calculating how much a particular investment grows over a period of time. The arithmetic average tells you what you earned in a typical year. When we are looking at the historical description of the distribution of returns and want to predict what to expect in a particular year, the arithmetic average is the relevant calculation.

Measuring Risk

Although the arithmetic average return for Delta Airlines (DAL) for 2011–2020 was 22.4%, there is not a year in which the return was exactly 22.4%. In fact, in some years, the return was much higher than the average, such as in 2013, when it was 132.61%. In other years, the return was negative, such as 2011, when it was −35.79%. Looking at the yearly returns in Table 15.2, the return for DAL varies widely from year to year. In finance, this volatility of returns is considered risk.

Volatility of Returns

The most commonly used measure of volatility of returns in finance is the standard deviation of the returns. The standard deviation of returns for DAL for the sample period 2011–2020 is 51.9%. Remember that if the normal distribution (a bell-shaped curve) describes returns, then 68% (or about two-thirds) of the time, the return in a particular year will be within one standard deviation above and one standard deviation below the arithmetic average return. Given DAL’s average return of 22.4%, the actual yearly return will be somewhere between −29.5% and 74.29% in two out of three years. A very high return of greater than 74.29% would occur 16% of the time; a very large loss of more than 29.5% would also occur 16% of the time.

As you can see, there is a wide range of what can be considered a “typical” year for DAL. Although we can calculate an average return, the return in any particular year is likely to vary from that average. The larger the standard deviation, the greater this range of returns is. Thus, a larger standard deviation indicates a greater volatility of returns and, hence, more risk.

THINK IT THROUGH

Calculating the Standard Deviation of Returns

You calculated the arithmetic average return for CVS to be 11.11% for the 10-year period of 2011–2020. Calculate the standard deviation of returns for CVS for the same period (see Table 15.5). What does this tell you about what an investor in CVS experienced in a typical year during that decade?

Solution:

Year	Return	Return – Mean	Squared Difference	
2011	0.1894	0.0783	0.0061	
2012	0.2028	0.0917	0.0084	
2013	0.5038	0.3927	0.1542	
2014	0.3712	0.2601	0.0676	
2015	0.0290	−0.0821	0.0067	
2016	−0.1783	−0.2894	0.0838	
2017	−0.0575	−0.1686	0.0284	
2018	−0.0704	−0.1815	0.0329	
2019	0.1726	0.0615	0.0038	
2020	−0.0514	−0.1625	0.0264	
Mean	**0.1111**		**0.4185**	**Sum of Squared Differences**
			0.0465	**Sum Divided by N – 1**
			0.2156	**Square Root**

Table 15.5 Standard Deviation of CVS Returns

The standard deviation of returns for CVS during the sample period of 2011–2020 was 21.56%. With an arithmetic average return of 11.11%, the return would lie between −10.45% and 32.67% in about two out of three years. Even though the average return is 11.11%, a return in a particular year might be much higher or much lower than that average. In fact, a loss of more than 10.45% would be expected about once every six years. Also, about once every six years, a return greater than 32.67% would be expected.

Firm-Specific Risk

Investors purchase a share of stock hoping that the stock will increase in value and they will receive a positive return. You can see, however, that even with well-established companies such as ExxonMobil and CVS, returns are highly volatile. Investors can never perfectly predict what the return on a stock will be, or even if it will be positive.

The yearly returns for four companies—Delta Airlines (DAL), Southwest Airlines (LUV), ExxonMobil (XOM), and CVS Health Corp. (CVS)—are shown in Table 15.6. Each of these stocks had years in which the performance was much better or much worse than the arithmetic average. In fact, none of the stocks appear to have a typical return that occurs year after year.

		Two-Stock Portfolio		
Year	**DAL**	**LUV**	**XOM**	**CVS**
2011	−35.79%	−33.93%	18.67%	18.94%
2012	46.72%	20.03%	4.70%	20.28%
2013	132.61%	85.38%	20.12%	50.38%
2014	80.53%	126.47%	−6.06%	37.12%
2015	4.05%	2.43%	−12.79%	2.90%

Table 15.6 Yearly Returns for DAL, LUV, XOM, and CVS (source: Yahoo! Finance)

	Two-Stock Portfolio			
Year	DAL	LUV	XOM	CVS
2016	−1.35%	16.72%	19.88%	−17.83%
2017	16.23%	32.41%	−3.81%	−5.75%
2018	−8.66%	−28.28%	−15.09%	−7.04%
2019	20.38%	17.69%	7.23%	17.26%
2020	−30.77%	−13.04%	−36.21%	−5.14%
Average	22.40%	22.59%	−0.34%	11.11%
Std Dev	51.90%	49.84%	18.18%	21.56%

Table 15.6 Yearly Returns for DAL, LUV, XOM, and CVS (source: Yahoo! Finance)

Figure 15.2 contains a graph of the returns for each of these four stocks by year. In this graph, it is easy to see that DAL and LUV both have more volatility, or returns that vary more from year to year, than do XOM or CVS. This higher volatility leads to DAL and LUV having higher standard deviations of returns than XOM or CVS.

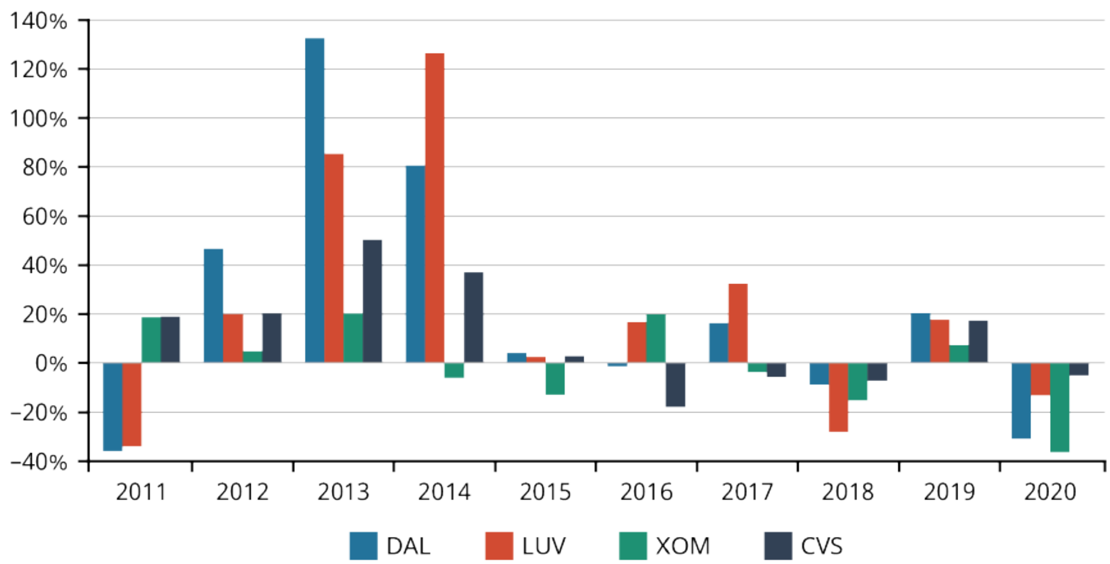


Figure 15.2 Yearly Returns for DAL, LUV, XOM, and CVS (data source: Yahoo! Finance)

Standard deviation is considered a measure of the risk of owning a stock. The larger the standard deviation of a stock's annual returns, the further from the average that stock's return is likely to be in any given year. In other words, the return for the stock is highly unpredictable. Although the return for CVS varies from year to year, it is not subject to the wide swings of the returns for DAL or LUV.

Why are stock returns so volatile? The value of the stock of a company changes as the expectations of the future revenues and expenses of the company change. These expectations may change due to a number of events and new information. Good news about a company will tend to result in an increase in the stock price. For example, DAL announcing that it will be opening new routes and flying to cities it has not previously serviced suggests that DAL will have more customers and more revenue in future years. Or if CVS announces that it has negotiated lower rent for many of its locations, investors will expect the expenses of the company to fall, leading to more profits. Those types of announcements will often be associated with a higher stock price. Conversely, if the pilots and flight attendants for DAL negotiate higher salaries, the expenses for DAL will increase, putting downward pressure on profits and the stock price.

LINK TO LEARNING

Peloton and Risk

An example of how news can impact the price of a stock occurred on May 5, 2021, when Peloton recalled all of its Tread+ and Tread products after the tragic death of a child and 70 injuries associated with use of its products.[1] The previous day, Peloton stock traded for $96.70 per share. The stock price dropped approximately 15% when the recall was announced. The closing price for a share of Peloton on May 5 was $82.62.[2] You can read the company's statement about this recall (https://openstax.org/r/the_companys_recall) online.

15.2 Risk and Return to Multiple Assets

Learning Outcomes

By the end of this section, you will be able to:

- Explain the benefits of diversification.
- Describe the relationship between risk and return for large portfolios.
- Compare firm-specific and systematic risk.
- Discuss how portfolio size impacts risk.

Diversification

So far, we have looked at the return and the volatility of an individual stock. Most investors, however, own shares of stock in multiple companies. This collection of stocks is known as a **portfolio**. Let's explore why it is wise for investors to hold a portfolio of stocks rather than to pick just one favorite stock to own.

We saw that investors who owned DAL experienced an average annual return of 20.87% but also a large standard deviation of 51.16%. Investors who used all their funds to purchase DAL stock did exceptionally well during 2012–2014. But in 2020, those investors lost almost one-third of their money as COVID-19 caused a sharp reduction in air travel worldwide. To protect against these extreme outcomes, investors practice what is called **diversification**, or owning a variety of stocks in their portfolios.

Suppose, for example, you have saved $50,000 that you want to invest. If you purchased $50,000 of DAL stock, you would not be diversified. Your return would depend solely on the return on DAL stock. If, instead, you used $5,000 to purchase DAL stock and used the remaining $45,000 to purchase nine other stocks, you would be diversifying. Your return would depend not only on DAL's return but also on the returns of the other nine stocks in your portfolio. Investors practice diversification to manage risk.

It is akin to the saying "Don't put all of your eggs in one basket." If you place all of your eggs in one basket and that basket breaks, all of your eggs will fall and crack. If you spread your eggs out across a number of baskets, it is unlikely that all of the baskets will break and all of your eggs will crack. One basket may break, and you will lose the eggs in that basket, but you will still have your other eggs. The same idea holds true for investing. If you own stock in a company that does poorly, perhaps even goes out of business, you will lose the money you placed in that particular investment. However, with a diversified portfolio, you do not lose all your money because your money is spread out across a number of different companies.

1 Trefis Team and Great Speculations. "Is Peloton's Tread+ Recall an Opportunity to Buy the Stock?" Forbes, May 7, 2021. https://www.forbes.com/sites/greatspeculations/2021/05/07/is-pelotons-tread-recall-an-opportunity-to-buy-the-stock/
2 Tomi Kilgore. "Peloton Stock Sinks to 8-Month Low after 125,000 Treadmills Recalled for 'Risk of Injury or Death.'" MarketWatch. May 6, 2021. https://www.marketwatch.com/story/peloton-stock-sinks-toward-9-month-low-after-125-000-treadmills-recalled-for-risk-of-injury-or-death-11620233715

LINK TO LEARNING

Diversification

Fidelity Investments Inc. is a multinational financial services firm and one of the largest asset managers in the world. In this educational video for investors (https://openstax.org/r/educational_investors), Fidelity provides an explanation of what diversification is and how it impacts an investor's portfolio.

Table 15.7 shows the returns of investors who placed 50% of their money in DAL and the remaining 50% in LUV, XOM, or CVS. Notice that the standard deviation of returns is lower for the two-stock portfolios than for DAL as an individual investment.

		Two-Stock Portfolio		
Year	**DAL**	**DAL and LUV**	**DAL and XOM**	**DAL and CVS**
2011	−35.79%	−34.86%	−8.56%	−8.43%
2012	46.72%	33.38%	25.71%	33.50%
2013	132.61%	109.00%	76.36%	91.50%
2014	80.53%	103.50%	37.24%	58.83%
2015	4.05%	3.24%	−4.37%	3.47%
2016	−1.35%	7.69%	9.27%	−9.59%
2017	16.23%	24.32%	6.21%	5.24%
2018	−8.66%	−18.47%	−11.88%	−7.85%
2019	20.38%	19.03%	13.81%	18.82%
2020	−30.77%	−21.90%	−33.49%	−17.95%
Average	**22.40%**	**22.49%**	**11.03%**	**16.75%**
Std Dev	**51.90%**	**49.11%**	**30.43%**	**35.10%**

Table 15.7 Yearly Returns for DAL Versus a Two-Stock Portfolio Containing DAL and LUV, XOM, or CVS (data source: Yahoo! Finance)

As investors diversify their portfolios, the volatility of one particular stock becomes less important. XOM has good years with above-average returns and bad years with below-average (and even negative) returns, just like DAL. But the years in which those above-average and below-average returns occur are not always the same for the two companies. In 2014, for example, the return for DAL was greater than 80%, while the return for XOM was negative. On the other hand, in 2011, when DAL had a return of −35.15%, XOM had a positive return. When more than one stock is held, the gains in one stock can offset the losses in another stock, washing away some of the volatility.

When an investor holds only one stock, that one stock's volatility contributes 100% to the portfolio's volatility. When two stocks are held, the volatility of each stock contributes to the volatility of the portfolio. However, the volatility of the portfolio is not simply the average of the volatility of each stock held independently. How correlated the two stocks are, or how much they move together, will impact the volatility of the portfolio.

You will recall from our study of correlation in Regression Analysis in Finance that a correlation coefficient describes how two variables move relative to each other. A correlation coefficient of 1 means that there is a perfect, positive correlation between the two variables, while a correlation coefficient of −1 means that the two variables move exactly opposite of each other. Stocks that are in the same industry will tend to be more strongly correlated than stocks that are in much different industries. During the 2011–2020 time period, the correlation coefficient for DAL and LUV was 0.87, the correlation coefficient for DAL and XOM was 0.35, and the correlation coefficient for DAL and CVS was 0.79. Combining stocks that are not perfectly positively correlated in a portfolio decreases risk.

Notice that investors who owned DAL and LUV from 2011 to 2020 would have had a lower portfolio standard deviation, but not much lower, than investors who just owned DAL. Because the correlation coefficient is less than one, the standard deviation fell. However, because the two stocks are in the same industry and exposed to many of the same economic issues, the correlation coefficient is relatively high, and combining those two stocks provides only a small decrease in risk.

This is because, as airlines, DAL and LUV face many of the same market conditions. In years when the economy is strong, the weather is good, fuel prices are low, and people are traveling a lot, both companies will do well. When something such as bad weather conditions reduces the amount of air travel for several weeks, both companies are harmed. By holding LUV in addition to DAL, investors can reduce exposure to risk that is specific to DAL (perhaps a problem that DAL has with its reservation system), but they do not reduce exposure to the risk associated with the airline industry (perhaps rising jet fuel prices). DAL and LUV tend to experience positive returns in the same years and negative returns in the same years.

On the other hand, investors who added XOM to their portfolio saw a significantly lower standard deviation than those who held just DAL. In years when jet fuel prices rise, harming the profits of both DAL and LUV, XOM is likely to see high profits. Diversifying a portfolio across firms that are less correlated will reduce the standard deviation of the portfolio more.

LINK TO LEARNING

How to Build a Diversified Portfolio

TV personality, former hedge fund manager, and author Jim Cramer encourages investors to build a diversified portfolio, having no more than 20% of a portfolio in one sector.[3] Watch this CNBC video (https://openstax.org/r/CNBC_video) to learn more about how he suggests investors can build a diversified portfolio by purchasing five to 10 stocks.

Portfolio Size and Risk

As you add more stocks to a portfolio, the volatility, or standard deviation, of the portfolio decreases. The volatility of individual assets becomes less and less important. As we discussed earlier, the risk that is associated with events related to a particular company is called **firm-specific risk**, or unsystematic, risk. Examples of unsystematic risk would include a company facing a product liability lawsuit, a company inventing a new product, or accounting irregularities being detected. Holding a portfolio of stocks means that if one company you have invested in goes out of business because of poor management, you do not lose all your savings because some of your money is invested in other companies. Portfolio diversification protects you from being significantly impacted by unsystematic risk.

However, there is a level below which the portfolio risk does not drop, no matter how diversified the portfolio becomes. The risk that never goes away is known as **systematic risk**. Systematic risk is the risk of holding the market portfolio.

We have talked about reasons why a firm's returns might be volatile; for example, the firm discovering a new technology or having a product liability lawsuit brought against it will impact that firm specifically. There are also events that broadly impact the stock market. Changes in the Federal Reserve Bank's monetary policy and

3 Abigail Stevenson. "Jim Cramer Shares His #1 Rule for Investing." Make It. CNBC, March 15, 2016. https://www.cnbc.com/2016/03/03/cramer-forget-sectors-a-better-way-to-diversify.html

interest rates impact all companies. Geopolitical events, major storms, and pandemics can also impact the entire market. Investors in stocks cannot avoid this type of risk. This unavoidable risk is the systematic risk that investors in stocks have. This systematic risk cannot be eliminated through diversification.

In addition, as per research conducted by Meir Statman,[4] the standard deviation of a portfolio drops quickly as the number of stocks in the portfolio increases from one to two or three (see Figure 2 illustration in this subsequent article by Statman (https://openstax.org/r/subsequent_Statman) for context). Increasing the size of the portfolio decreases the standard deviation, and thus the risk, of the portfolio. However, as the portfolio increases in size, the amount of risk reduced by adding one more stock to the portfolio will decrease. How many stocks does an investor need for a portfolio to be well-diversified? There is not an exact number that all financial managers agree on. A portfolio of 15 highly correlated stocks will offer less benefits of diversification than a portfolio of 10 stocks with lower correlation coefficients. A portfolio that consists of American Airlines, Spirit Airlines, United Airlines, Southwest Airlines, Delta Airlines, and Jet Blue, along with a few other stocks, is not very diversified because of the heavy concentration in the airline industry. The term *diversified portfolio* is a relative concept, but the average investor can create a reasonably diversified portfolio with approximately a dozen stocks.

15.3 The Capital Asset Pricing Model (CAPM)

Learning Outcomes

By the end of this section, you will be able to:

- Define risk premium.
- Explain the concept of beta.
- Compute the required return of a security using the CAPM.

Risk-Free Rate

The **capital asset pricing model (CAPM)** is a financial theory based on the idea that investors who are willing to hold stocks that have higher systematic risk should be rewarded more for taking on this market risk. The CAPM focuses on systematic risk, rather than a stock's individual risk, because firm-specific risk can be eliminated through diversification.

Suppose that your grandparents have given you a gift of $20,000. After you graduate from college, you plan to work for a few years and then apply to law school. You want to use the $20,000 your grandparents gave you to pay for part of your law school tuition. It will be several years before you are ready to spend the money, and you want to keep the money safe. At the same time, you would like to invest the money and have it grow until you are ready to start law school.

Although you would like to earn a return on the money so that you have more than $20,000 by the time you start law school, your primary objective is to keep the money safe. You are looking for a risk-free investment. Lending money to the US government is considered the lowest-risk investment that you can make. You can purchase a US Treasury security. The chances of the US government not paying its debts is close to zero. Although, in theory, no investment is 100% risk-free, investing in US government securities is generally considered a risk-free investment because the risk is so miniscule.

4 Meir Statman. "How Many Stocks Make a Diversified Portfolio?" Journal of Financial and Quantitative Analysis 22, no. 3 (September 1987): 353–363. https://doi.org/10.2307/2330969

The rate that you can earn by purchasing US Treasury securities is a proxy for the **risk-free rate**. It is used as an investing benchmark. The average rate of return for the three-month US Treasury security from 1928 to 2020 is 3.36%.[5] You can see that you will not become immensely wealthy by investing in US Treasury bills. Another characteristic of US Treasury securities, however, is that their volatility tends to be much lower than that of stocks. In fact, the standard deviation of returns for the US Treasury bills is 3.0%. Unlike the returns for stocks, the return on US Treasury bills has never been negative. The lowest annual return was 0.03%, which occurred in 2014.[6]

LINK TO LEARNING

US Treasury Securities

Visit the website of the US Department of the Treasury (https://openstax.org/r/home.treasury) to learn more about US Treasury securities. You will find current interest rates for both short-term securities (US Treasury bills) and long-term securities (US Treasury bonds).

Risk Premium

You know that if you use your $20,000 to invest in stock rather than in US Treasury bills, the outcome of the investment will be uncertain. Your investments may do well, but there is also a risk of losing money. You will only be willing to take on this risk if you are rewarded for doing so. In other words, you will only be willing to take the risk of investing in stocks if you think that doing so will make you more than you would make investing in US Treasury securities.

From 1928 to 2020, the average return for the S&P 500 stock index has been 11.64%, which is much higher than the 3.36% average return for US Treasury bills.[7] Stock returns, with a standard deviation of 19.49%, however, have also been much more volatile. In fact, there were 25 years in which the return for the S&P 500 index was negative.

You may not be willing to take the risk of losing some of the money your grandparents gave you because you have been setting it aside for law school. If that’s the case, you will want to invest in US Treasury securities. You may have money that you are saving for other long-term goals, such as retirement, with which you are willing to take some risk. The extra return that you will earn for taking on risk is known as the **risk premium**. The risk premium can be thought of as your reward for being willing to bear risk.

The risk premium is calculated as the difference between the return you receive for taking on risk and what you would have returned if you did not take on risk. Using the average return of the S&P 500 (to measure what investors who bear the risk earn) and the US Treasury bill rate (to measure what investors who do not bear risk earn), the risk premium is calculated as

$$\begin{aligned}\text{Risk Premium} &= \text{S\&P 500 Avg Return} - \text{US T-Bill Avg Return}\\ &= 11.64\% - 3.36\% \ = \ 8.28\%\end{aligned}$$

Beta

The risk premium represents how much an investor who takes on the market portfolio is rewarded for risk. Investors who purchase one stock—DAL, for example—experience volatility, which is measured by the standard deviation of that stock’s returns. Remember that some of that volatility, the volatility caused by firm-specific risk, can be diversified away. Because investors can eliminate firm-specific risk through diversification, they will not be rewarded for that risk. Investors are rewarded for the amount of systematic risk they incur.

5 “Historical Return on Stocks, Bonds and Bills: 1928–2020.” Damodaran Online. Stern School of Business, New York University, January 2021. http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html
6 Ibid.
7 Ibid.

Interpreting Beta

The relevant risk for investors is the systematic risk they incur. The systematic risk of a particular stock is measured by how much the stock moves with the market. The measure of how much a stock moves with the market is known as its **beta**. A stock that tends to move in sync with the market will have a beta of 1. For these stocks, if the market goes up 10%, the stock generally also goes up 10%; if the market goes down 5%, stocks with a beta of 1 also tend to go down 5%.

If a company has a beta greater than 1, then the stock tends to have a more pronounced move in the same direction as a market move. For example, if a stock has a beta of 2, the stock will tend to increase by 20% when the market goes up by 10%. If the market falls by 5%, that same stock will tend to fall by twice as much, or 10%. Thus, stocks with a beta greater than 1 experience greater swings than the overall market and are considered to be riskier than the average stock.

On the other hand, stocks with a beta less than 1 experience smaller swings than the overall market. A beta of 0.5, for example, means that a stock tends to experience moves that are only 50% of overall market moves. So, if the market increases by 10%, a stock with a beta of 0.5 would tend to rise by only 5%. A market decline of 5% would tend to be associated with a 2.5% decrease in the stock.

Calculating Betas

The calculation of beta for DAL is demonstrated in Figure 15.3. Monthly returns for DAL and for the S&P 500 are plotted in the diagram. Each dot in the scatter plot corresponds to a month from 2018 to 2020; for example, the dot that lies furthest in the upper right-hand corner represents November 2020. The return for the S&P 500 was 10.88% that month; this return is plotted along the horizontal axis. The return for DAL during November 2020 was 31.36%; this return is plotted along the vertical axis.

You can see that generally, when the overall stock market as measured by the S&P 500 is positive, the return for DAL is also positive. Likewise, in months in which the return for the S&P 500 is negative, the return for DAL is also usually negative. Drawing a line that best fits the data, also known as a regression line, summarizes the relationship between the returns for DAL and the S&P 500. The slope of this line, 1.39, is DAL's beta. Beta measures the amount of systematic risk that DAL has.

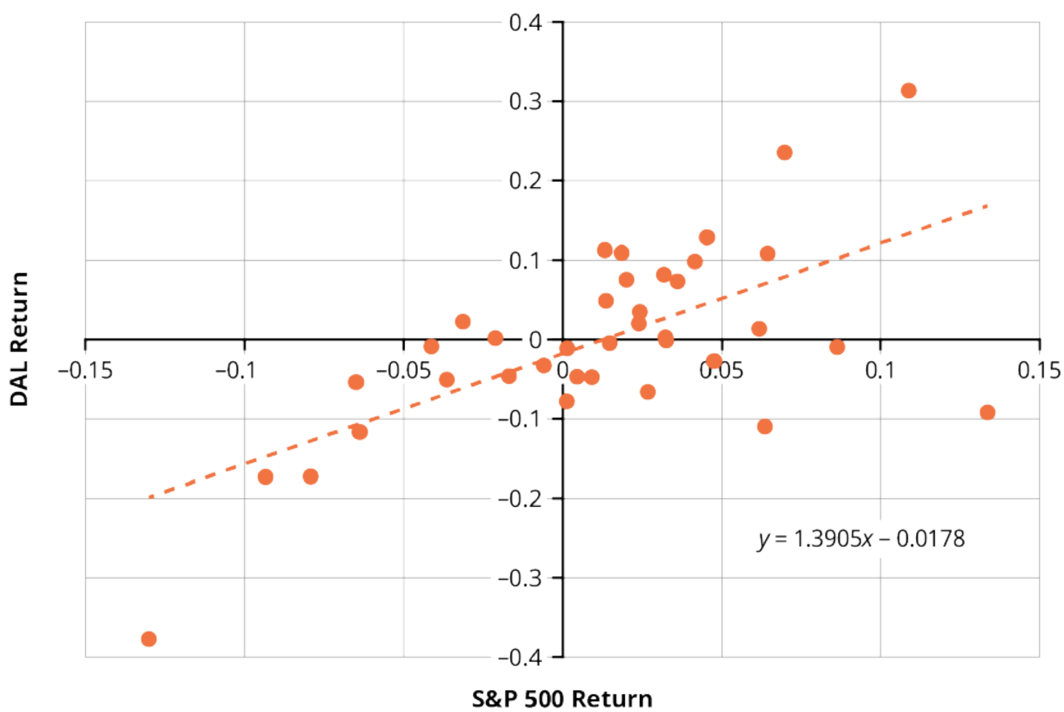


Figure 15.3 Calculation of Beta for DAL (data source: Yahoo! Finance)

CAPM Equation

Because DAL's beta of 1.39 is greater than 1, DAL is riskier than the average stock in the market. Finance theory suggests that investors who purchase DAL will expect a higher rate of return to compensate them for this risk. DAL has 139% of the average stock's systematic risk; therefore, investors in the stock should receive 139% of the **market risk premium**.

The capital asset pricing model (CAPM) equation is

$$R_e = R_f + \text{Beta} \times \text{Market Risk Premium}$$
$$R_e = R_f + \text{Beta} \times (R_m - R_f)$$

where R_e is the expected return of the asset, R_f is the risk-free rate of return, and R_m is the expected return of the market. Given the average S&P 500 return of 11.64% and the average US Treasury bill return of 3.36%, the expected return of DAL would be calculated as

$$R_e = R_{\text{US T-bill}} + \text{Beta} \times (R_{\text{S\&P}} - R_{\text{US T-bill}})$$
$$R_e = 0.0336 + 1.39 \times (0.1164 - 0.0336) = 14.87\%$$

LINK TO LEARNING

Calculating Beta

Many providers of stock data and investment information will list a company's beta. Two internet sources that can be used to find a company's beta are Yahoo! Finance (https://openstax.org/r/finance.yahoo) and MarketWatch (https://openstax.org/r/marketwatch_search). Various sources may not provide the exact same value for beta for a company. For example, in early February 2021, Yahoo! Finance reported that the beta for DAL was 1.46,[8] while MarketWatch reported it as 1.29.[9] Both of these numbers are slightly different from the 1.39 calculated in the graph above.

There are several reasons why beta may vary slightly from source to source. One is the time frame used in the beta calculation. Data from three years were used to calculate the beta in Figure 15.3. Time frames ranging from three to five years are commonly used when calculating beta. Another reason different sources might report different betas is the frequency with which the data is collected. Monthly returns are used in Figure 15.3; some analysts will use weekly data. Finally, the S&P 500 is used to measure the market return in Figure 15.3; the S&P 500 is one of the most common measures of overall market returns, but alternatives exist and are used by some analysts

LINK TO LEARNING

CAPM

Watch this video (https://openstax.org/r/pricing-model-capm) for further information about the CAPM.

8 "Delta Air Lines, Inc. (DAL)." Yahoo! Finance. Verizon Media, accessed February 2021. https://finance.yahoo.com/quote/DAL/
9 "Delta Air Lines Inc." MarketWatch. Accessed February 2021. https://www.marketwatch.com/investing/stock/dal

15.4 Applications in Performance Measurement

Learning Outcomes

By the end of this section, you will be able to:

- Interpret a Sharpe ratio.
- Interpret a Treynor measurement.
- Interpret Jensen's alpha.

Sharpe Ratio

Investors want a measure of how good a professional money manager is before they entrust their hard-earned funds to that professional for investing. Suppose that you see an advertisement in which McKinley Investment Management claims that the portfolios of its clients have an average return of 20% per year. You know that this average annual return is meaningless without also knowing something about the riskiness of the firm's strategy. In this section, we consider some ways to evaluate the riskiness of an investment strategy.

A basic measure of investment performance that includes an adjustment for risk is the **Sharpe ratio**. The **Sharpe ratio** is computed as a portfolio's risk premium divided by the standard deviation of the portfolio's return, using the formula

$$\text{Sharpe Ratio} = \frac{R_{\text{P}} - R_{\text{f}}}{\sigma_{\text{P}}}$$

The portfolio risk premium is the portfolio return R_{P} minus the risk-free return R_{f}; this is the basic reward for bearing risk. If the risk-free return is 3%, McKinley Investment Management's clients who are earning 20% on their portfolios have an excess return of 17%.

The standard deviation of the portfolio's return, σ_{P}, is a measure of risk. Although you see that McKinley's clients earn a nice 20% return on average, you find that the returns are highly volatile. In some years, the clients earn much more than 20%, and in other years, the return is much lower, even negative. That volatility leads to a standard deviation of returns of 26%. The Sharpe ratio would be $\frac{17\%}{26\%}$, or 0.65.

Thus, the Sharpe ratio can be thought of as a reward-to-risk ratio. The standard deviation in the denominator can be thought of as the units of risk the investor has. The numerator is the reward the investor is receiving for taking on that risk.

LINK TO LEARNING

Sharpe Ratio

The Sharpe ratio was developed by Nobel laureate William F. Sharpe. You can visit Sharpe's Stanford University website (https://openstax.org/r/stanford_wfsharpe) to find videos in which he discusses financial topics and links to his research as well as his advice on how to invest.

Treynor Measurement of Performance

Another reward-to-risk ratio measurement of investment performance is the **Treynor ratio**. The Treynor ratio is calculated as

$$\text{Treynor Ratio} = \frac{R_{\text{P}} - R_{\text{f}}}{\beta_{\text{P}}}$$

Just as with the Sharpe ratio, the numerator of the Treynor ratio is a portfolio's risk premium; the difference is that the Treynor ratio focus focuses on systematic risk, using the beta of the portfolio in the denominator, while the Shape ratio focuses on total risk, using the standard deviation of the portfolio's returns in the denominator.

If McKinley Investment Management has a portfolio with a 20% return over the past five years, with a beta of 1.2 and a risk-free rate of 3%, the Treynor ratio would be $\frac{(0.20-0.03)}{1.2}=0.14$.

Both the Sharpe and Treynor ratios are relative measures of investment performance, meaning that there is not an absolute number that indicates whether an investment performance is good or bad. An investment manager's performance must be considered in relation to that of other managers or to a benchmark index.

Jensen's Alpha

Jensen's alpha is another common measure of investment performance. It is computed as the raw portfolio return minus the expected portfolio return predicted by the CAPM:

$$\begin{aligned}\text{Jensen's Alpha}=\alpha_{\mathrm{P}} &= R_{\mathrm{P}} - R_{\mathrm{e}}\\ &= R_{\mathrm{P}} - [R_{\mathrm{f}} + \beta_{\mathrm{P}}(R_{\mathrm{m}} - R_{\mathrm{f}})]\end{aligned}$$

Suppose that the average market return has been 12%. What would Jensen's alpha be for McKinley Investment Management's portfolio with a 20% average return and a beta of 1.2?

$$\alpha_{\text{McKinley}} = 0.2 - [0.03 + 1.2(0.12 - 0.03)] = 0.062$$

Unlike the Sharpe and Treynor ratios, which are meaningful in a relative sense, Jensen's alpha is meaningful in an absolute sense. An alpha of 0.062 indicates that the McKinley Investment Management portfolio provided a return that was 6.2% higher than would be expected given the riskiness of the portfolio. A positive alpha indicates that the portfolio had an abnormal return. If Jensen's alpha equals zero, the portfolio return was exactly what was expected given the riskiness of the portfolio as measured by beta.

THINK IT THROUGH

Comparing the Returns and Risks of Portfolios

You are interviewing two investment managers. Mr. Wong shows that the average return on his portfolio for the past 10 years has been 14%, with a standard deviation of 8% and a beta of 1.2. Ms. Petrov shows that the average return on her portfolio for the past 10 years has been 16%, with a standard deviation of 10% and a beta of 1.6. You know that over the past 10 years, the US Treasury security rate has averaged 2% and the return on the S&P 500 has averaged 11%. Which portfolio manager do you think has done the better job?

Solution:

The Sharpe ratio for Mr. Wong's portfolio is $\frac{14\% - 2\%}{8\%} = 1.5$, and the Treynor ratio is $\frac{14\% - 2\%}{1.2} = 10$. The Sharpe ratio for Ms. Petrov's portfolio is $\frac{16\% - 2\%}{10\%} = 1.4$, and the Treynor ratio is $\frac{16\% - 2\%}{1.6} = 8.75$.

Jensen's alpha for Mr. Wong's portfolio is

$$\alpha_{\text{Wong}} = 0.14 - [0.02 + 1.2(0.11 - 0.02)] = 0.012$$

Jensen's alpha for Ms. Petrov's portfolio is

$$\alpha_{\text{Petrov}} = 0.16 - [0.02 + 1.6(0.11 - 0.02)] = -0.004$$

All three measures of portfolio performance suggest that Mr. Wong's portfolio has performed better than Ms. Petrov's has. Although Ms. Petrov has had a larger average return, the portfolio she manages is riskier. Ms. Petrov's portfolio is more volatile than Mr. Wong's, resulting in a higher standard deviation. Ms. Petrov's portfolio has a higher beta, which means it has a higher amount of systematic risk. The CAPM suggests that a portfolio with a beta of 1.6 should have an expected return of 16.4%. Because Ms. Petrov's portfolio has an average return of less than that, investors in Ms. Petrov's portfolio are not rewarded for the risk that they have taken as much as would be expected.

15.5 Using Excel to Make Investment Decisions

Learning Outcomes

By the end of this section, you will be able to:

- Calculate the average return and standard deviation for a stock.
- Calculate the average return and standard deviation for a portfolio.
- Calculate the beta of a stock.

Average Return and Standard Deviation for a Single Stock

Excel can be used to calculate the average returns and the standard deviation of returns for both a single stock and a portfolio of stocks. It can also be used to calculate the beta for a stock. Historic stock price data for stocks you are interested in analyzing can easily be downloaded from sites such as Yahoo! Finance into Excel. The examples in this section use monthly stock data from December 2017 to December 2020 from Yahoo! Finance.

Monthly price data for AMZN (Amazon) is shown in column B of Figure 15.4. To begin, monthly returns must be calculated from the price data using the formula

$$\text{Monthly Return} = \frac{\text{Ending Price} - \text{Beginning Price}}{\text{Beginning Price}}$$

The ending prices shown in Figure 15.4 are the last price the stock traded for each month. Each month, the return is calculated under the assumption that you purchased the stock at the last trading price of the previous month and sold at the last price of the current month. Thus, the return for January 2018 is calculated as

$$\text{Monthly Return} = \frac{\text{Jan 2018 Price} - \text{Dec 2017 Price}}{\text{Dec 2017 Price}} = \frac{\$1{,}450.89 - \$1{,}169.47}{\$1{,}169.47} = 0.2406 = 24.06\%$$

This is accomplished in Excel by placing the formula =(B3-B2)/B2 in cell C3. This formula can then be copied down the spreadsheet through row C38. Now that each monthly return is in column C, you can calculate the average of the monthly returns in cell C39 and the standard deviation of returns in cell C40.

	A	B	C	D
1	**Date**	**Ending Price**	**Monthly Return**	
2	12/1/2017	1169.4700		
3	1/1/2018	1450.8900	0.2406	
4	2/1/2018	1512.4500	0.0424	
29	3/1/2020	1949.7200	0.0350	
30	4/1/2020	2474.0000	0.2689	
31	5/1/2020	2442.3701	-0.0128	
32	6/1/2020	2758.8201	0.1296	
33	7/1/2020	3164.6799	0.1471	
34	8/1/2020	3450.9600	0.0905	
35	9/1/2020	3148.7300	-0.0876	
36	10/1/2020	3036.1499	-0.0358	
37	11/1/2020	3168.0400	0.0434	
38	12/1/2020	3256.9299	0.0281	
39		Average Monthly Return	0.0330	
40		Standard Deviation	0.0933	

Figure 15.4 Calculating the Average Return and the Standard Deviation of Returns for AMZN (data source: Yahoo! Finance)

Over the three-year period, the average monthly return for AMZN was 3.3%. However, this return was highly volatile, with a standard deviation of 9.33%. Remember that this means that approximately two-thirds of the time, the monthly return from AMZN was between −6.03% and 12.63%.

Download the spreadsheet file (https://openstax.org/r/google_spread_sheet) containing key Chapter 15 Excel exhibits.

Average Return and Standard Deviation for a Portfolio

The Excel screenshot in Figure 15.5 shows the return and standard deviation calculation for a portfolio. This sample four-stock portfolio contains AMZN, CVS, AAPL (Apple), and NFLX (Netflix). This portfolio is constructed as an equally weighted portfolio; because there are four stocks in this portfolio, each has a weight of 25%.

	A	B	C	D	E	F
1	Weights	0.25	0.25	0.25	0.25	
2	**Date**	**AMZN**	**CVS**	**AAPL**	**NFLX**	**Portfolio Return**
3	1/1/2018	0.2406	0.0854	-0.0106	0.4081	**0.1809**
4	2/1/2018	0.0424	-0.1393	0.0638	0.0780	**0.0112**
5	3/1/2018	-0.0430	-0.0815	-0.0542	0.0136	**-0.0413**
6	4/1/2018	0.0821	0.1225	-0.0150	0.0579	**0.0619**
27	1/1/2020	0.0871	-0.0871	0.0540	0.0665	**0.0301**
28	2/1/2020	-0.0622	-0.1274	-0.1168	0.0694	**-0.0593**
29	3/1/2020	0.0350	0.0025	-0.0676	0.0175	**-0.0031**
30	4/1/2020	0.2689	0.0374	0.1554	0.1181	**0.1450**
31	5/1/2020	-0.0128	0.0653	0.0822	-0.0003	**0.0336**
32	6/1/2020	0.1296	-0.0092	0.1505	0.0841	**0.0888**
33	7/1/2020	0.1471	-0.0312	0.1651	0.0744	**0.0888**
34	8/1/2020	0.0905	-0.0130	0.2144	0.0832	**0.0938**
35	9/1/2020	-0.0876	-0.0599	-0.1009	-0.0558	**-0.0760**
36	10/1/2020	-0.0358	-0.0396	-0.0600	-0.0486	**-0.0460**
37	11/1/2020	0.0434	0.2086	0.0936	0.0314	**0.0943**
38	12/1/2020	0.0281	0.0075	0.1165	0.1020	**0.0635**
39	Monthly Avg Ret	0.0330	0.0021	0.0380	0.0347	**0.0269**
40	Std Dev	0.0920	0.0863	0.0967	0.1087	**0.0710**

Figure 15.5 Calculation of the Average Return and Standard Deviation for a Portfolio (data source: Yahoo! Finance)

The monthly returns for each stock are recorded in their respective columns. The portfolio return for each month is calculated as the weighted average of the four monthly individual stock returns. The formula for the portfolio return is

$$\text{Portfolio Return} = 0.25 \times R_{\text{AMZN}} + 0.25 \times R_{\text{CVS}} + 0.25 \times R_{\text{AAPL}} + 0.25 \times R_{\text{NFLX}}$$

The formula =$B$1*B3+$C$1*C3+$D$1*D3+$E$1*E3 is placed in cell F3. The formula is then copied down column F to calculate the portfolio return for each month. After the monthly portfolio return is calculated, then the average monthly portfolio return is calculated in cell F39. The average monthly portfolio return is 2.69%.

Because this is an equally weighted portfolio, with each of the four stocks impacting the portfolio return in the same way, the average monthly portfolio return of 2.69% is the same as the sum of the average monthly returns of the four stocks divided by four, or $\frac{0.0330 + 0.0021 + 0.0380 + 0.0347}{4} = 0.0269 = 2.69\%$.

The standard deviation of the monthly portfolio returns is calculated in cell F40. This four-stock portfolio has a standard deviation of 7.10%. Unlike the average return, this standard deviation is not equal to the average of the standard deviations of returns of the four stocks. In fact, the standard deviation for the portfolio is less than the standard deviation for any one of the four stocks. Remember that this occurs because the stock returns are not perfectly positively correlated. The high return of one of the stocks in one month is dampened by a lower return in another stock during the same month. Likewise, a negative return in one stock during a month might be offset by a positive return in one of the other three stocks during the same month. This is the risk reduction benefit of holding a portfolio of stocks.

Calculating Beta

The standard deviation of a stock's returns indicates the stock's volatility. Remember that the volatility is caused by both firm-specific and systematic risk. Investors will not be rewarded for firm-specific risk because they can diversify away from it. Investors are, however, rewarded for systematic risk. To determine how much of a firm's risk is due to systematic risk, you can use Excel to calculate the stock's beta.

To calculate a stock's beta, you need the monthly return for the market in addition to the monthly market return for the stock. In column B in Figure 15.6, the monthly return for SPY, the SPDR S&P 500 Trust, is recorded. SPY is an ETF that was created to mimic the performance of the S&P 500 index by State Street Global Advisors and is often used as a proxy for the overall market performance. The monthly returns for AMZN are visible in column C. It is important that these returns be lined up so that the returns for a particular month for both securities appear in the same row number. Also, you want to place the returns for SPY in the column to the left of the returns for AMZN so that when you create your graph, SPY will automatically appear on the horizontal axis.

LINK TO LEARNING

State Street Global Advisors

You can learn more about State Street Global Advisors and its creation of the first ETF by visiting the company's history page at its website (ssga.com) (https://openstax.org/r/ssga_institutional_our-history).

You will use a scatter plot to create a graph. In Excel, go to the Insert tab, and then from the Chart menu, choose the first scatter plot option.

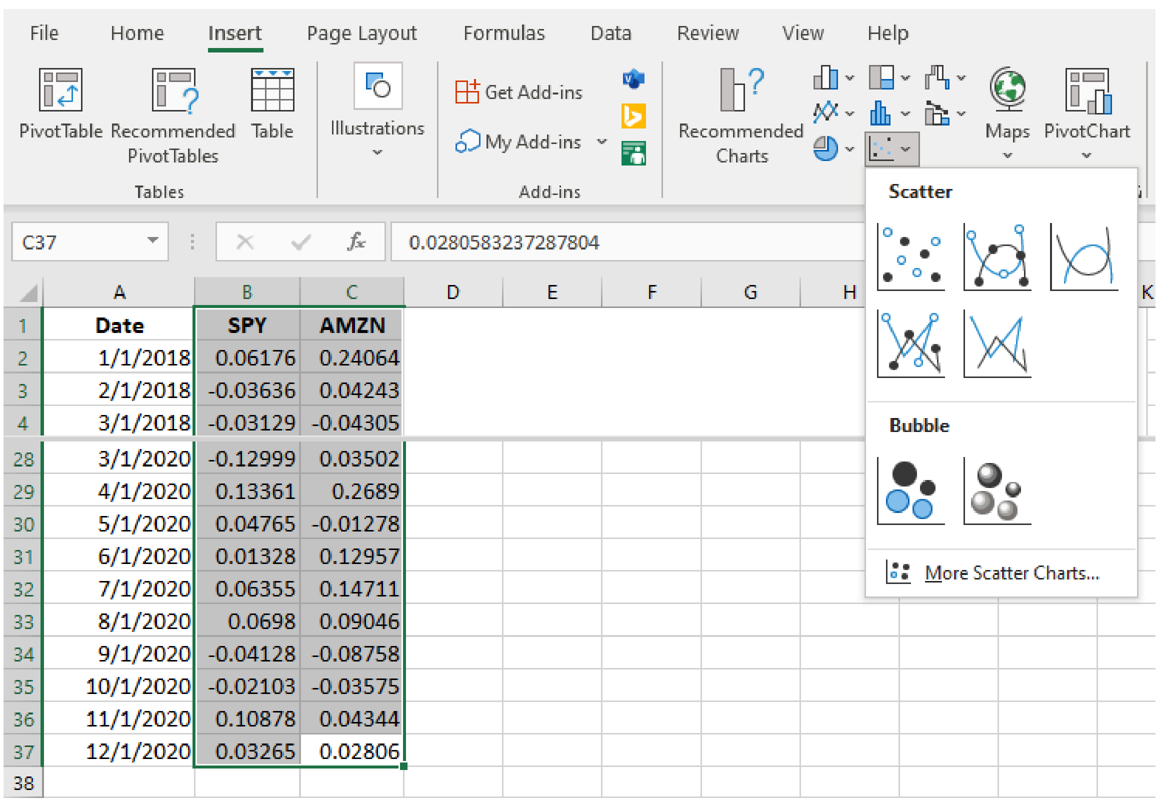


Figure 15.6 Excel Format for Calculating Beta (data source: Yahoo! Finance)

Selecting the scatter plot option will result in a chart being inserted that looks like the chart in Figure 15.7. Each dot represents one month's combination of returns, with the return for SPY measured on the horizontal axis and the return for AMZN measured on the vertical axis. Consider, for example, the dot in the furthest upper right-hand section of the figure. This dot is the plot of returns for the month of April 2020, when the return for SPY was 13.36% (measured on the horizontal axis) and the return for AMZN was 26.89% (measured on the vertical axis).

Hover your mouse over one of the dots, and right-click the dot to pull up a chart formatting menu. This menu will allow you to add labels to your axis and polish your chart in additional ways if you would like. Select the option Add Trendline.

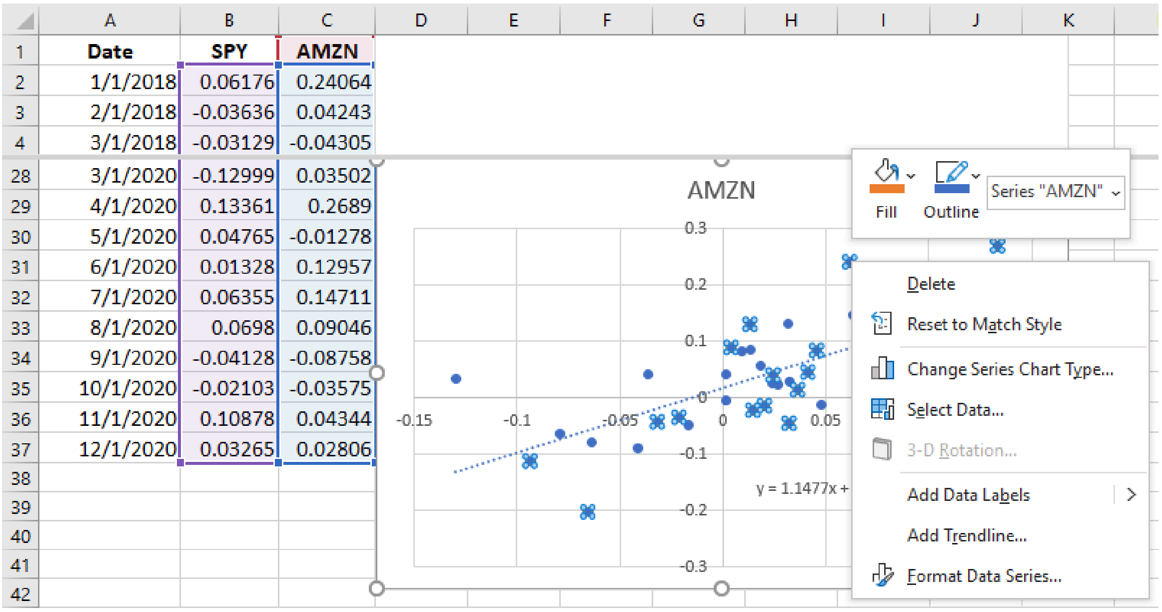


Figure 15.7 Creating a Scatter Plot in Excel (data source: Yahoo! Finance)

When the trendline is inserted, a formatting box will appear on the right of your screen (see Figure 15.8). If it is not already selected, choose the Linear trendline option. Scroll down and select the "Display Equation on chart" option. You will see the equation $y = 1.1477x + 0.0186$ appear on the screen. This is the equation for the best-fit line that shows how AMZN moves when the market moves. The slope of this line, 1.1477, is the beta for AMZN. This tells you that for every 10% move the overall market makes, AMZN tends to move 11.477%. Because AMZN tends to move a little more than the broader market, it has a little more systematic risk than the average stock in the market.

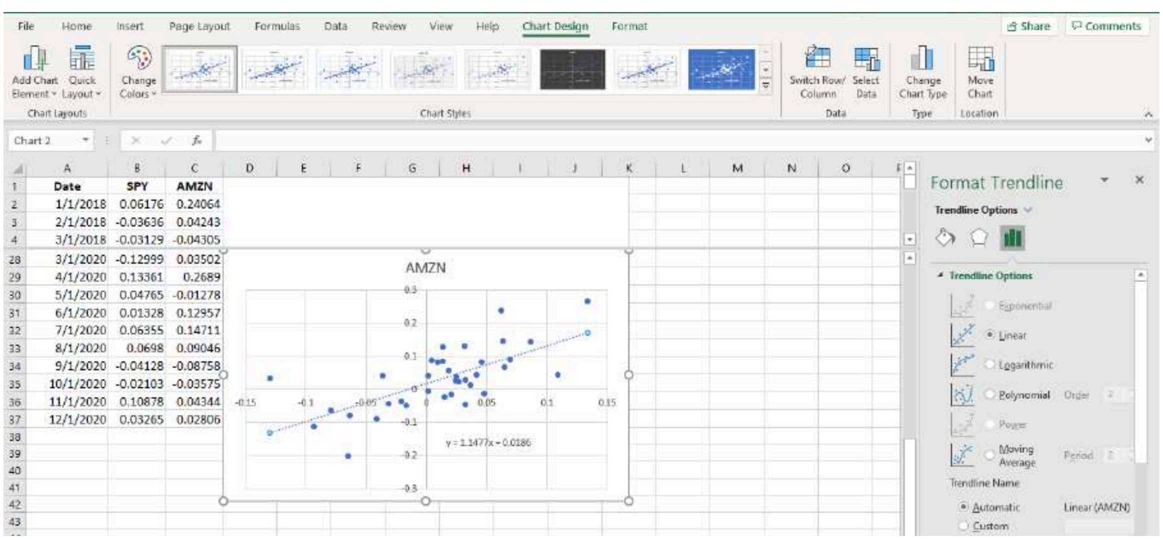


Figure 15.8 Inserting a Trendline to Determine Beta (data source: Yahoo! Finance)

Summary

15.1 Risk and Return to an Individual Asset

Investors are interested in both the return they can expect to receive when making an investment and the risk associated with that investment. In finance, risk is considered the volatility of the return from time period to time period. Historical returns are measured by the arithmetic average, and the risk is measured by the standard deviation of returns.

15.2 Risk and Return to Multiple Assets

As investors hold multiple assets in a portfolio, they are able to eliminate firm-specific risk. However, systematic or market risk remains, even if an investor holds the market portfolio. The return to a portfolio is measured by the arithmetic average, and the risk is measured by the standard deviation of the returns of the portfolio. The risk of the portfolio will be lower than the weighted average of the risk of the individual securities because the returns of the securities are not perfectly correlated. A low or negative return for one stock in a period can be offset by a high return for another stock in the same period.

15.3 The Capital Asset Pricing Model (CAPM)

The capital asset pricing model (CAPM) relates the expected return of an asset to the systematic risk of that asset. Investors will be rewarded for taking on systematic risk. They will not be rewarded for taking on firm-specific risk, however, because that risk can be diversified away.

15.4 Applications in Performance Measurement

Because investors are not simply interested in returns but are also interested in risk, the success of a portfolio cannot be measured simply by considering the portfolio's return. In order to compare investment portfolios, risk and return must both be taken into consideration. The Sharpe ratio and the Treynor ratio are two measures that provide a reward-to-risk measure of a portfolio. Jensen's alpha provides a measure of the abnormal return of a portfolio, considering the portfolio's risk level.

15.5 Using Excel to Make Investment Decisions

Using Excel to manipulate publicly available stock data makes calculating the average return of a stock and the standard deviation of returns easy. The average return for a portfolio and the standard deviation of the portfolio returns can also be calculated easily. By comparing the returns of a stock with the returns of the overall market using Excel charting tools, the beta for a stock, which measures systematic risk, can be determined.

Key Terms

arithmetic average return the sum of an asset's annual returns over a number of years divided by the number of years

beta a measure of how a stock moves relative to the market

capital asset pricing model (CAPM) the expected return of a security, equal to the risk-free rate plus a premium for the amount of risk taken

capital gain yield the difference between the price a stock is sold for and the price that was originally paid for it divided by the price originally paid

diversification holding a variety of assets in a portfolio

dividend yield the total dividends received by the owner of a share of stock divided by the price originally paid for the stock

effective annual rate (EAR) returns expressed on an annualized or yearly basis; allows for the comparison of various investments

firm-specific risk the risk that an event may impact the expected revenue or costs of a firm, thereby impacting the returns to investors; also known as diversifiable risk

geometric average return the compound annual return derived from the effective annual rate and time value of money formulas

holding period percentage return the gain received from holding a stock, calculated by adding the amount received when the stock is sold to any dividends earned while holding the stock, subtracting the price originally paid for the stock, then dividing the difference by the price originally paid

Jensen's alpha a measure of portfolio performance, calculated as the raw portfolio return minus the expected portfolio return predicted by the CAPM

market risk premium the reward for taking on the average amount of market risk

portfolio a collection of owned stocks

realized return the total return of an investment that occurs over a particular time period

risk premium the extra return earned by taking on risk

risk-free rate the reward for lending money when there is no risk of not receiving the principal and interest as promised

Sharpe ratio a reward-to-risk measure of portfolio performance, calculated by subtracting the risk-free rate from the average portfolio return and then dividing by the standard deviation of the portfolio

systematic risk risk that impacts the entire market and cannot be diversified away; also known as market risk

Treynor ratio a reward-to-risk measure of portfolio performance, calculated by subtracting the risk-free rate from the average portfolio return and then dividing by the beta of the portfolio

CFA Institute

This chapter supports some of the Learning Outcome Statements (LOS) in this [CFA® Level I Study Session (https://openstax.org/r/cfa-inst-study-session)](https://openstax.org/r/cfa-inst-study-session). Reference with permission of CFA Institute.

Multiple Choice

1. The total dollar return equals _____________.

a. the EPS of a stock
b. capital gains income plus dividend income
c. the price paid for a share of stock minus the selling price of the stock
d. the price paid for a share of stock divided by the selling price of the stock

2. The dividend yield is calculated by _____________.

a. dividing the price of the stock by the EPS
b. subtracting any capital loss from the capital gain
c. dividing the annual dividend by the initial stock price
d. dividing the annual dividend by the net income for the year

3. Which of the following is the best example of firm-specific risk?

a. A global pandemic causes major disruptions in the economy.
b. The Federal Reserve increases the money supply dramatically, leading to massive inflation.
c. AAA Pharmaceuticals withdraws a medication as it studies whether strokes five people suffered after taking the medication were related to the medication.
d. As an arctic blast descends on North America, most of the United States is blanketed in snow or ice.

4. Investors diversify their portfolio in order to _____________.

a. reduce risk
b. increase risk

c. increase return
d. increase the standard deviation

5. Which of the following would be the best example of systematic risk?
    a. An error in the company's computer system miscalculates the amount of inventory that Monique's Boutique is holding.
    b. BlueJay Air has a reduction in new reservations following a crash of one of its jets.
    c. The spokesperson for Serena's Sports Shoes is involved in an ethical scandal.
    d. Interest rates rise after the Federal Reserve announces it will slow down the rate of growth of the money supply.

6. As the number of stocks in a portfolio increases, _____________.
    a. firm-specific risk increases
    b. systematic risk becomes zero
    c. systematic risk decreases and returns increase
    d. firm-specific risk is reduced but systematic risk remains

7. Beta is a measure of _____________.
    a. systematic risk
    b. firm-specific risk
    c. a firm's profitability
    d. a stock's dividend yield

8. Which of the following would be the best estimate of the risk-free rate?
    a. The rate of inflation
    b. The average return on the S&P 500
    c. The average return on Amazon's stock
    d. The average return on US Treasury bills

9. The Sharpe ratio can be considered a measure of _____________.
    a. the reward of an investment in relation to the risk
    b. the systematic risk of a stock
    c. the total return of a stock investment
    d. the historical return of an individual security

10. A positive Jensen's alpha indicates that a portfolio has _____________.
    a. a negative beta
    b. an abnormal return
    c. more total risk than the average portfolio
    d. more systematic risk than the average portfolio

11. If an equally weighted portfolio contains 10 stocks, then _____________.
    a. the stocks in the portfolio will each have a weight of 0.10
    b. the return of the portfolio must be multiplied by 10 to get the annualized return
    c. the standard deviation of the portfolio will be one-tenth the standard deviation of one of the stocks
    d. the standard deviation of the portfolio will be 10 times the standard deviation of one of the stocks

Review Questions

1. What is the difference between firm-specific risk and unsystematic risk?

2. Explain why diversification reduces unsystematic risk but not systematic risk.
3. Explain what happens to the standard deviation of returns of a portfolio as the number of stocks in the portfolio increases.
4. Enrique owns five stocks: Alaska Airlines, American Airlines, Delta Airlines, Southwest Airlines, and Ford. Radha also owns five stocks: Apple, McDonald's, Tesla, Facebook, and Disney. Does Enrique or Radha have a more diversified portfolio?
5. You are considering purchasing shares in a company that has a beta of 0.8. Explain what this beta means.
6. Explain how the Sharpe ratio and the Treynor ratio can be considered reward-to-risk measures.

Problems

1. You purchase 100 shares of COST (Costco) for $280 per share. Three months later, you sell the stock for $290 per share. You receive a dividend of $0.57 a share. What is your total dollar return?
2. You purchase 100 shares of COST for $280 per share. Three months later, you sell the stock for $290 per share. You receive a dividend of $0.57 a share. What are your dividend yield, capital gain yield, and total percentage return?
3. You purchase 100 shares of COST for $280 per share. Three months later, you sell the stock for $290 per share. You receive a dividend of $0.57 a share. What is the EAR of your investment?
4. You invest in a stock for four years. The returns for the four years are 20%, -10%, 15%, and -5%. Calculate the arithmetic average return and the geometric average return.
5. You are considering purchasing shares in a company that has a beta of 0.9. The average return for the S&P 500 is 11%, and the average return for US Treasury bills has been 2%. Based on the CAPM, what is your expected return for the stock?
6. Your portfolio has had a 15% rate of return with a standard deviation of 18% and a beta of 1.1. The average return for the S&P 500 has been 11%, and the average return for US Treasury bills has been 2%. Calculate the Sharpe ratio, Treynor ratio, and Jensen's alpha for your portfolio.
7. The monthly returns for Visa (V) and Pfizer (PFE) for 2018–2020 are provided in the chart below. In addition, the monthly return for the SPDR S&P 500 ETF Trust (SPY) is provided; SPY is often used as a proxy for the returns of the S&P 500, or a broad market index. Using Excel, calculate the arithmetic average monthly returns for V, PFE, and SPY. Also, calculate the standard deviation of returns for each of V, PFE, and SPY.

Monthly Returns for SPY, V, and PFE for 2018–2020

Date	SPY	V	PFE
Jan-18	0.0618	0.0895	0.0226
Feb-18	-0.0364	-0.0104	-0.0197
Mar-18	-0.0313	-0.0253	-0.0135
Apr-18	0.0092	0.0607	0.0316
May-18	0.0243	0.0303	-0.0186
Jun-18	0.0013	0.0149	0.0196
Jul-18	0.0417	0.0324	0.1006

Table 15.8

Date	SPY	V	PFE
Aug-18	0.0319	0.0742	0.0398
Sep-18	0.0014	0.0233	0.0705
Oct-18	-0.0649	-0.0816	-0.0229
Nov-18	0.0185	0.0280	0.0736
Dec-18	-0.0933	-0.0673	-0.0485
Jan-19	0.0864	0.0233	-0.0275
Feb-19	0.0324	0.0971	0.0301
Mar-19	0.0136	0.0563	-0.0203
Apr-19	0.0454	0.0528	-0.0438
May-19	-0.0638	-0.0189	0.0224
Jun-19	0.0644	0.0774	0.0526
Jul-19	0.0201	0.0256	-0.1034
Aug-19	-0.0167	0.0158	-0.0847
Sep-19	0.0148	-0.0473	0.0201
Oct-19	0.0268	0.0398	0.0679
Nov-19	0.0362	0.0316	0.0039
Dec-19	0.0240	0.0201	0.0270
Jan-20	0.0045	0.0589	-0.0495
Feb-20	-0.0792	-0.0865	-0.0934
Mar-20	-0.1300	-0.1123	-0.0233
Apr-20	0.1336	0.1092	0.1752
May-20	0.0476	0.0924	-0.0044
Jun-20	0.0133	-0.0089	-0.1352
Jul-20	0.0636	-0.0143	0.1768
Aug-20	0.0698	0.1134	-0.0083
Sep-20	-0.0413	-0.0553	-0.0288
Oct-20	-0.0210	-0.0913	-0.0332
Nov-20	0.1088	0.1576	0.1381
Dec-20	0.0326	0.0414	-0.0293

Table 15.8

8. Using the monthly returns provided in the table in problem 7, use Excel to calculate the beta for V and the beta for PFE. Which of these stocks has more systematic risk? What would you expect for the comparative returns of V and PFE?

Video Activity

How to Double Your Money in Seven Years

Click to view content (https://openstax.org/r/double_your_money)

In this video, Jim Cramer explains how compounding can help investors build and preserve wealth. He provides suggestions for how young people can use the stock market to build financial independence.

1. According to Jim Cramer, if you invest $1,000 in the S&P 500, how much can you expect your investment to be worth in 35 years?
2. Gather data over the past 10 years for the level of the S&P 500. How many of those years did the S&P 500 have a return of at least 10%? If you had invested in $1,000 in an S&P 500 index fund 10 years ago, would you have doubled your money yet? Is your answer consistent with Jim Cramer's message?

John Bogle and the Buy-and-Hold Strategy

Click to view content (https://openstax.org/r/grow_with_America)
In this video, the legendary investor Jack Bogle, founder and former CEO of Vanguard, discusses strategies for investors.

3. When discussing following a buy-and-hold strategy, in which an investor makes a purchase and holds the same investment for the long term, Bogle says that the success of such a strategy depends on what is bought. What distinction does Bogle make between buying and holding an individual stock and buying and holding a broad-based index fund?
4. How would you describe Bogle's attitude toward risk in the stock market? Do you agree with this attitude? Why or why not?

16

How Companies Think about Investing

Figure 16.1 Companies make decisions about investments every day. (credit: modification of “Tesla Factory, Fremont (CA, USA)” by Maurizio Pesce/flickr, CC BY 2.0)

Chapter Outline

Why It Matters

One of the most important decisions a company faces is choosing which investments it should make. Should an automobile manufacturer purchase a new robot for its assembly line? Should an airline purchase a new plane to add to its fleet? Should a hotel chain build a new hotel in Atlanta? Should a bakery purchase tables and chairs to provide places for customers to eat? Should a pharmaceutical company spend money on research for a new vaccine? All of these questions involve spending money today to make money in the future.

The process of making these decisions is often referred to as **capital budgeting**. In order to grow and remain competitive, a firm relies on developing new products, improving existing products, and entering new markets. These new ventures require investments in fixed assets. The company must decide whether the project will generate enough cash to cover the costs of these initial expenditures once the project is up and running.

For example, Sam’s Sporting Goods sells sporting equipment and uniforms to players on local recreational and school teams. Customers have been inquiring about customizing items such as baseball caps and equipment bags with logos and other designs. Sam’s is considering purchasing an embroidery machine so that it can provide these customized items in-house. The machine will cost $16,000. Purchasing the embroidery machine would be an investment in a fixed asset. If it purchases the machine, Sam’s will be able to charge customers for customization.

The managers think that selling customized items will allow the company to increase its cash flow by $2,000 next year. They predict that as customers become more aware of this service, the ability to customize products in-house will increase the company's cash flow by $4,000 the following year. The managers expect the machine will be used for five years, with the embroidery products increasing cash flows by $5,000 during each of the last three years the machine is used. Should Sam's Sporting Goods invest in the embroidery machine? In this chapter, we consider the main capital budgeting techniques Sam's and other companies can use to evaluate these types of decisions.

16.1 Payback Period Method

Learning Outcomes

By the end of this section, you will be able to:

- Define payback period.
- Calculate payback period.
- List the advantages and disadvantages of using the payback period method.

The payback period method provides a simple calculation that the managers at Sam's Sporting Goods can use to evaluate whether to invest in the embroidery machine. The **payback period** calculation focuses on how long it will take for a company to make enough free cash flow from the investment to recover the initial cost of the investment.

Payback Period Calculation

In order to purchase the embroidery machine, Sam's Sporting Goods must spend $16,000. During the first year, Sam's expects to see a $2,000 benefit from purchasing the machine, but this means that after one year, the company will have spent $14,000 more than it has made from the project. During the second year that it uses the machine, Sam's expects that its cash inflow will be $4,000 greater than it would have been if it had not had the machine. Thus, after two years, the company will have spent $10,000 more than it has benefited from the machine. This process is continued year after year until the accumulated increase in cash flow is $16,000, or equal to the original investment. The process is summarized in Table 16.1.

Year	0	1	2	3	4	5
Initial Investment ($)	(16,000)					
Cash Inflow ($)	-	2,000	4,000	5,000	5,000	5,000
Accumulated Inflow ($)	-	2,000	6,000	11,000	16,000	21,000
Balance ($)	(16,000)	(14,000)	(10,000)	(5,000)	-	5,000

Table 16.1

Sam's Sporting Goods is expecting its cash inflow to increase by $16,000 over the first four years of using the embroidery machine. Thus, the payback period for the embroidery machine is four years. In other words, it takes four years to accumulate $16,000 in cash inflow from the embroidery machine and recover the cost of the machine.

LINK TO LEARNING

Calculating the Payback Period

It is possible that a project will not fully recover the initial cost in one year but will have more than recovered its initial cost by the following year. In these cases, the payback period will not be an integer but will contain a fraction of a year. This video demonstrates how to calculate the payback period (https://openstax.org/r/how-to-calculate) in such a situation.

Advantages

The principal advantage of the payback period method is its simplicity. It can be calculated quickly and easily. It is easy for managers who have little finance training to understand. The payback measure provides information about how long funds will be tied up in a project. The shorter the payback period of a project, the greater the project's liquidity.

Disadvantages

Although it is simple to calculate, the payback period method has several shortcomings. First, the payback period calculation ignores the time value of money. Suppose that in addition to the embroidery machine, Sam's is considering several other projects. The cash flows from these projects are shown in Table 16.2. Both Project B and Project C have a payback period of five years. For both of these projects, Sam's estimates that it will take five years for cash inflows to add up to $16,000. The payback period method does not differentiate between these two projects.

Year	0	1	2	3	4	5	6
Project A ($)	(16,000)	2,000	4,000	5,000	5,000	5,000	5,000
Project B ($)	(16,000)	1,000	2,000	3,000	4,000	6,000	-
Project C ($)	(16,000)	6,000	4,000	3,000	2,000	1,000	-
Project D ($)	(16,000)	1,000	2,000	3,000	4,000	6,000	8,000

Table 16.2

However, we know that money has a time value, and receiving $6,000 in year 1 (as occurs in Project C) is preferable to receiving $6,000 in year 5 (as in Projects B and D). From what we learned about the time value of money, Projects B and C are not identical projects. The payback period method breaks the important finance rule of not adding or comparing cash flows that occur in different time periods.

A second disadvantage of using the payback period method is that there is not a clearly defined acceptance or rejection criterion. When the payback period method is used, a company will set a length of time in which a project must recover the initial investment for the project to be accepted. Projects with longer payback periods than the length of time the company has chosen will be rejected. If Sam's were to set a payback period of four years, Project A would be accepted, but Projects B, C, and D have payback periods of five years and so would be rejected. Sam's choice of a payback period of four years would be arbitrary; it is not grounded in any financial reasoning or theory. No argument exists for a company to use a payback period of three, four, five, or any other number of years as its criterion for accepting projects.

A third drawback of this method is that cash flows after the payback period are ignored. Projects B, C, and D all have payback periods of five years. However, Projects B and C end after year 5, while Project D has a large cash flow that occurs in year 6, which is excluded from the analysis. The payback method is shortsighted in that it favors projects that generate cash flows quickly while possibly rejecting projects that create much larger cash flows after the arbitrary payback time criterion.

Fourth, no risk adjustment is made for uncertain cash flows. No matter how careful the planning and analysis, a business is seldom sure what future cash flows will be. Some projects are riskier than others, with less certain cash flows, but the payback period method treats high-risk cash flows the same way as low-risk cash flows.

16.2 Net Present Value (NPV) Method

Learning Outcomes

By the end of this section, you will be able to:

- Define net present value.
- Calculate net present value.
- List the advantages and disadvantages of using the net present value method.
- Graph an NPV profile.

Net Present Value (NPV) Calculation

Sam's purchasing of the embroidery machine involves spending money today in the hopes of making more money in the future. Because the cash inflows and outflows occur in different time periods, they cannot be directly compared to each other. Instead, they must be translated into a common time period using time value of money techniques. By converting all of the cash flows that will occur from a project into present value, or current dollars, the cash inflows from the project can be compared to the cash outflows. If the cash inflows exceed the cash outflows in present value terms, the project will add value and should be accepted. The difference between the present value of the cash inflows and the present value of cash outflows is known as **net present value (NPV)**.

The equation for NPV can be written as

$$\text{NPV} = \text{PV(Cash Inflows)} - \text{PV(Cash Outflows)}$$

Consider Sam's Sporting Goods' decision of whether to purchase the embroidery machine. If we assume that after six years the embroidery machine will be obsolete and the project will end, when placed on a timeline, the project's expected cash flow is shown in Table 16.3:

Year	0	1	2	3	4	5	6
Cash Flow ($)	(16,000)	2,000	4,000	5,000	5,000	5,000	5,000

Table 16.3

Calculating NPV is simply a time value of money problem in which each cash flow is discounted back to the present value. If we assume that the cost of funds for Sam's is 9%, then the NPV can be calculated as

$$\begin{aligned}\text{NPV} &= \frac{\$2{,}000}{1.09^1} + \frac{\$4{,}000}{1.09^2} + \frac{\$5{,}000}{1.09^3} + \frac{\$5{,}000}{1.09^4} + \frac{\$5{,}000}{1.09^5} + \frac{\$5{,}000}{1.09^6} - \$16{,}000 \\ &= \$1{,}834.86 + \$3{,}366.72 + \$3{,}860.92 + \$3{,}542.13 + \$3{,}249.66 + \$2{,}981.34 - \$16{,}000 \\ &= \$2{,}835.63\end{aligned}$$

Because the NPV is positive, Sam's Sporting Goods should purchase the embroidery machine. The value of the firm will increase by $2,835.63 as a result of accepting the project.

Calculating NPV involves computing the present value of each cash flow and then summing the present values of all cash flows from the project. This project has six future cash flows, so six present values must be computed. Although this is not difficult, it is tedious.

A financial calculator is able to calculate a series of present values in the background for you, automating much of the process. You simply have to provide the calculator with each cash flow, the time period in which each cash flow occurs, and the discount rate that you want to use to discount the future cash flows to the present.

Follow the steps in Table 16.4 for calculating NPV:

Step	Description	Enter	Display	
1	Select cash flow worksheet	CF	CF0	XXXX
2	Clear the cash flow worksheet	2ND [CLR WORK]	CF0	0
3	Enter initial cash flow	16000 +/− ENTER	CF0 =	-16,000.00
4	Enter cash flow for the first year	↓ 2000 ENTER	C01 =	2,000.00
		↓	F01 =	1.0
5	Enter cash flow for the second year	↓ 4000 ENTER	C02 =	4,000.00
		↓	F02 =	1.0
6	Enter cash flow for the third year	↓ 5000 ENTER	C03 =	5,000.00
		↓	F03 =	1.0
7	Enter cash flow for the fourth year	↓ 5000 ENTER	C04 =	5,000.00
		↓	F04 =	1.0
8	Enter cash flow for the fifth year	↓ 5000 ENTER	C05 =	5,000.00
		↓	F05 =	1.0
9	Enter cash flow for the sixth year	↓ 5000 ENTER	C06 =	5,000.00
		↓	F06 =	1.0
10	Select NPV	NPV	I	0.00
11	Enter discount rate	9 ENTER	I =	9.00
12	Compute NPV	↓ CPT	NPV =	2,835.63

Table 16.4 Calculator Steps for NPV[1]

LINK TO LEARNING

Net Present Value

This video provides another example of [how to use NPV (https://openstax.org/r/how-to-use-NPV)](https://openstax.org/r/how-to-use-NPV) to evaluate whether a project should be accepted or rejected.

Advantages

The NPV method solves several of the listed problems with the payback period approach. First, the NPV method uses the time value of money concept. All of the cash flows are discounted back to their present value to be compared. Second, the NPV method provides a clear decision criterion. Projects with a positive NPV should be accepted, and projects with a negative NPV should be rejected. Third, the discount rate used to discount future cash flows to the present can be increased or decreased to adjust for the riskiness of the project's cash flows.

Disadvantages

The NPV method can be difficult for someone without a finance background to understand. Also, the NPV method can be problematic when available capital resources are limited. The NPV method provides a criterion

1 The specific financial calculator in these examples is the Texas Instruments BA II Plus[TM] Professional model, but you can use other financial calculators for these types of calculations.

for whether or not a project is a good project. It does not always provide a good solution when a company must make a choice between several acceptable projects because funds are not available to pursue them all.

THINK IT THROUGH

Calculating NVP

Suppose your company is considering a project that will cost $30,000 this year. The cash inflow from this project is expected to be $6,000 next year and $8,000 the following year. The cash inflow is expected to increase by $2,000 yearly, resulting in a cash inflow of $18,000 in year 7, the final year of the project. You know that your company's cost of funds is 9%. Use a financial calculator to calculate NPV to determine whether this is a good project for your company to undertake (see Table 16.5).

Solution:

Step	Description	Enter	Display	
1	Select cash flow worksheet	CF	CF0	XXXX
2	Clear the cash flow worksheet	2ND [CLR WORK]	CF0	0
3	Enter initial cash flow	30000 +/− ENTER	CF0 =	-30,000.00
4	Enter cash flow for the first year	↓ 6000 ENTER	C01 =	6,000.00
		↓	F01 =	1.0
5	Enter cash flow for the second year	↓ 8000 ENTER	C02 =	8,000.00
		↓	F02 =	1.0
6	Enter cash flow for the third year	↓ 10000 ENTER	C03 =	10,000.00
		↓	F03 =	1.0
7	Enter cash flow for the fourth year	↓ 12000 ENTER	C04 =	12,000.00
		↓	F04 =	1.0
8	Enter cash flow for the fifth year	↓ 14000 ENTER	C05 =	14,000.00
		↓	F05 =	1.0
9	Enter cash flow for the sixth year	↓ 16000 ENTER	C06 =	16,000.00
		↓	F06 =	1.0
10	Enter cash flow for the seventh year	↓ 18000 ENTER	C07 =	18,000.00
		↓	F07 =	1.0
11	Select NPV	NPV	I	0.00
12	Enter discount rate	9 ENTER	I =	9.00
13	Compute NPV	↓ CPT	NPV =	26,946.90

Table 16.5 Calculator Steps for NPV

The NPV for this project is $26,946.90. Undertaking this project will add a net present value of $26,946.90; therefore, this is a good project that should be undertaken.

LINK TO LEARNING

Calculating the NPV of an MBA Program

The NPV calculation can be used as a decision tool when you are deciding whether you should spend money today to make money in the future. This website on calculating the NPV on an MBA degree (https://openstax.org/r/calculating-the-NPV) lets you apply this concept in an educational setting. The initial cost of the MBA includes both the dollars spent on tuition and the wages that a full-time student could have earned if they were not in school. Why is it appropriate to include these forgone wages in the calculation? What adjustments would students need to make to this analysis if they wanted to consider attending a part-time MBA program that allowed them to continue working while completing the program?

NPV Profile

The NPV of a project depends on the expected cash flows from the project and the discount rate used to translate those expected cash flows to the present value. When we used a 9% discount rate, the NPV of the embroidery machine project was $2,836. If a higher discount rate is used, the present value of future cash flows falls, and the NPV of the project falls.

Theoretically, we should use the firm's cost to attract capital as the discount rate when calculating NPV. In reality, it is difficult to estimate this cost of capital accurately and confidently. Because the discount rate is an approximate value, we want to determine whether a small error in our estimate is important to our overall conclusion. We can do this by creating an NPV profile, which graphs the NPV at a variety of discount rates and allows us to determine how sensitive the NPV is to changes in the discount rate.

To construct an NPV profile for Sam's, select several discount rates and compute the NPV for the embroidery machine project using each of those discount rates. Table 16.6 below shows the NPV for several discount rates. Notice that if the discount rate is zero, the NPV is simply the sum of the cash flows. As the discount rate becomes larger, the NPV falls and eventually becomes negative.

The information in Table 16.6 is presented in a graph in Figure 16.2. We can see that the graph crosses the horizontal axis at about 14%. To the left, or at lower discount rates, the NPV is positive. If you are confident that the firm's cost of attracting funds is less than 14%, the company should accept the project. If the cost of capital is more than 14%, however, the NPV is negative, and the company should reject the project.

Discount Rate	NPV ($)
0%	10,000
3%	7,231
9%	2,836
12%	1,081
14%	42
15%	(442)
18%	(1,773)
21%	(2,939)

Table 16.6 NPV for Various Discount Rates

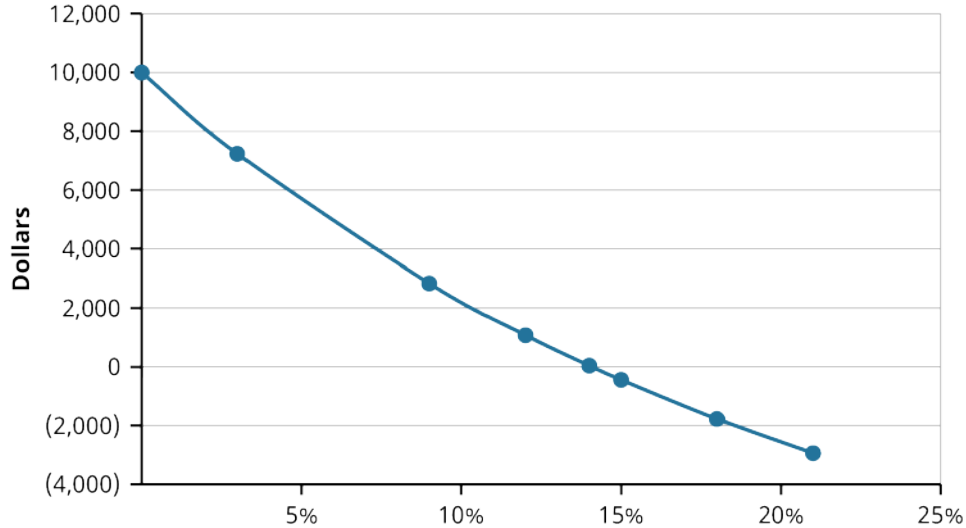


Figure 16.2 NPV Profile Graph

16.3 Internal Rate of Return (IRR) Method

Learning Outcomes

By the end of this section, you will be able to:

- Define internal rate of return (IRR).
- Calculate internal rate of return.
- List advantages and disadvantages of using the internal rate of return method.

Internal Rate of Return (IRR) Calculation

The **internal rate of return (IRR)** is the discount rate that sets the present value of the cash inflows equal to the present value of the cash outflows. In considering whether Sam's Sporting Goods should purchase the embroidery machine, the IRR method approaches the time value of money problem from a slightly different angle. Instead of using the company's cost of attracting funds for the discount rate and solving for NPV, as we did in the first NPV equation, we set NPV equal to zero and solve for the discount rate to find the IRR:

$$\text{NPV} = \frac{\$2{,}000}{(1+i)^1} + \frac{\$4{,}000}{(1+i)^2} + \frac{\$5{,}000}{(1+i)^3} + \frac{\$5{,}000}{(1+i)^4} + \frac{\$5{,}000}{(1+i)^5} + \frac{\$5{,}000}{(1+i)^6} - \$16{,}000 = 0$$

The IRR is the discount rate at which the NPV profile graph crosses the horizontal axis. If the IRR is greater than the cost of capital, a project should be accepted. If the IRR is less than the cost of capital, a project should be rejected. The NPV profile graph for the embroidery machine crossed the horizontal axis at 14%. Therefore, if Sam's Sporting Goods can attract capital for less than 14%, the IRR exceeds the cost of capital and the embroidery machine should be purchased. However, if it costs Sam's more than 14% to attract capital, the embroidery machine should not be purchased.

In other words, a company wants to accept projects that have an IRR that exceed the company's cost of attracting funds. The cash flow from these projects will be great enough to cover the cost of attracting money from investors in addition to the other costs of the project. A company should reject any project that has an IRR less than the company's cost of attracting funds; the cash flows from such a project are not enough to compensate the investors for the use of their funds.

Calculating IRR without a financial calculator is an arduous, time-consuming process that requires trial and error to find the discount rate that makes NPV exactly equal zero. Your calculator uses the same type of trial-and-error iterative process, but because it uses an automated process, it can do so much more quickly than you can. A problem that might require 30 minutes of detailed mathematical calculations by hand can be completed in a matter of seconds with the assistance of a financial calculator.

All the information your calculator needs to calculate IRR is the value of each cash flow and the time period in which it occurs. To calculate IRR, begin by entering the cash flows for the project, just as you do for the NPV calculation (see Table 16.7). After these cash flows are entered, simply compute IRR in the final step.

Step	Description	Enter	Display	
1	Select cash flow worksheet	CF	CF0	XXXX
2	Clear the cash flow worksheet	2ND [CLR WORK]	CF0	0
3	Enter initial cash flow	16000 +/− ENTER	CF0 =	-16,000.00
4	Enter cash flow for the first year	↓ 2000 ENTER	C01 =	2,000.00
		↓	F01 =	1.0
5	Enter cash flow for the second year	↓ 4000 ENTER	C02 =	4,000.00
		↓	F02 =	1.0
6	Enter cash flow for the third year	↓ 5000 ENTER	C03 =	5,000.00
		↓	F03 =	1.0
7	Enter cash flow for the fourth year	↓ 5000 ENTER	C04 =	5,000.00
		↓	F04 =	1.0
8	Enter cash flow for the fifth year	↓ 5000 ENTER	C05 =	5,000.00
		↓	F05 =	1.0
9	Enter cash flow for the sixth year	↓ 5000 ENTER	C06 =	5,000.00
		↓	F06 =	1.0
10	Compute IRR	IRR CPT	IRR =	14.09

Table 16.7 Calculator Steps for IRR

Advantages

The primary advantage of using the IRR method is that it is easy to interpret and explain. Investors like to speak in terms of annual percentage returns when evaluating investment possibilities.

Disadvantages

One disadvantage of using IRR is that it can be tedious to calculate. We knew the IRR was about 14% for the embroidery machine project because we had previously calculated the NPV for several discount rates. The IRR is about, but not exactly, 14%, because NPV is not exactly equal to zero (just very close to zero) when we use 14% as the discount rate. Before the prevalence of financial calculators and spreadsheets, calculating the exact IRR was difficult and time-consuming. With today's technology, this is no longer a major consideration. Later in this chapter, we will look at how to use a spreadsheet to do these calculations.

No Single Mathematical Solution. Another disadvantage of using the IRR method is that there may not be a single mathematical solution to an IRR problem. This can happen when negative cash flows occur in more than one period in the project. Suppose your company is considering building a facility for an upcoming Olympic competition. The construction cost would be $350 million. The facility would be used for one year and generate cash inflows of $950 million. Then, the following year, your company would be required to convert the facility into a public park area for the city, which is expected to cost $620 million. Placing these cash flows in a timeline results in the following (Table 16.8):

Year	0	1	2
Cash Flow ($Millions)	(350)	950	(620)

Table 16.8

The NPV profile for this project looks like Figure 16.3. The NPV is negative at low interest rates, becomes positive at higher interest rates, and then turns negative again as the interest rate continues to rise. Because the NPV profile line crosses the horizontal axis twice, there are two IRRs. In other words, there are two interest rates at which NPV equals zero.

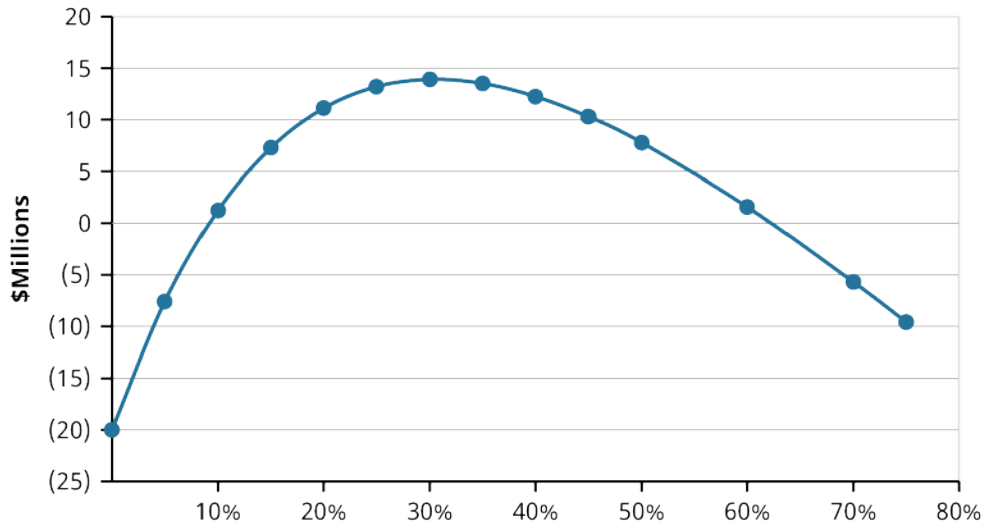


Figure 16.3 NPV Profile Graph for a Project with Two IRRs

Reinvestment Rate Assumption. The IRR assumes that the cash flows are reinvested at the internal rate of return when they are received. This is a disadvantage of the IRR method. The firm may not be able to find any other projects with returns equal to a high-IRR project, so the company may not be able to reinvest at the IRR.

The reinvestment rate assumption becomes problematic when a company has several acceptable projects and is attempting to rank the projects. We will look more closely at the issues that can arise when considering mutually exclusive projects later in this chapter. If a company is simply deciding whether to accept a single project, the reinvestment assumption limitation is not relevant.

Overlooking Differences in Scale. Another disadvantage of using the IRR method to choose among various acceptable projects is that it ignores differences in scale. The IRR converts the cash flows to percentages and ignores differences in the size or scale of projects. Issues that occur when comparing projects of different scales are covered later in this chapter.

16.4 Alternative Methods

Learning Outcomes

By the end of this section, you will be able to:

- Calculate profitability index.
- Calculate discounted payback period.
- Calculate modified internal rate of return.

Profitability Index (PI)

The **profitability index (PI)** uses the same inputs as the NPV calculation, but it converts the results to a ratio. The numerator is the present value of the benefits of doing a project. The denominator is the present value of the cost of doing the project. The formula for calculating PI is

$$\text{PI} = \frac{\text{PV(Cash Inflows)}}{\text{PV(Cash Outflows)}}$$

For the embroidery machine project that Sam's Sporting Goods is considering, the PI would be calculated as

$$\text{PI} = \frac{\$18{,}836}{\$16{,}000} = 1.18$$

The numerator of the PI formula is the benefit of the project, and the denominator is the cost of the project. Thus, the PI is the benefit relative to the cost. When NPV is greater than zero, PI will be greater than 1. When NPV is less than zero, PI will be less than 1. Therefore, the decision criterion using the PI method is to accept a project if the PI is greater than 1 and reject a project if the PI is less than 1.

Note that the NPV method and the PI method of project evaluation will always provide the same answer to the accept-or-reject question. The advantage of using the PI method is that it is helpful in ranking projects from best to worst. Issues that arise when ranking projects are discussed later in this chapter.

Discounted Payback Period

The payback period method provides a fast, simple approach to evaluating a project, but it suffers from the fact that it ignores the time value of money. The **discounted payback period** method addresses this flaw by discounting cash flows using the company's cost of funds and then using these discounted values to determine the payback period.

Consider Sam's Sporting Goods' decision regarding whether to purchase an embroidery machine. The expected cash flows and their values when discounted using the company's 9% cost of funds are shown in Table 16.9. Earlier, we calculated the project's payback period as four years; that is how long it would take the company to recover all of the cash that it would spend on the project. Remember, however, that the payback period does not consider the company's cost of funds, so it underestimates the true breakeven time period.

Year	0	1	2	3	4	5	6
Cash Flow ($)	(16,000.00)	2,000.00	4,000.00	5,000.00	5,000.00	5,000.00	5,000.00
Discounted Cash Flow ($)	(16,000)	1,834.86	3,366.72	3,860.92	3,542.13	3,249.66	2,981.34
Cumulative Discounted Cash Flow ($)	(16,000.00)	(14,165.14)	(10,798.42)	(6,937.50)	(3,395.37)	(145.72)	2,835.62

Table 16.9

When the cash flows are appropriately discounted, the project still has not broken even by the end of year 5. The discounted payback period would be $5 + \frac{145.72}{2{,}981.34} = 5.05$ years. This adjusted calculation addresses the payback period method's flaw of not considering the time value of money, but managers are still confronted with the other disadvantages. No objective criterion for acceptance or rejection exists because of the lack of a theoretical underpinning for what is an acceptable payback period length. The discounted payback period ignores any cash flows after breakeven occurs; this is a serious drawback, especially when comparing mutually exclusive projects.

Modified Internal Rate of Return (MIRR)

Financial analysts have developed an alternative evaluation technique that is similar to the IRR but modified in an attempt to address some of the weakness of the IRR method. This **modified internal rate of return (MIRR)** is calculated using the following steps:

1. Find the present value of all of the cash outflows using the firm's cost of attracting capital as the discount

rate.
2. Find the future value of all cash inflows using the firm's cost of attracting capital as the discount rate. All cash inflows are compounded to the point in time at which the last cash inflow will be received. The sum of the future value of cash inflows is known as the project terminal value.
3. Compute the yield that sets the future value of the inflows equal to the present value of the outflows. This yield is the modified internal rate of return.

For our embroidery machine project, the MIRR would be calculated as shown in Table 16.10:

Year	0	1	2	3	4	5	6
Cash Flow ($)	(16,000.00)	2,000.00	4,000.00	5,000.00	5,000.00	5,000.00	5,000.00
							3,077.25
							5,646.33
							6,475.15
							5,940.50
							5,450.00
						Terminal Value	**$31,595.22**

Table 16.10

1. The only cash outflow is the $16,000 at time period 0.
2. The future value of each of the six expected cash inflows is calculated using the company's 9% cost of attracting capital. Each of the cash flows is translated to its value in time period 6, the time period of the final cash inflow. The sum of the future value of these six cash flows is $31,595.22. Thus, the terminal value is $31,595.22
3. The interest rate that equates the present value of the outflows, $16,000, to the terminal value of $31,595.22 six years later is found using the formula

$$\$16{,}000(1 + i)^6 = \$31{,}595.22$$
$$(1 + i)^6 = 1.97$$
$$i = 0.12 = 12\%$$

The MIRR solves the reinvestment rate assumption problem of the IRR method because all cash flows are compounded at the cost of capital. In addition, solving for MIRR will result in only one solution, unlike the IRR, which may have multiple mathematical solutions. However, the MIRR method, like the IRR method, suffers from the limitation that it does not distinguish between large-scale and small-scale projects. Because of this limitation, the MIRR cannot be used to rank projects; it can only be used to make accept-or-reject decisions.

16.5 Choosing between Projects

Learning Outcomes

By the end of this section, you will be able to:
- Choose between mutually exclusive projects.
- Compare projects with different lives.
- Compare projects of different scales.
- Rank projects when resources are limited.

So far, we have considered methods for deciding to accept or to reject a single stand-alone project. Sometimes, managers must make decisions regarding which of two projects to accept, or a company might be faced with a number of good, acceptable projects and have to decide which of those projects to take on during the current year.

Choosing between Mutually Exclusive Projects

Earlier in this chapter, we saw that the embroidery machine that Sam's Sporting Goods was considering had a positive NPV, making it a project that Sam's should accept. However, another, more expensive embroidery machine may be available that is able to make more stitches per minute. Although the initial cost of this heavy-duty machine is higher, it would allow Sam's to embroider and sell more items each year, generating more revenue. The two embroidery machines are **mutually exclusive projects**. Mutually exclusive projects compete with one another; purchasing one embroidery machine excludes Sam's from purchasing the other embroidery machine.

Table 16.11 shows the cash outflow and inflows expected from the original embroidery machine considered as well as the heavy-duty machine. The heavy-duty machine costs $25,000, but it will generate more cash inflows in years 3 through 6. Both machines have a positive NPV, leading to decisions to accept the projects. Also, both machines have an IRR exceeding the company's 9% cost of raising capital, also leading to decisions to accept the projects.

When considered by themselves, each of the machines is a good project for Sam's to pursue. The question the managers face is which is the better of the two projects. When faced with this type of decision, the rule is to take the project with the highest NPV. Remember that the goal is to choose projects that add value to the company. Because the NPV of a project is the estimate of how much value it will create, choosing the project with the higher NPV is choosing the project that will create the greater value.

Year	0	1	2	3	4	5	6	NPV	IRR
Regular Machine ($)	(16,000)	2,000	4,000	5,000	5,000	5,000	5,000	**2,835.62**	**14.10%**
Heavy-Duty Machine ($)	(25,000)	2,000	4,000	8,000	9,000	9,000	9,000	**3,970.67**	**13.20%**

Table 16.11

LINK TO LEARNING

Olympic Project Economics

The investment analysis procedures used by companies are also used by government entities when evaluating projects. Olympic host cities receive direct revenues from broadcast rights, ticket sales, and licensing agreements. The cities also expect indirect benefits from increased tourism, including increased employment and higher tax revenues. These benefits come after the city makes a major investment in infrastructure, spending money on stadiums, housing, and transportation. The investment in infrastructure for the 2014 Winter Olympics in Sochi, Russia, was over $50 billion.[2] Why do you think the infrastructure investment for these games was so much higher than the amount spent by cities hosting previous games? If your city were discussing the possibility of bidding to be an Olympic host city, what would you suggest it consider when evaluating the opportunity? Check out this article (https://openstax.org/r/this-article) for more information.

Choosing between Projects with Different Lives

Suppose you are considering starting an ice-cream truck business. You find that you can purchase a used truck for $50,000. You estimate that the truck will last for three years, and you will be able to sell enough ice cream

2 David Filipov. "Russia Spent $50 Billion on the Sochi Olympics. It Might Actually Have Been Worth It." Washington Post, November 15, 2017. https://www.washingtonpost.com/world/europe/that-sochi-olympic-boondoggle-russians-say-all-the-investment-is-paying-off/2017/11/13/65014bd0-b82c-11e7-9b93-b97043e57a22_story.html

treats to generate a cash inflow of $40,000 during each of those years. Your cost of capital is 10%. The positive NPV of $49,474 for the project makes this an acceptable project.

Another ice-cream truck is also for sale for $50,000. This truck is smaller and will not be able to hold as many frozen treats. However, the truck is newer, with lower mileage, and you estimate that you can use it for six years. This newer truck will allow you to generate a cash inflow of $30,000 each year for the next six years. The NPV of the newer truck is $80,658.

Because both trucks are acceptable projects but you can only drive one truck at a time, you must choose which truck to purchase. At first, it may be tempting to purchase the newer, lower-mileage truck because of its higher NPV. Unfortunately, when comparing two projects that have different lives, a decision cannot be made simply by comparing the NPVs. Although the ice-cream truck with the six-year life span has a much higher NPV than the larger truck, it consumes your resources for a long time.

There are two methods for comparing projects with different lives. Both assume that when the short-life project concludes, another, similar project will be available.

Replacement Chain Approach

With the **replacement chain approach**, as many short-life projects as necessary are strung together to equal the life of the long-life project. You can purchase the newer, lower-mileage ice-cream truck and run your business for six years. To make a comparison, you assume that if you purchase the larger truck that will last for three years, you will be able to repeat the same project, purchasing another larger truck that will last for the next three years. In essence, you are comparing a six-year project with two consecutive three-year projects so that both options will generate cash inflows for six years. Your timeline for the projects (comparing an older, larger truck with a newer, lower-mileage truck) will look like Table 16.12:

Year	0	1	2	3	4	5	6
Older Truck ($)	($50,000)	40,000	40,000	40,000	**40,000**	**40,000**	**40,000**
Older Truck ($)				**(50,000)**			
Newer Truck ($)	(50,000)	30,000	30,000	30,000	30,000	30,000	30,000

Table 16.12

The present values of all of the cash inflows and outflows from purchasing two of the older, larger trucks consecutively are added together to find the NPV of that alternative. The NPV of this alternative is $86,645, which is higher than the NPV of $80,658 of the newer truck, as shown in Table 16.13:

Year	0	1	2	3	4	5	6
Older Truck ($)		40,000	40,000	40,000	**40,000**	**40,000**	**40,000**
Older Truck ($)				**(50,000)**			
Net Present Value	**(50,000)**	**36,363.64**	**33,057.85**	**(7,513.15)**	**27,320.54**	**24,836.85**	**22,578.96**

$$\text{NPV} = \$86{,}644.69$$

Table 16.13

When using the replacement chain approach, the short-term project is repeated any number of times to equal the length of the longer-term project. If one project is 5 years and another is 20 years, the short one is repeated four times. This method can become tedious when the length of the longer project is not a multiple of the shorter project. For example, when choosing between a five-year project and a seven-year project, the short one would have to be duplicated seven times and the long project would have to be repeated five times to get to a common length of 35 years for the two projects.

Equal Annuity Approach

The **equal annuity approach** assumes that both the short-term and the long-term projects can be repeated forever. This approach involves the following steps:

Step 1: Find the NPV of each of the projects.

- The NPV of the larger, older ice-cream truck is $49,474.
- The NPV of the smaller, newer ice-cream truck is $80,658.

Step 2: Find the annuity that has the same present value as the NPV and the same number of periods as the project.

- For the larger, older ice-cream truck, we want to find the three-year annuity that would have a present value of $49,474 when using a 10% discount rate. This is $19,894.
- For the smaller, newer ice-cream truck, we want to find the six-year annuity that would have a present value of $80,658 when using a 10% discount rate. This is $18,520.

Step 3: Assume that these projects, or similar projects, can be repeated over and over and that these annuities will continue forever. Calculate the present value of these annuities continuing forever using the perpetuity formula.

$$\begin{aligned} \text{PV(Larger Truck)} &= \frac{\$19{,}894}{0.10} = \$198{,}940 \\ \text{PV(Smaller Truck)} &= \frac{\$18{,}520}{0.10} = \$185{,}200 \end{aligned}$$

We again find that the older, larger truck is preferred to the newer, smaller truck.

These methods correct for unequal lives, but managers need to be aware that some unavoidable issues come up when these adjustments are made. Both the replacement chain and equal annuity approaches assume that projects can be replicated with identical projects in the future. It is important to note that this is not always a reasonable assumption; these replacement projects may not exist. Estimating cash flows from potential projects is prone to errors, as we will discuss in Financial Forecasting these errors are compounded and become more significant as projects are expected to be repeated. Inflation and changing market conditions are likely to result in cash flows varying in the future from our predictions, and as we go further into the future, these changes are potentially greater.

Choosing Projects When Resources Are Limited

Choosing positive NPV projects adds value to a company. Although we often assume that the company will choose to pursue all positive NPV projects, in reality, managers often face a budget that restricts the amount of capital that they may invest in a given time period. Thus, managers are forced to choose among several positive NPV projects. The goal is to maximize the total NPV of the firm’s projects while remaining within budget constraints.

LINK TO LEARNING

Profitability Index

Managers should reject any project with a negative NPV. When managers find themselves with an array of projects with a positive NPV, the profitability index can be used to choose among those projects. To learn more, watch this video about how a company might use the profitability index (https://openstax.org/r/might-use).

For example, suppose Southwest Manufacturing is considering the seven projects displayed in Table 16.14. Each of the projects has a positive NPV and would add value to the company. The firm has a budget of $200 million to put toward new projects in the upcoming year. Doing all seven of the projects would require initial investments totaling $430 million. Thus, although all of the projects are good projects, Southwest Manufacturing cannot fund them all in the upcoming year and must choose among these projects. Southwest Manufacturing could choose the combination of Projects A and D; the combination of Projects B, C, and E; or several other combinations of projects and exhaust its $200 million investment budget.

Project	NPV ($Millions)	Initial Investment ($Millions)	Profitability Index	Cumulative Investment Required ($Millions)
A	60	150	1.40	150
B	25	100	1.25	250
C	10	70	1.14	320
D	15	50	1.30	370
E	11	30	1.37	400
F	7	20	1.35	420
G	2	10	1.20	430

Table 16.14 Projects Being Considered by Southwest Manufacturing

To decide which combination results in the largest added NPV for the company, rank the projects based on their profitability index, as is done in Table 16.15. Projects A, E, and F should be chosen, as they have the highest profitability indexes. Because those three projects require a cumulative investment of $200 million, none of the remaining projects can be undertaken at the present time. Doing those three projects will add $78 million in NPV to the firm. Out of this set of choices, there is no combination of projects that is affordable given Southwest Manufacturing’s budget that would add more than $78 million in NPV.

Project	NPV ($Millions)	Initial Investment ($Millions)	Profitability Index	Cumulative Investment Required ($Millions)
A	60	150	1.40	150
E	11	30	1.37	180
F	7	20	1.35	200
D	15	50	1.30	250
B	25	100	1.25	350
G	2	10	1.20	360
C	10	70	1.14	430

Table 16.15 Projects Ranked by Profitability Index

Notice that when choices must be made among projects, the decision cannot be made by simply ranking the projects from highest to lowest NPV. Project D has an NPV of $15 million, which is higher than both the $11 million of Project E and the $7 million of Project F. However, Project D requires $50 million for an initial investment. For the same $50 million of investment funds, Southwest Manufacturer can accept both Projects E and F for a total NPV of $18 million. Investment capital is a scare resource for this company. By ranking projects based on their profitability index, the company is able to determine the best way to allocate its scarce capital for the largest potential increase in NPV.

CONCEPTS IN PRACTICE

Capital Budgeting Challenges

Although the basic techniques of project evaluation are straightforward, real-world capital budgeting decisions are complex and multifaceted. The goal of capital budgeting is to choose the projects that will bring the most value to the shareholders of the company. The NPV rule provides a clear, concise criterion for which projects will bring value to the shareholders. It is important to remember, however, that all of the project valuation calculations are based on projected cash flows. These projected cash flows are estimates, based on the best educated guesses that a company makes about its business opportunities over the next few years. Because no company has a crystal ball that can predict the future, its calculation of NPV is an estimate of what it expects.

Think, for example, of an oil company deciding whether to drill for oil. The project will require expenditures on equipment, land, and other items. The cash inflows will depend on the likelihood of oil being found, the quantity of oil produced by the well, and the price at which the oil can be sold. If a company estimates that oil will sell for $100 per barrel during the next few years, the project will have a much higher NPV than if the company estimates that oil will sell for only $50 per barrel.

A project that has a positive NPV and is accepted when a company is planning how to allocate its capital toward investments may end up being a bad project that the company wishes it had avoided if the future is much different from what it projected. Managers must stay attuned to economic developments and reevaluate capital budgeting decisions when significant changes occur. In spring 2020, managers around the globe were faced with a dramatically changing economic environment amid a pandemic. Oil companies, for example, saw oil prices drop from over $50 per barrel at the beginning of March to under $15 per barrel by the end of April.

LINK TO LEARNING

Reducing Capital Spending

In June 2020, McKinsey & Company looked at major companies around the world that were reducing their capital expenditures in the face of the COVID-19 pandemic. These companies were cutting their capital budgets by 10% to 80% from their originally planned levels for 2020. Reductions were especially large in the oil and gas industry, as companies found their revenue projections, and thus the NPV of their planned projects, falling dramatically. In addition, companies found themselves needing to free up cash; with more limited cash resources, fewer positive NPV projects could be accepted and funded.[3] Due to the COVID-19 pandemic, many CFOs were challenged to stabilize their corporate cash flows. This article explains how quickly reducing capital spending (https://openstax.org/r/quickly-reducing), which is usually a quick enough fix, was able to help.

3 Tom Brinded, Zak Cutler, Erikhans Kok, and Prakash Parbhoo. "Resetting Capital Spending in the Wake of COVID-19." McKinsey & Company. June 25, 2020. https://www.mckinsey.com/business-functions/operations/our-insights/resetting-capital-spending-in-the-wake-of-covid-19

16.6 Using Excel to Make Company Investment Decisions

Learning Outcomes

By the end of this section, you will be able to:

- Calculate NPV using Excel.
- Calculate IRR using Excel.
- Create an NPV profile using Excel.

A Microsoft Excel spreadsheet provides an alternative to using a financial calculator to automate the arithmetic necessary to calculate NPV and IRR. An advantage of using Excel is that you can quickly change any assumptions or numbers in your problem and recalculate NPV or IRR based on that updated information. Excel is a versatile tool with more than one way to set up most problems. We will consider a couple of straightforward examples of using Excel to calculate NPV and IRR.

Suppose your company is considering a project that will cost $30,000 this year. The cash inflow from this project is expected to be $6,000 next year and $8,000 the following year. The cash inflow is expected to increase by $2,000 yearly, resulting in a cash inflow of $18,000 in year 7, the final year of the project. You know that your company's cost of funds is 9%. Your company would like to evaluate this project.

Calculating NPV Using Excel

To calculate NPV using Excel, you would begin by placing each year's expected cash flows in a sheet, as in row 5 in Figure 16.4. One approach to calculating NPV is to use the formula for discounting future cash flows, as is shown in row 6.

	A	B	C	D	E	F	G	H	I	J
1										
2	**Company's Cost of Funds**		**9%**							
3										
4		**Year**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5		Cash Flow	(30,000)	6,000	8,000	10,000	12,000	14,000	16,000	18,000
6		Present Value of Cash Flow	=C5/(1+$C2)^C4	=D5/(1+$C2)^D4	=E5/(1+$C2)^E4	=F5/(1+$C2)^F4	=G5/(1+$C2)^G4	=H5/(1+$C2)^H4	=I5/(1+$C2)^I4	=J5/(1+$C2)^J4
7									**NPV =**	**=SUM(C6:J6)**

Figure 16.4 Inserting Present Cash Flows Using Excel ($ except Cost of Funds)

Figure 16.5 shows the present value of each year's cash flow resulting from the formula. The NPV is then calculated by summing the present values of the cash flows.

Download the spreadsheet file (https://openstax.org/r/spreadsheet-file) containing key Chapter 16 Excel exhibits.

	A	B	C	D	E	F	G	H	I	J
1										
2	**Company's Cost of Funds**		**9%**							
3										
4		**Year**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5		Cash Flow	(30,000)	6,000	8,000	10,000	12,000	14,000	16,000	18,000
6		Present Value of Cash Flow	(30,000)	5,505	6,733	7,722	8,501	9,099	9,540	9,847
7									**NPV =**	**26,947**

Figure 16.5 NPV Calculated by Summing Present Values of Cash Flows ($ except Cost of Funds)

Alternatively, Excel is programmed with financial functions, including a calculation for NPV. The NPV formula is shown in cell J7 in Figure 16.6 below. However, it is important to pay attention to how Excel defines NPV. The Excel NPV function calculates the sum of the present values of the cash flows occurring from period 1 through the end of the project using the designated discount rate, but it fails to include the initial investment at time period zero at the beginning of the project. The NPV function in cell J6 will return $56,947 for this project. You must subtract the initial cash outflow of $30,000 that occurs at time 0 to get the NPV of $26,947 for the project.

When entering the Excel-programmed NPV function, you must remember to include references only to the cells that contain cash flows from year 1 to the end of the project. Then, subtract the initial investment of year 0 to calculate NPV according to the standard definition of NPV—the present values of the cash inflows minus the present value of the cash outflow. Note: Because of the nonstandard use of the term NPV by Excel, many users prefer to use the method described above rather than this predefined function.

	A	B	C	D	E	F	G	H	I	J
1										
2	**Company's Cost of Funds**		**9%**							
3										
4		**Year**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5		Cash Flow	(30,000)	6,000	8,000	10,000	12,000	14,000	16,000	18,000
7									**NPV =**	**=NPV(C2,D5:J5)+C5**

Figure 16.6 NPV Formula ($ except IRR/Cost of Funds)

Calculating IRR Using Excel

Excel also provide a function for calculating IRR. This function is shown in Figure 16.7, cell J8. The IRR function properly uses all the project's cash flows, including the initial cash outflow at time 0, in its calculation, unlike the NPV function. This function will correctly return the IRR of 27.7% for the project. Figure 16.8 shows the completed spreadsheet.

	A	B	C	D	E	F	G	H	I	J
1										
2	**Company's Cost of Funds**		**9%**							
3										
4		**Year**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5		Cash Flow	(30,000)	6,000	8,000	10,000	12,000	14,000	16,000	18,000
6		Present Value of Cash Flow	=C5/(1+$C2)^C4	=D5/(1+$C2)^D4	=E5/(1+$C2)^E4	=F5/(1+$C2)^F4	=G5/(1+$C2)^G4	=H5/(1+$C2)^H4	=I5/(1+$C2)^I4	=J5/(1+$C2)^J4
7									**NPV =**	**=SUM(C6:J6)**
8									**IRR =**	**=IRR(C5:J5)**

Figure 16.7 Function for Calculating IRR ($ except IRR/Cost of Funds)

	A	B	C	D	E	F	G	H	I	J
1										
2	**Company's Cost of Funds**		**9%**							
3										
4		**Year**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5		Cash Flow	(30,000)	6,000	8,000	10,000	12,000	14,000	16,000	18,000
6		Present Value of Cash Flow	(30,000)	5,505	6,733	7,722	8,501	9,099	9,540	9,847
7									**NPV =**	**26,947**
8									**IRR =**	**27.7%**

Figure 16.8 Final Spreadsheet ($ except IRR/Cost of Funds)

Using Excel to Create an NPV Profile

Firms often do not know exactly what their cost of attracting capital is, so they must use estimates in their decision-making. Also, the cost of attracting capital can change with economic and market conditions. Especially if markets are volatile, a company may use an NPV profile to see how sensitive their decisions are to changes in financing costs. Excel simplifies the creation of an NPV profile.

Middleton Manufacturing is considering installing solar panels to heat water and provide lighting throughout its plant. To do so will cost the company $800,000 this year. However, this upgrade will save the company an estimated $150,000 in electrical costs each year for the next 10 years. Constructing an NPV profile of this project will allow Middleton to see how the NPV of the project changes with the cost of attracting funds.

First, the project cash flows must be placed in an Excel spreadsheet, as is shown in cells D2 through N2 in Figure 16.9. The company's cost of funds is placed in cell B1; begin by putting in 10% for this rate. Next, the formula for NPV is placed in cell B6; cell B6 shows the NPV of the cash flows in cells D2 through N2, using the rate that is in cell B1.

For reference, compute IRR in cell B4. Calculating IRR is not necessary for creating the NPV profile. However, it gives a good reference point. Remember that if the IRR of a project is greater than the firm's cost of attracting capital, then the NPV will be positive; if the IRR of a project is less than the firm's cost of attracting capital, then the NPV will be negative.

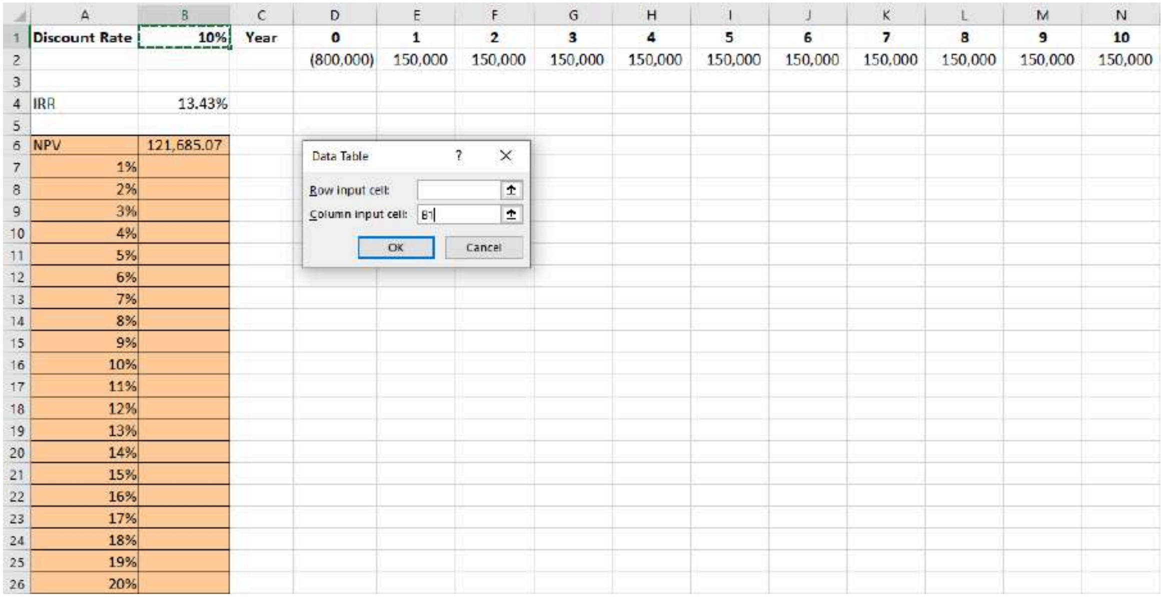
An NPV profile is created by calculating the NPV of the project for a variety of possible costs of attracting capital. In other words, you want to calculate NPV using the project cash flows in cells D2 through N2, using a variety of discount rates in cell B1. This is accomplished by using the Excel data table function. The data table function shows how the outcome of an Excel formula changes when one of the cells in the spreadsheet changes. In this instance, you want to determine how the value of the NPV formula (cell B6) changes when the discount rate (cell B1) changes.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Discount Rate**	**10%**	**Year**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2				(800,000)	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
3														
4	IRR	13.43%												
5														
6	NPV	121,685.07												
7	1%													
8	2%													
9	3%													
10	4%													
11	5%													
12	6%													
13	7%													
14	8%													
15	9%													
16	10%													
17	11%													
18	12%													
19	13%													
20	14%													
21	15%													
22	16%													
23	17%													
24	18%													
25	19%													
26	20%													

Figure 16.9 Project Cash Flows Inserted into Excel

To do this, enter the range of interest rates that you want to consider down a column, beginning in cell A7. This example shows rates from 1% to 20% entered in cells A7 through A26. Your Excel file should now look like the screenshot in Figure 16.9.

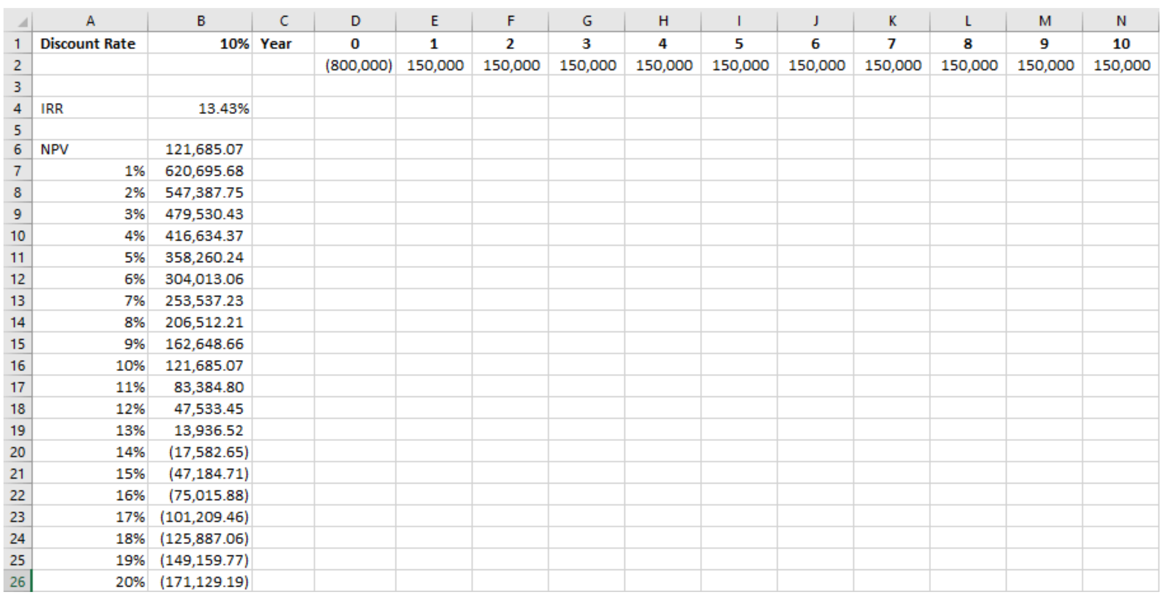
Next, highlight the cells containing the NPV calculation and the range of discount rates. Thus, you will highlight cells A6 through A26 and B6 through B26 (see Figure 16.10). Click Data at the top of the Excel menu so that you see the What-If Analysis feature. Choose Data Table. Because the various discount rates you want to use are in a column, use the "Column input cell" option. Enter "B1" in this box. You are telling Excel to calculate NPV using each of the numbers in this column as the cost of attracting funds in cell B1. Click OK.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Discount Rate	10%	Year	0	1	2	3	4	5	6	7	8	9	10
2				(800,000)	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
3														
4	IRR	13.43%												
5														
6	NPV	121,685.07												
7	1%													
8	2%													
9	3%													
10	4%													
11	5%													
12	6%													
13	7%													
14	8%													
15	9%													
16	10%													
17	11%													
18	12%													
19	13%													
20	14%													
21	15%													
22	16%													
23	17%													
24	18%													
25	19%													
26	20%													

Figure 16.10 Creating a Data Table in Excel

After clicking OK, the cells in column B next to the list of various discount rates will fill with the NPVs corresponding to each of the rates. This is shown in [Figure 16.11](#).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Discount Rate	10%	Year	0	1	2	3	4	5	6	7	8	9	10
2				(800,000)	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
3														
4	IRR	13.43%												
5														
6	NPV	121,685.07												
7	1%	620,695.68												
8	2%	547,387.75												
9	3%	479,530.43												
10	4%	416,634.37												
11	5%	358,260.24												
12	6%	304,013.06												
13	7%	253,537.23												
14	8%	206,512.21												
15	9%	162,648.66												
16	10%	121,685.07												
17	11%	83,384.80												
18	12%	47,533.45												
19	13%	13,936.52												
20	14%	(17,582.65)												
21	15%	(47,184.71)												
22	16%	(75,015.88)												
23	17%	(101,209.46)												
24	18%	(125,887.06)												
25	19%	(149,159.77)												
26	20%	(171,129.19)												

Figure 16.11 NPV Calculated for Various Discount Rates

Now that the various NPVs are calculated, you can create the NPV profile graph. To create the graph, begin by highlighting the discount rates and NPVs that are in cells A7 through A26 and B7 through B26. Next, go to the Insert tab in the menu at the top of Excel. Several different chart options will be available; choose Scatter. You will end up with a chart that looks like the one in [Figure 16.12](#). You can customize the chart by renaming it, labeling the axes, and making other cosmetic changes if you like.

You will notice that the NPV profile crosses the *x*-axis between 13% and 14%; remember that the NPV will be zero when the discount rate that is used to calculate the NPV is equal to the project's IRR, which we previously calculated to be 13.43%. If the firm's cost of raising funds is lower than 13.43%, the NPV profile shows that the project has a positive NPV, and the project should be accepted. Conversely, if the firm's cost of raising funds is greater than 13.43%, the NPV of this project will be negative, and the project should not be accepted.

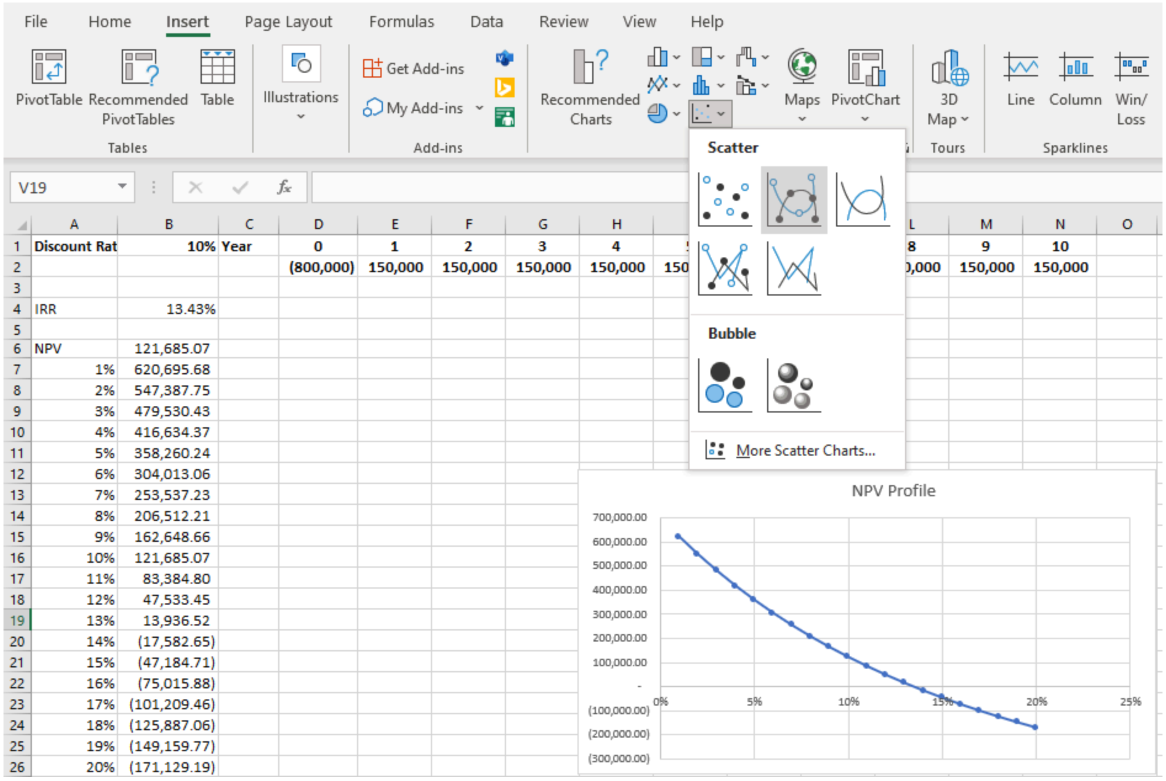


Figure 16.12 NPV Profile Created Using Excel

Middleton Manufacturing can use this NPV profile to evaluate its solar panel installation project. If the managers think that the cost of attracting funds for the company is 10%, then the project has a positive NPV of $121,685 and the company should install the panels. The NPV profile shows that if the managers are underestimating the cost of funds even by 30% and it will really cost Middleton 13% to attract funds, the project is still a good project. The cost of attracting funds would have to be higher than 13.43% for the solar panel project to be rejected.

Summary

16.1 Payback Period Method

The payback period is the simplest project evaluation method. It is the time it takes the company to recoup its initial investment. Its usefulness is limited, however, because it ignores the time value of money.

16.2 Net Present Value (NPV) Method

Net present value (NPV) is calculated by subtracting the present value of a project's cash outflows from the present value of the project's cash inflows. A project should be accepted if its NPV is positive and rejected if its NPV is negative.

16.3 Internal Rate of Return (IRR) Method

The internal rate of return (IRR) of a project is the discount rate that sets the present value of a project's cash inflows exactly equal to the present value of the project's cash outflows. A project should be accepted if its IRR is greater than the firm's cost of attracting capital.

16.4 Alternative Methods

The discounted payback period uses the time value of money to discount future cash flows to see how long it will be before the initial investment of a project is recovered. MIRR provides a variation on IRR in which all cash flows are compounded using the cost of capital, resolving the reinvestment rate assumption problem of the IRR method; unlike IRR, which may have multiple mathematical solutions, MIRR will result in one solution. The profitability index is calculated as the NPV of the project divided by the initial cost of the project.

16.5 Choosing between Projects

Firms may need to choose among a variety of good projects. The projects may have different lives or be differently sized projects that require different amounts of resources. By choosing projects with the highest profitability index, companies can take on the projects that will lead to the greatest increase in value for the company.

16.6 Using Excel to Make Company Investment Decisions

Excel spreadsheets provide a way to easily calculate the NPV and IRR of a project. Using Excel to create an NPV profile allows a company to see how much its estimates of the cost of raising funds can err from the true cost and have the project still be an acceptable project.

Key Terms

capital budgeting the process a business follows to evaluate potential major projects or investments

discounted payback period the length of time it will take for the present value of the future cash inflows of a project to equal the initial cost of the investment

equal annuity approach a method of comparing projects of different lives by assuming that the projects can be repeated forever

internal rate of return (IRR) the discount rate that sets the NPV of a project equal to zero

modified internal rate of return (MIRR) the yield that sets the future value of the cash inflows of a project equal to the present value of the cash outflows of the project

mutually exclusive projects projects that compete against each other so that when one project is chosen, the other project cannot be done

net present value (NPV) the present value of the cash inflows of a project minus the present value of the cash outflows of the project

payback period the length of time it will take for a company to make enough money from an investment to recover the initial cost of the investment

profitability index (PI) the present value of cash inflows divided by the present value of cash outflows

replacement chain approach a method of comparing projects of differing lives by repeating shorter projects multiple times until they reach the lifetime of the longest project

CFA Institute

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Multiple Choice

1. Which of the following is a disadvantage of using the payback method?
   a. It only considers cash flows that occur after the project breaks even.
   b. It ignores the time value of money.
   c. It is difficult to calculate.
   d. You must know the company's cost of raising funds to be able to use it.

2. A company should accept a project if _______.
   a. the NPV of the project is positive
   b. the NPV of the project is negative
   c. the IRR of the project is positive
   d. the IRR of the project is negative

3. The net present value of a project equals _______.
   a. the future value of the cash inflows minus the future value of the cash outflows
   b. the present value of the cash inflows minus the future value of the cash outflows
   c. the present value of the cash inflows minus the present value of the cash outflows
   d. the future value of the cash inflows minus the present value of the cash outflows

4. The IRR of a project is the discount rate that _______.
   a. makes the NPV equal to zero
   b. equates the present value of the cash inflows to the future value of the cash outflows
   c. makes the NPV positive
   d. equates the present value of cash outflows to the future value of the cash inflows

5. The IRR method assumes that _______.
   a. cash flows are reinvested at the firm's cost of attracting funds when they are received
   b. cash flows of a project are never reinvested
   c. cash flows are reinvested at the internal rate of return when they are received
   d. the NPV of a project is negative

6. When cash outflows occur during more than one time period, _______.
   a. the project's NPV will definitely be negative
   b. the project can have multiple IRRs
   c. the project should not be done
   d. the time value of money is not important

7. The discounted payback period method _______.
   a. is used to compare two projects that have different lives
   b. fails to consider the time value of money

c. provides an objective criterion for an accept-or-reject decision grounded in financial theory
d. discounts cash flows using the company's cost of funds to overcome a flaw of the payback period method

8. Which of the following is a method of adjustment for comparing projects of different lives?
a. IRR
b. Modified IRR
c. Payback period
d. Equal annuity

9. When a company can only fund some of its good projects, it should rank the projects by ________.
a. PI
b. IRR
c. NPV
d. payback period

10. If a company is considering two mutually exclusive projects, which of the following statements is true?
a. The company must do both projects if it chooses to do one of the projects.
b. The IRR method should be used to compare the projects.
c. Doing one of the projects means the other project cannot be done.
d. The company does not need to compare the projects because it can choose to do both.

Review Questions

1. Describe the disadvantages of using the payback period to evaluate a project.

2. Explain why a company would want to accept a project with a positive NPV and reject a project with a negative NPV.

3. Westland Manufacturing could spend $5,000 to update its existing fluorescent lighting fixtures to newer fluorescent fixtures that would be more energy efficient. Explain why updating the light fixtures with newer fluorescent fixtures and replacing the existing fixtures with LED fixtures would be considered mutually exclusive projects.

4. When faced with a decision between two good but mutually exclusive projects, should a manager base the decision on NPV or IRR? Why?

Problems

1. Westland Manufacturing spends $20,000 to update the lighting in its factory to more energy-efficient LED fixtures. This will save the company $4,000 per year in electricity costs. What is the payback period of this project?

2. Westland Manufacturing spends $20,000 to update the lighting in its factory to more energy-efficient LED fixtures. This will save the company $4,000 per year in electricity costs. The company estimates that these fixtures will last for 10 years. If the company's cost of funds is 8%, what is the NPV of this project?

3. If Westland Manufacturing finds that its cost of funds is 11%, what will happen to the NPV of the project in problem 2?

4. Westland Manufacturing spends $20,000 to update the lighting in its factory to more energy-efficient LED fixtures. This will save the company $4,000 per year in electricity costs. The company estimates that these fixtures will last for 10 years. What is the IRR of this project?

5. Westland Manufacturing spends $20,000 to update the lighting in its factory to more energy-efficient LED fixtures. This will save the company $4,000 per year in electricity costs. The company estimates that these fixtures will last for 10 years. If the company's cost of funds is 8%, what is the PI of this project?
6. Westland Manufacturing spends $20,000 to update the lighting in its factory to more energy-efficient LED fixtures. This will save the company $4,000 per year in electricity costs. The company estimates that these fixtures will last for 10 years. If the company's cost of funds is 8%, what is the modified IRR of this project?
7. Westland Manufacturing spends $20,000 to update the lighting in its factory to more energy-efficient LED fixtures. This will save the company $4,000 per year in electricity costs. The company estimates that these fixtures will last for 10 years. If the company's cost of funds is 8%, what is the discounted payback period of this project?
8. Holiday Hotels is considering two different floorings to use in its buildings. The less expensive tile will need to be replaced every five years. The more durable, more expensive tile will need to be replaced every eight years. To use the replacement chain approach to compare these two projects, how many times would you have to assume each type of tile would be replaced?
9. You will be living in your college town for two more years. You are considering purchasing a townhouse that will cost you $250,000 today. You estimate that if you do, your expenses for each of the next two years will be $6,000 less than if you rented an apartment. You think that you would be able to lease the townhouse to another college student afterward for $12,000 per year and that your taxes, maintenance, and other expenses for the townhouse would be $5,000 per year. You expect to lease the townhouse for five years before you sell it, and you expect to be able to sell the townhouse for $275,000. Use Excel to create an NPV profile for this undertaking. If it will cost you 3% to borrow money, should you buy the townhouse? What if it will cost you 8% to borrow money?

Video Activity

Calculating NPV and IRR

Click to view content (https://openstax.org/r/CFA-Level-I)
Businesses use NPV and IRR to determine whether or not a project will add value for shareholders. Watch this CFA® Level I Corporate Finance video to learn more. Working along with the video, you will gain practice in using your financial calculator to calculate IRR.

1. According to the video, how should a company use NPV and IRR to decide whether a project should be undertaken?
2. In the video, Trim Corp. is considering a project that is expected to have cash inflows of $350, $250, and $150 in years 1, 2, and 3, respectively. What do you think would happen to the NPV of the project if the company expected the same cash flows, but in reverse order? In other words, what do you think would happen to the NPV if the $150 were the cash inflow of year 1, $250 were the cash inflow for year 2, and $350 were the cash inflow for year 3? Using the same discount rate as in the video, 25%, calculate the NPV for the project with this string of cash outflows. Was the outcome what you thought it would be?

The Tokyo Olympics

Click to view content (https://openstax.org/r/tokyo-olympics)
The capital investment a city must undertake to host the Olympic Games is massive. Learn more about the capital investments and expenses Tokyo faced as host of the 2020 Summer Olympics and how it was impacted by a global pandemic by watching this video, How the Tokyo Olympics Became the Most Expensive Summer Games Ever.

3. Given the costs discussed in the video, create an Excel spreadsheet to estimate the NPV and IRR of hosting

the Olympic Games for a city.

4. How would the numbers in your Excel spreadsheet change because of the COVID-19 pandemic? Create an NPV profile for Tokyo’s Olympic Games given the changes that were caused by the pandemic.

17

How Firms Raise Capital

Figure 17.1 A company can only attract capital if it offers an expected return that is competitive with other options. (credit: modification of “1166357_33949449” by Jenifer Corrêa/flickr, CC BY 2.0)

Chapter Outline

Why It Matters

The most important job that company managers have is to maximize the value of the company. Some obvious things come to mind when you think of how managers would do this. For example, to maximize the value of American Airlines, the managers need to attract customers and sell seats on flights. They also need to keep costs as low as possible, which means keeping the costs of purchasing fuel and making plane repairs as low as possible. While the concept of keeping costs low is simple, the specific decisions a firm makes can be complex. If American Airlines wants to purchase a new airplane, it needs to consider not just the dollar cost of the initial purchase but also the passenger and cargo capacity of the plane as well as ongoing maintenance costs.

In addition to paying salaries to its pilots and flight attendants, American Airlines must pay to use investors’ money. If the company wants to purchase a new airplane, it may borrow money to pay for the plane. Even if American Airlines does not need to incur debt to buy the plane, the money it uses to buy the plane ultimately belongs to the owners or shareholders of the company. The company must consider the opportunity cost of this money and the return that shareholders are expecting on their investments.

Just as different planes have distinctive characteristics and costs, the different types of financing that American Airlines can use will have different characteristics and costs. One of the tasks of the financial manager is to consider the trade-offs of these sources of funding. In this chapter, we look at the basic principles that managers use to minimize the cost of funding and maximize the value of the firm.

17.1 The Concept of Capital Structure

By the end of this section, you will be able to:

- Distinguish between the two major sources of capital appearing on a balance sheet.
- Explain why there is a cost of capital.
- Calculate the weights in a company's capital structure.

The Basic Balance Sheet

In order to produce and sell its products or services, a company needs assets. If a firm will produce shirts, for example, it will need equipment such as sewing machines, cutting boards, irons, and a building in which to store its equipment. The company will also need some raw materials such as fabric, buttons, and thread. These items the company needs to conduct its operations are *assets*. They appear on the left-hand side of the balance sheet.

The company has to pay for these assets. The sources of the money the company uses to pay for these assets appear on the right-hand side of the balance sheet. The company's sources of financing represent its **capital**. There are two broad types of capital: debt (or borrowing) and equity (or ownership).

Figure 17.2 is a representation of a basic balance sheet. Remember that the two sides of the balance sheet must be $\text{Assets} = \text{Liabilities} + \text{Equity}$. Companies typically finance their assets through equity (selling ownership shares to stockholders) and debt (borrowing money from lenders). The debt that a firm uses is often referred to as **financial leverage**. The relative proportions of debt and equity that a firm uses in financing its assets is referred to as its **capital structure**.

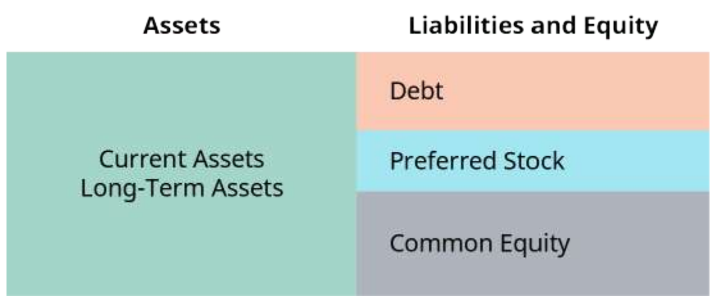

Figure 17.2 Basic Balance Sheet for Company with Debt, Preferred Stock, and Common Equity in Capital Structure

Attracting Capital

When a company raises money from investors, those investors forgo the opportunity to invest that money elsewhere. In economics terms, there is an *opportunity cost* to those who buy a company's bonds or stock.

Suppose, for example, that you have $5,000, and you purchase Tesla stock. You could have purchased Apple stock or Disney stock instead. There were many other options, but once you chose Tesla stock, you no longer had the money available for the other options. You would only purchase Tesla stock if you thought that you would receive a return as large as you would have for the same level of risk on the other investments.

From Tesla's perspective, this means that the company can only attract your capital if it offers an expected return high enough for you to choose it as the company that will use your money. Providing a return equal to what potential investors could expect to earn elsewhere for a similar risk is the cost a company bears in exchange for obtaining funds from investors. Just as a firm must consider the costs of electricity, raw materials, and wages when it calculates the costs of doing business, it must also consider the cost of attracting capital so that it can purchase its assets.

Weights in the Capital Structure

Most companies have multiple sources of capital. The firm's overall cost of capital is a weighted average of its debt and equity costs of capital. The average of a firm's debt and equity costs of capital, weighted by the fractions of the firm's value that correspond to debt and equity, is known as the **weighted average cost of capital (WACC)**.

The weights in the WACC are the proportions of debt and equity used in the firm's capital structure. If, for example, a company is financed 25% by debt and 75% by equity, the weights in the WACC would be 25% on the debt cost of capital and 75% on the equity cost of capital. The balance sheet of the company would look like Figure 17.3.

These weights can be derived from the right-hand side of a market-value-based balance sheet. Recall that accounting-based book values listed on traditional financial statements reflect historical costs. The market-value balance sheet is similar to the accounting balance sheet, but all values are current market values.

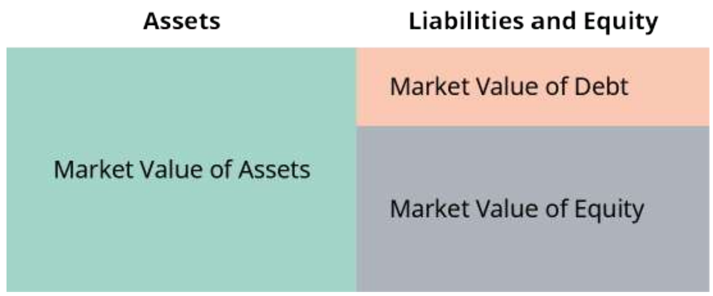

Figure 17.3 Balance Sheet of Company with Capital Structure of 25% Debt and 75% Equity

Just as the accounting balance sheet must balance, the market-value balance sheet must balance:

$$\text{Market Value of Assets} = \text{Market Value of Debt} + \text{Market Value of Equity}$$

This equation reminds us that the values of a company's debt and equity flow from the market value of the company's assets.

Let's look at an example of how a company would calculate the weights in its capital structure. Bluebonnet Industries has debt with a book (face) value of $5 million and equity with a book value of $3 million. Bluebonnet's debt is trading at 97% of its face value. It has one million shares of stock, which are trading for $15 per share.

First, the market values of the company's debt and equity must be determined. Bluebonnet's debt is trading at a discount; its market value is $0.97 \times \$5{,}000{,}000 = \$4{,}850{,}000$. The market value of Bluebonnet's equity equals $\text{Number of Shares} \times \text{Price per Share} = 1{,}000{,}000 \times \$15 = \$15{,}000{,}000$. Thus, the total market value of the company's capital is $\$4{,}850{,}000 + \$15{,}000{,}000 = \$19{,}850{,}000$. The weight of debt in Bluebonnet's capital structure is $\frac{\$4{,}850{,}000}{\$19{,}850{,}000} = 24.4\%$. The weight of equity in its capital structure is $\frac{\$15{,}000{,}000}{\$19{,}850{,}000} = 75.6\%$.

17.2 The Costs of Debt and Equity Capital

By the end of this section, you will be able to:

- Calculate the after-tax cost of debt capital.
- Explain why the return to debt holders is not the same as the cost to the firm.
- Calculate the cost of equity capital.

The costs of debt and equity capital are what company lenders (those who allow the firm to use their capital) expect in return for providing that capital. Just as current market values of debt and equity should be used in determining their weights in the capital structure, current market values of debt and equity should be used in determining the costs of those types of financing.

Cost of Debt Capital

A company's cost of debt is the interest rate it would have to pay to refinance its existing debt. Because a firm's existing debt trades in the marketplace, its price changes according to market conditions. The overall credit environment can change due to changing macroeconomic conditions, causing a change in the price of debt securities. In addition, as there are changes in the overall riskiness of the firm and its ability to repay its creditors, the price of the debt securities issued by the firm will change.

The market price of a company's existing bonds implies a yield to maturity. Recall that the *yield to maturity* is the return that current purchasers of the debt will earn if they hold the bond to maturity and receive all of the payments promised by the borrowing firm.

Yield to Maturity and the Cost of Debt

Bluebonnet's debt is selling for 97% of its face value. This means that for every $100 of face value, investors are currently paying $97 for an outstanding bond issued by Bluebonnet Industries. This debt has a coupon rate of 6%, paid semiannually, and the bonds mature in 15 years.

Because the bonds are selling at a discount, the yield that investors who purchase these bonds will receive if they hold the bond to maturity exceeds 6%. The purchasers of these bonds will receive a coupon payment of $\$100 \times \frac{0.06}{2} = \$3$ every six months for the next 15 years. They will also receive the $100 face value when the bonds mature in 15 years. To calculate the yield to maturity of these bonds using your financial calculator, input the information shown in Table 17.1.

Step	Description	Enter	Display	
1	Enter number of coupon payments	30 N	N =	30.00
2	Enter the price paid for the bond	97 +/− PV	PV =	-97.00
3	Enter the coupon payment	3 PMT	PMT =	3.00
4	Enter the face value of the bond	100 FV	FV =	100.00
5	Compute the semiannual rate	CPT I/Y	I/Y =	3.156
6	Multiply 3.156 by 2 to get YTM	$\times 2 =$		6.312

Table 17.1 Calculator Steps for Finding the Yield to Maturity[1]

The yield to maturity (YTM) of Bluebonnet Industries bonds is 6.312%. This YTM should be used in estimating the firm's overall cost of capital, not the coupon rate of 6% that is stated on the outstanding bonds. The coupon rate on the existing bonds is a historical rate, set under economic conditions that may have been different from the current market conditions. The YTM of 6.312% represents what investors are currently requiring to purchase the debt issued by the company.

After-Tax Cost of Debt

Although current debt holders demand to earn 6.312% to encourage them to lend to Bluebonnet Industries, the cost to the firm is less than 6.312%. This is because interest paid on debt is a tax-deductible expense. When a firm borrows money, the interest it pays is offset to some extent by the tax savings that occur because of this deductible expense.

The **after-tax cost of debt** is the net cost of interest on a company's debt after taxes. This after-tax cost of debt is the firm's effective cost of debt. The after-tax cost of debt is calculated as $r_{\mathrm{d}}(1 - T)$, where r_{d} is the before-tax cost of debt, or the return that the lenders receive, and *T* is the company's tax rate. If Bluebonnet

1 The specific financial calculator in these examples is the Texas Instruments BA II Plus[TM] Professional model, but you can use other financial calculators for these types of calculations.

Industries has a tax rate of 21%, then the firm's after-tax cost of debt is $6.312\%\ (1 - 0.21) = 4.986\%$.

This means that for every $1,000 Bluebonnet borrows, the company will have to pay its lenders $1{,}000(6.312\%) = \$63.12$ in interest every year. The company can deduct $63.12 from its income, so this interest payment reduces the taxes the company must pay to the government by $\$63.12\ (0.21) = \$13.26\%$. Thus, Bluebonnet's effective cost of debt is $\$63.12 - \$13.26 = \$49.86$, or $\frac{\$49.86}{\$1{,}000} = 4.986\%$.

THINK IT THROUGH

Calculating the After-Tax Cost of Debt

Royer Roasters has issued bonds that will mature in 18 years. The bonds have a coupon rate of 8%, and coupon payments are made semiannually. These bonds are currently selling at a price of $102.20 per $100 face value. Royer's tax rate is 28%. What is Royer's after-tax cost of debt?

Solution:

The purchasers of these bonds will receive a coupon payment of $\$100 \times \frac{0.08}{2} = \$4$ every six months for the next 18 years. The owners of the bonds will also receive the $100 face value when the bonds mature in 18 years. To calculate the yield to maturity of these bonds, input the information in Table 17.2 in your financial calculator.

Step	Description	Enter	Display	
1	Enter number of coupon payments	36 N	N =	36.00
2	Enter the price paid for the bond	102.20 +/− PV	PV =	-102.20
3	Enter the coupon payment	4 PMT	PMT =	4.00
4	Enter the face value of the bond	100 FV	FV =	100.00
5	Compute the semiannual rate	CPT I/Y	I/Y =	3.885
6	Multiply 3.885 by 2 to get YTM	$\times 2 =$		7.771

Table 17.2 Calculator Steps to Find Bond Yield to Maturity

The bondholders require 7.771% to entice them to purchase the debt issued by the company. Royer Roasters is able to deduct interest expenses before taxes. Thus, its after-tax cost of debt is $7.771\% \times (1 - 0.28) = 5.595\%$.

Cost of Equity Capital

Companies can raise money by selling stock, or ownership shares, of the company. Stock is known as equity capital. The cost of common stock capital cannot be directly observed in the market; it must be estimated. Two primary methods for estimating the cost of common stock capital are the capital asset pricing model (CAPM) and the constant dividend growth model.

CAPM

The CAPM is based on using the firm's systematic risk to estimate the expected returns that shareholders require to invest in the stock. According to the CAPM, the cost of equity (r_e) can be estimated using the formula

$$r_e = \text{Risk-Free Rate} + (\text{Equity Beta} \times \text{Market Risk Premium})$$

For example, suppose that Bluebonnet Industries has an equity beta of 1.3. Because the beta is greater than one, the stock has more systematic risk than the average stock in the market. Assume that the rate on 10-year US Treasury notes is 3% and serves as a proxy for the risk-free rate. If the long-run average return for the stock market is 11%, the market risk premium is $11\% - 3\% = 8\%$; this means that people who invest in the stock market are rewarded for the risk they are taking by being paid 8% more than they would have been paid if they had purchased US Treasury notes. Bluebonnet Industries cost of equity capital can be estimated as

$$r_e = 0.03 + (1.3 \times 0.08) = 0.03 + 0.104 = 0.134 = 13.4\%$$

Constant Dividend Growth Model

The constant dividend growth model provides an alternative method of calculating a company's cost of equity. The basic formula for the constant dividend growth model is

$$r_e = \frac{\text{Dividend in One Year}}{\text{Current Stock Price}} + \text{Dividend Growth Rate} = \frac{Div_1}{P_0} + g$$

Thus, three things are needed to complete this calculation: the current stock price, what the dividend will be in one year, and the growth rate of the dividend. The current price of the stock is easy to obtain by looking at the financial news. The other two items, the dividend next year and the growth rate of the dividend, will occur in the future and at the current time are not known with certainty; these two items must be estimated.

Suppose Bluebonnet paid a dividend of $1.50 per share to its shareholders last year. Also suppose that this dividend has been growing at a rate of 2% each year for the past several years and that growth rate is expected to continue into the future. Then, the dividend in one year can be expected to be $\$1.50(1 + 0.02) = \$1.53$. If the current stock price is $12.50 per share, then that cost of equity is estimated as

$$r_e = \frac{\$1.53}{\$12.50} + 0.02 = 0.1224 + 0.02 = 0.1424 = 14.24\%$$

THINK IT THROUGH

Using the Constant Dividend Growth Model

What does an increase in the price of a company's stock imply about the equity cost of capital for the company? To find out what the constant dividend growth model suggests, assume that the stock price for Bluebonnet Industries increases to $16.50 per share. If there is no expectation that the growth rate of the dividends will increase, what would the new estimated equity cost of capital be?

Solution:

Using the price of $16.50 per share in the constant dividend growth model equation results in an estimated equity cost of capital of

$$r_e = \frac{\$1.53}{\$16.50} + 0.02 = 0.0927 + 0.02 = 0.1127 = 11.27\%$$

Thus, an increase in the price of the stock, holding all of the other variables in the equation constant, implies that the equity cost of capital drops to 11.27%.

17.3 Calculating the Weighted Average Cost of Capital

By the end of this section, you will be able to:

- Calculate the weighted average cost of capital (WACC).
- Describe issues that arise from estimating the cost of equity capital.
- Describe the use of net debt in calculating WACC.

Once you know the weights in a company's capital structure and have estimated the costs of the different sources of its capital, you can calculate the company's weighted average cost of capital (WACC).

WACC Equation

WACC is calculated using the equation

$$\text{WACC} = D\% \times r_{\text{d}}(1 - T) + P\% \times r_{\text{pfd}} + E\% \times r_{\text{e}}$$

D%, *P%*, and *E%* represent the weight of debt, preferred stock, and common equity, respectively, in the capital structure. Note that $D\% + P\% + E\%$ must equal 100% because the company must account for 100% of its financing. The after-tax cost of debt is $r_{\text{d}}(1 - T)$. The cost of preferred stock capital is represented by r_{pfd}, and the cost of common stock capital is represented by r_{e}.

For a company that does not issue preferred stock, *P%* is equal to zero, and the WACC equation is simply

$$\text{WACC} = D\% \times r_{\text{d}}(1 - T) + E\% \times r_{\text{e}}$$

Earlier in this chapter, we calculated the weights in Bluebonnet Industries' capital structure to be $D\% = 24.4\%$ and $E\% = 75.6\%$. We also calculated the after-tax cost of debt for Bluebonnet to be 4.99%. If we use the CAPM to estimate the cost of equity capital for the firm, Bluebonnet's WACC is computed as

$$\text{WACC} = 24\% \times 4.99\% + 75.6\% \times 13.4\% = 1.20\% + 10.13\% = 11.33\%$$

If we use the constant dividend discount model to estimate the cost of equity for Bluebonnet Industries, the WACC is computed as

$$\text{WACC} = 24\% \times 4.99\% + 75.6\% \times 14.24\% = 1.20\% + 10.77\% = 11.97\%$$

Calculating WACC in Practice

The equation for calculating WACC is straightforward. However, issues come up when financial managers calculate WACC in practice. Both the weights of the equity components and the cost of the equity components are needed to calculate the WACC. The WACC that financial managers derive will depend on the assumptions and models they use to determine what weights and capital costs to use.

Issues in Estimating the Cost of Equity Capital

We have explored two ways of estimating the cost of equity capital: the CAPM and the constant dividend growth model. Often, these methods will produce similar estimates of the cost of capital; seldom will the two methods provide the same value.

In our example for Bluebonnet Industries, the CAPM estimated the cost of equity capital as 13.4%. The constant dividend growth model estimated the cost of capital as 14.24%. The exact value of the WACC calculation depends on which of these estimates is used. It is important to remember that the WACC is an estimate that is based on a number of assumptions that financial managers made.

For example, using the CAPM requires assumptions be made regarding the values of the risk-free interest rate, the market risk premium, and a firm's beta. The risk-free interest rate is generally determined using US Treasury security yields. In theory, the yield on US Treasury securities that have a maturity equivalent to the length of the company's investors' investment horizon should be used. It is common for financial analysts to use yields on long-term US Treasury bonds to determine the risk-free rate.

To estimate the market risk premium, analysts turn to historical data. Because this historical data is used to estimate the future market risk premium, the question arises of how many years of historical data should be used. Using more years of historical data can lead to more accurate estimates of what the average past return has been, but very old data may have little relevance if today's financial market environment is different from what it was in the past. Old data may have little relevance for investors' expectations today. Typical market risk premiums used by financial managers range from 5% to 8%.

The same issue with how much historical data should be considered arises when calculating a company's beta. Different financial managers can calculate significantly different betas even for well-established, stable companies. In April 2021, for example, the beta for IBM was reported as 0.97 by MarketWatch and as 1.25 by Yahoo! Finance.

The CAPM estimate of the cost of equity capital for IBM is significantly different depending on what source is used for the company's beta and what value is used for the market risk premium. Using a market risk premium of 5%, the beta of 0.97 provided by MarketWatch, and a risk-free rate of 3% results in a cost of capital of

$$r_e = 0.03 + (0.97 \times 0.05) = 0.03 + 0.0485 = 0.0785 = 7.85\%$$

If, instead, a market risk premium of 8% and the beta of 1.25 provided by Yahoo! Finance are used, the cost of capital is estimated to be

$$r_e = 0.03 + (1.25 \times 0.08) = 0.03 + 0.10 = 0.13 = 13.0\%$$

CONCEPTS IN PRACTICE

Estimating the Equity Cost of Capital

Although the calculation of the cost of capital using the CAPM equation is simple and straightforward, there is not one definitive equity cost of capital for a company that all financial managers will agree on. Consider the eight companies spotlighted in Table 17.3.

Four estimates of the equity cost of capital are calculated for each firm. The first two estimates are based on the beta provided by MarketWatch for each of the companies. A risk-free rate of 3% is assumed. Market risk premiums of both 5% and of 8% are considered. A market risk premium of 5% would suggest that long-run investors who hold a well-diversified portfolio, such as one with all of the stocks in the S&P 500, will average a return 5 percentage points higher than the risk-free rate, or 8%. If you assume instead that the average long-run return on the S&P 500 is 11%, then people who purchase a portfolio of those stocks are rewarded by earning 8 percentage points more than the 3% they would earn investing in the risk-free security.

The last two estimates of the cost of equity capital for each company also use the same risk-free rate of 3% and the possible market risk premiums of 5% and 8%. The only difference is that the beta provided by Yahoo! Finance is used in the calculation.

Company	Industry	MarketWatch			Yahoo! Finance		
		Beta	MRP = 5%	MRP = 8%	Beta	MRP = 5%	MRP = 8%
Kroger	Food retail	0.31	4.55%	5.48%	0.66	6.30%	8.28%
Coca-Cola	Nonalcoholic beverages	0.69	6.45%	8.52%	0.62	6.10%	7.96%
AT&T	Telecommunications	0.74	6.70%	8.92%	0.74	6.70%	8.92%
Kraft Heinz	Food products	0.82	7.10%	9.56%	1.14	8.70%	12.12%
Microsoft	Software	1.19	8.95%	12.52%	0.79	6.95%	9.32%
Goodyear Tire and Rubber	Tires	1.24	9.20%	12.92%	2.26	14.30%	21.08%
American Airlines	Passenger airlines	1.34	9.70%	13.72%	1.93	12.65%	18.44%
KB Homes	Residential construction	1.42	10.10%	14.36%	1.83	12.15%	17.64%

Table 17.3 **Estimates of Equity Cost of Capital for Eight Companies** (source: Yahoo! Finance; MarketWatch)

The range of the equity cost of capital estimates for each of the firms is significant. Consider, for example, Goodyear Tire and Rubber. According to MarketWatch, the beta for the company is 1.24, resulting in an estimated cost of equity capital between 9.20% and 12.92%. The beta provided by Yahoo! Finance is much higher, at 2.26. Using this higher beta results in an estimated equity cost of capital for Goodyear Tire and Rubber between 14.30% and 21.08%. This leaves the financial managers of Goodyear Tire and Rubber with an estimate of the equity cost of capital between 9.20% and 21.08%, using a range of reasonable assumptions.

What is a financial manager to do when one estimate is more than twice as large as another estimate? A financial manager who believes the equity cost of capital is close to 9% is likely to make very different choices from one who believes the cost is closer to 21%. This is why it is important for a financial manager to have a broad understanding of the operations of a particular company. First, the manager must know the historical background from which these numbers were derived. It is not enough for the manager to know that beta is estimated as 1.24 or 2.26; the manager must be able to determine why the estimates are so different. Second, the manager must be familiar enough with the company and the economic environment to draw a conclusion about what set of assumptions will most likely be reasonable going forward. While these numbers are based on historical data, the financial manager's main concern is what the numbers will be going forward.

It is evident that estimating the equity cost of capital is not a simple task for companies. Although we do see a wide range of estimates in the table, some general principles emerge. First, the average company has a beta of 1. With a risk-free rate of 3% and a market risk premium in the range of 5% to 8%, the cost of equity capital will fall within a range of 8% to 11% for the average company. Companies that have a beta less than 1 will have an equity cost of capital that falls below this range, and companies that have a beta greater than 1 will have an equity cost of capital that rises above this range.

Recall that a company's beta is heavily influenced by the type of industry. Grocery stores and providers of food products, for example, tend to have betas less than 1. During recessionary times, people still eat, but during expansionary times, people do not significantly increase their spending on these products. Thus, companies such as Kroger, Coca-Cola, and Kraft Heinz will tend to have low betas and a range of equity cost of capital below 8% to 11%.

The sales of companies in other industries tend to be much more volatile. During expansionary periods, people fly to vacation destinations and purchase new homes. During recessionary periods, families cut back on these discretionary expenditures. Thus, companies such as American Airlines and KB Homes will have higher betas and ranges of equity cost of capital that exceed the 8% to 11% average. The higher equity cost of capital is needed to incentivize investors to invest in these companies with riskier cash flows rather than in lower-risk companies.

The CAPM estimate depends on assumptions made, but issues also exist with the constant dividend growth model. First, the constant dividend growth model can be used only for companies that pay dividends. Second, the model assumes that the dividends will grow at a constant rate in the future, an assumption that is not always reasonable. It also assumes that the financial manager accurately forecasts the growth rate of dividends; any error in this forecast results in an error in estimating the cost of equity capital.

Given the differences in assumptions made when using the constant dividend growth model and the CAPM to estimate the equity cost of capital, it is not surprising that the numbers from the two models differ. When estimating the cost of equity capital for a particular firm, financial managers must examine the assumptions made for both approaches and decide which set of assumptions is more realistic for that particular company.

Net Debt

Many practitioners use **net debt** rather than total debt when calculating the weights for WACC. Net debt is the amount of debt that would remain if a company used all of its liquid assets to pay off as much debt as possible. Net debt is calculated as the firm's total debt, both short-term and long-term, minus the firm's cash and cash equivalents. Cash equivalents are current assets that can quickly and easily be converted into cash, such as Treasury bills, commercial paper, and marketable securities.

Consider, for example, Apple, which had $112.436 billion in total debt in 2020. The company also had $38.016 billion in cash and cash equivalents. This meant that the net debt for Apple was only $74.420 billion. If Apple used all of its cash and cash equivalents to pay debt, it would be left with $74.420 billion in debt.[2]

Cash and cash equivalents can be viewed as negative debt. For firms with relatively low levels of cash, this adjustment will not have a large impact on the overall WACC estimate. However, the adjustment can be important for firms that hold substantial cash reserves.

17.4 Capital Structure Choices

By the end of this section, you will be able to:

- Distinguish between a levered and an unlevered firm.
- Explain why the choice of capital structure does not impact the value of a firm in perfect financial markets.
- Calculate the interest tax shield.
- Explain how the interest tax shield encourages the use of leverage.

So far, we have taken the company's capital structure as given. Each firm's capital structure, however, is a result of intentional decisions made by the financial managers of the company. We now turn our attention to the issues that financial managers consider when making these decisions.

The Unlevered Firm

Let's begin our discussion of capital structure choices by exploring the financing decisions you would face if you were to start a T-shirt business. Suppose that your hometown will host an international cycling competition. The competition itself will last for a month; cyclists will arrive early to train in the local climate. News coverage will be significant, meaning a lot of media personnel will be visiting your area. In addition to fans attending the event, it is expected that tourism will increase over the next year as recreational cyclists will want to ride the route of the professional race. You decide to operate a business for one year that will sell T-shirts highlighting this event.

You will need to make an up-front investment of $40,000 to start the business. You estimate that you will generate a cash flow of $52,000, after you cover all of your operating costs, at the end of next year. You know that these profits are risky; you think a 10% risk premium is appropriate for the level of riskiness of the business. If the risk-free rate is 4%, this means that the appropriate discount rate for you to use is 14%. The value of this business opportunity is

$$\text{Value of Business} = \frac{\$52{,}000}{1.14} - \$40{,}000 = \$45{,}614 - \$40{,}000 = \$5614$$

This looks as if it will be a profitable business that should be undertaken. However, you do not have the $40,000 for the up-front investment and will need to raise it.

First, consider raising money solely by selling ownership shares to your family and friends. How much would those shares be worth? The value of the stock would be equal to the present value of the expected future cash flows. The potential stockholders would expect to receive $45,614 in one year. If they agree with you that the riskiness of this T-shirt business warrants a discount rate of 14%, then they will value the stock at

2 "Historical Data." Apple Inc. (AAPL). Yahoo! Finance, accessed October 29, 2021. https://finance.yahoo.com/quote/AAPL/history/

$$\text{Present Value} = \frac{\$52{,}000}{1.14} = \$45{,}614$$

If you sell all of the equity in the company for $45,614 and purchase the equipment necessary for the project for $40,000, you have $5,614 to keep as the entrepreneur who created the business.

This business would be financed 100% by equity. The lack of any debt in the capital structure means the firm would have no financial leverage. The equity in a firm that has no financial leverage is called **unlevered equity**.

The Levered Firm

Next, consider borrowing some of the money that you will need to start this T-shirt business. Although the cash flows from the business are uncertain, suppose you are certain that the business will generate at least $18,000. (Perhaps you have a guaranteed order from the cycling competition sponsors.) If you borrowed $17,000 at the risk-free interest rate of 4%, you would owe $\$17{,}000 \times (1.04) = \$17{,}680$ to the lenders at the end of the year. Because you are certain that you will generate at least $18,000 in cash, which is greater than $17,680, you can borrow the $17,000 without any risk of defaulting.

The $17,000 will not be enough to pay for all the start-up costs. You will also need to raise some capital by selling equity. Because your firm will have some debt, or financial leverage, the equity that you raise will be known as **levered equity**. The equity holders expect the firm to generate $52,000 in cash flows. Debt holders must be paid before equity holders, so this will leave $\$52{,}000 - \$17{,}680 = \$34{,}320$ for the shareholders.

The expected future cash flows generated by the business are determined by the productivity of its assets, not the manner in which those assets are financed. It is the present value of these expected future cash flows that determines the firm's value. Thus, the firm's value in perfect capital markets will not change as a result of the company taking on leverage.

LINK TO LEARNING

MM Proposition I

Nobel laureates Franco Modigliani and Merton Miller wrote influential papers exploring capital structure and the cost of a firm's capital. They began by considering what would occur in a perfectly competitive market. One of the assumptions of this perfect capital market is that there are no taxes. The idea that the market value of the unlevered and levered firm is the same in perfect capital markets is known in the field of finance as MM Proposition I.

Visit Milken Institute's 5-Minute Finance site to explore more about Modigliani and Miller's contributions (https://openstax.org/r/Modigliani) to the understanding of capital structure.

The value of your T-shirt business remains at $45,614. You can calculate the value of the levered equity as

$$\begin{aligned} \text{Value of Firm} &= D + E \\ \$45{,}614 &= \$17{,}000 + E \\ E &= \$45{,}614 - \$17{,}000 = \$28{,}614 \end{aligned}$$

Now, shareholders are willing to pay $28,614 for ownership in this company. They expect to get $34,320 in one year in return for purchasing this equity. What discount rate does this imply?

$$\begin{aligned} \frac{\$34{,}320}{1 + r_E} &= \$28{,}614 \\ \frac{\$34{,}320}{\$28{,}614} &= 1 + r_E \\ r_E &= 19.94\% \end{aligned}$$

Notice that the expected return to shareholders has risen from 14% for the unlevered firm to 19.94% for the levered firm. Recall that the expected return to shareholders equals the risk-free rate plus a risk premium. The risk-free rate has remained 4%. With leverage, the risk premium rises from 10% to 15.94%.

Why does this risk premium increase? Recall that debt holders are paid before equity holders. Equity holders are residual claimants; they will only receive payment if there is money left over after the debt holders are fully paid. The business is risky. You are certain that the company will have cash flow of at least $18,000 at the end of the year and that $17,680 will be paid to the debt holders. Therefore, if the company performs poorly (perhaps bad weather results in the cancellation of much of the cycling competition) and the cash flows fall way below what you are expecting, there may be only several hundred dollars left for the shareholders.

When the firm was unlevered, if the cash flow at the end of the year was only $18,000, the shareholders would receive $18,000. When leverage is used, the same cash flow would result in shareholders receiving only $320. The risk to the shareholders increases as leverage is used; thus, the risk premium that shareholders require also increases as leverage is used.

Leverage and the WACC

What happens to the WACC as leverage is used? To figure this out, we must calculate the weights of debt and equity in the capital structure:

$$D\% = \frac{\$17{,}000}{\$45{,}614} = 37.27\%$$
$$E\% = \frac{\$28{,}614}{\$45{,}614} = 62.73\%$$

In perfect capital markets, an assumption we are making for now, there are no taxes. Because we are using only debt and common stock, the weight of preferred stock is zero, and our WACC can be calculated as

$$\begin{aligned}\text{WACC} &= 37.27\% \times 0.04(1-0) + 62.73\% \times 0.1994 \\ &= 1.49\% + 12.51\% \\ &= 14\%\end{aligned}$$

Notice that the use of leverage does not change the WACC. When only equity was used to finance the business, stockholders required a 14% expected return to encourage them to let the firm use their capital. When leverage was used, the debt holders only required a 4% return. However, the existence of debt holders, who stand in front of shareholders in the order of claimants, puts shareholders in a riskier position. There is a greater chance that the shareholders will not receive payment from this uncertain business. Thus, the shareholders require a higher rate of return to let the leveraged firm use their capital.

The cost-savings benefits of using lower-cost debt in your company's capital structure are exactly offset by the higher return that shareholders require when leverage is used. Mathematically, the increase in the cost of equity when leverage is used will be proportional to the debt–equity ratio. Financial managers refer to this outcome as MM Proposition II. The relationship is expressed by the formula

$$r_{\text{E}} = r_{\text{u}} + \frac{D}{E}(r_{\text{u}} - r_{\text{D}})$$

where r_{u} is the required return to equity holders of the unlevered firm.

Table 17.4 shows how the cost of equity increases as the weight of debt in the capital structure increases. As the company uses more debt, the risk to equity holders increases. Because equity holders risk that there will be no residual money after bondholders are paid, the equity holders require a higher rate of return to invest in the company as its use of leverage increases. Although debt holders face less risk than equity holders, the risk that they face increases as the amount of debt the company takes on increases. Once the company's debt exceeds its guaranteed cash flow, which is $18,000 in our example, debt holders face some risk that the company will not be able to pay them. At that point, the cost of debt rises above the risk-free rate. As the weight of debt approaches 100%, the cost of debt capital approaches the cost of equity of the unlevered firm. In other words, if you financed the T-shirt business solely through the use of debt, the debt holders would require a 14% return because they would be bearing the entire risk of the business and would demand to be rewarded for doing so.

As the leverage of the firm increases, both the cost of debt capital and the cost of equity capital increase. However, as the firm's leverage increases, it is using proportionately more of the relatively cheaper source of capital—debt— and proportionately less of the relatively more expensive source of capital—equity. Thus, the WACC remains constant as leverage increases, despite the rising cost of each component.

Amount of Debt	Amount of Equity	Weight of Debt	Weight of Equity	Cost of Debt	Cost of Equity	WACC
$ -	$45,614	0%	100%	0.0400	0.1400	14%
$5,000	$40,614	11%	89%	0.0400	0.1523	14%
$10,000	$35,614	22%	78%	0.0400	0.1681	14%
$15,000	$30,614	33%	67%	0.0400	0.1890	14%
$17,000	$28,614	37%	63%	0.0400	0.1994	14%
$20,000	$25,614	44%	56%	0.0600	0.2025	14%
$30,000	$15,614	66%	34%	0.0800	0.2553	14%
$40,000	$5,614	88%	12%	0.1000	0.4250	14%

Table 17.4 Alternative Capital Structures for Your T-Shirt Business

The Impact of Taxes

In perfect capital markets, the choice of capital structure will not impact the value of the firm or the cost of the firm's financing. In the real world, however, capital markets are not perfect. One of the important market imperfections is the presence of corporate taxes. Because the choice of capital structure can impact the taxes that a company pays, in the real world, capital structure can impact the cost of capital and the firm's value.

Assume that your T-shirt business venture will result in earnings before interest and taxes (EBIT) of $52,000 next year and that the corporate tax rate is 28%. If your company is unlevered, it has no interest expense, and its net income will be $37,440, as shown in Table 17.5.

	Without Leverage	With Leverage
EBIT	$52,000.00	$52,000.00
Interest Expense	0.00	280.00
Income before Taxes	52,000.00	51,720.00
Taxes (28%)	14,560.00	14,481.60
Net Income	**$37,440.00**	**$37,238.40**

Table 17.5 Net Income and Leverage

If your company uses leverage, raising $7,000 of financing by issuing debt with a 4% interest rate, it will have an interest expense of $280. This lowers its taxable income to $51,720 and its taxes to $14,481.60. Because interest is a tax-deductible expense, using leverage lowers the company's taxes.

Table 17.6 shows that the company's net income is lower with leverage than it would be without leverage. In other words, debt obligations will reduce the value of the equity. However, less equity is needed because some of the firm is financed through debt. The important consideration is how the use of leverage changes the total amount of dollars available to all investors. Table 17.6 shows this impact.

	Without Leverage	With Leverage
Interest Paid to Debt Holders	$0.00	$280.00
Amount Available to Stockholders	37,440.00	37,238.40
Total Available for All Investors	**$37,440.00**	**$37,518.40**

Table 17.6 Total Dollars Available to Investors

Using leverage allows the firm to generate $37,518.40 to pay its investors, compared to only $37,440 that is available if the firm is unlevered. Where does the extra $78.40 to pay investors come from? It comes from the reduction in taxes that the firm pays due to leverage. If the company uses no debt, it pays $14,560 in taxes. The levered firm pays only $14,481.60 in taxes, a savings of $78.40.

The $280 that the levered company pays in interest is shielded from the corporate tax, resulting in tax savings of $0.28 \times \$280 = \$78.40$. The additional amount available to investors because of the tax deductibility of interest payments is known as the **interest tax shield**. The interest tax shield is calculated as

$$\text{Interest Tax Shield} = \text{Corporate Tax Rate} \times \text{Interest Payments}$$

When interest is a tax-deductible expense, the total value of the levered firm will exceed the value of the unlevered firm by the amount of this interest tax shield. The tax-advantage status of debt financing impacts the WACC. The WACC with taxes is calculated as

$$\begin{aligned}\text{WACC} &= D\% \times r_{\text{d}}(1-T) + E\% \times r_{\text{e}} \\ &= \frac{D}{E+D} \times r_{\text{d}}(1-T) + \frac{E}{E+D} \times r_{\text{e}}\end{aligned}$$

This formula can be written as

$$\begin{aligned}\text{WACC} &= \frac{D}{E+D} \times r_{\text{d}} - \frac{D}{E+D} \times r_{\text{d}} \times T + \frac{E}{E+D} \times r_{\text{e}} \\ &= \frac{D}{E+D} \times r_{\text{d}} + \frac{E}{E+D} \times r_{\text{e}} - \frac{D}{E+D} \times r_{\text{d}} \times T\end{aligned}$$

Thus, the WACC with taxes is lower than the pretax WACC because of the interest tax shield. The more debt the firm has, the greater the dollar amount of this interest tax shield. The presence of the interest tax shield encourages firms to use debt financing in their capital structures.

17.5 Optimal Capital Structure

By the end of this section, you will be able to:

- Explain how increased use of leverage increases the possibility of financial distress.
- Explain how the possibility of financial distress impacts the cost of capital.
- Discuss the trade-offs a firm faces as it increases its leverage.
- Explain the concept of an optimal capital structure.

Debt and Financial Distress

The more debt a company uses in its capital structure, the larger the dollar value of the interest tax shield. Why, then, do we not see firms using a capital structure composed 100% of debt to maximize this interest tax shield?

The answer to this question lies in the fact that as a company increases its debt, there is a greater chance that the firm will be unable to make its required interest payments on the debt. If the firm has difficulty meeting its debt obligations, it is said to be in **financial distress**.

A firm in financial distress incurs both direct and indirect costs. The direct costs of financial distress include fees paid to lawyers, consultants, appraisers, and auctioneers. The indirect costs include loss of customers and suppliers.

Trade-Off Theory

Trade-off theory weighs the advantages and disadvantages of using debt in the capital structure. The advantage of using debt is the interest tax shield. The disadvantage of using debt is that it increases the risk of financial distress and the costs associated with financial distress.

A company has an incentive to increase leverage to exploit the interest tax shield. However, too much debt will make it more likely that the company will default and incur financial distress costs. Calculating the precise balance between these two is difficult if not impossible.

For companies with a low level of debt, the risk of default is low, and the main impact of an increase in leverage will be an increase in the interest tax shield. At some point, however, the tax savings that result from increasing the amount of debt in the capital structure will be just offset by the increased probability of incurring the costs of financial distress. For firms that have higher costs of financing distress, this point will be reached sooner. Thus, firms that face higher costs of financial distress have a lower optimal level of leverage than firms that face lower costs of financial distress.

LINK TO LEARNING

Netflix

Netflix has experienced phenomenal growth in the past 25 years. Starting as a DVD rental company, Netflix quickly shifted its model to content streaming. In recent years, the company has become a major producer of content, and it is currently the largest media/entertainment company by market capitalization. It is expensive for Netflix to fund the production of this content. Netflix has funded much of its content through selling debt.

You can view the company's explanation of this capital structure choice by looking at the answers the company provides to common investor questions (https://openstax.org/r/the-company-provides). You can also find the company's financial statements on its website and see how the level of debt on Netflix's balance sheet has increased over the past few years.

Figure 17.4 demonstrates how the value of a levered firm varies with the level of debt financing used. V_u is the value of the unlevered firm, or the firm with no debt. As the firm begins to add debt to its capital structure, the value of the firm increases due to the interest tax shield. The more debt the company takes on, the greater the tax benefit it receives, up until the point at which the company's interest expense exceeds its earnings before interest and taxes (EBIT). Once the interest expense equals EBIT, the firm will have no taxable income. There is no tax benefit from paying more interest after that point.

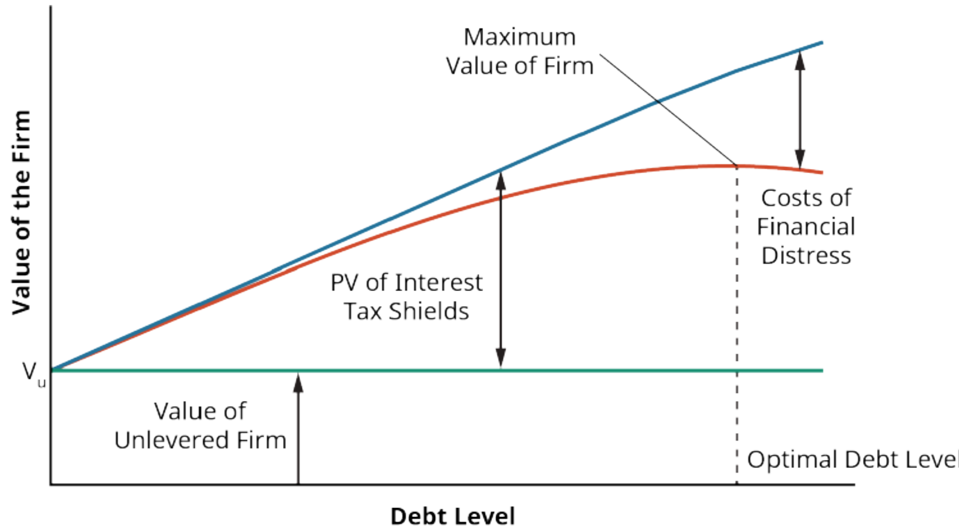

Figure 17.4 Maximum Value of a Levered Firm

As the firm increases debt and increases the value of the tax benefit of debt, it also increases the probability of facing financial distress. The magnitude of the costs of financial distress increases as the debt level of the company rises. To some degree, these costs offset the benefit of the interest tax shield.

The optimal debt level occurs at the point at which the value of the firm is maximized. A company will use this optimal debt level to determine what the weight of debt should be in its target capital structure. The optimal capital structure is the target. Recall that the market values of a company's debt and equity are used to determine the costs of capital and the weights in the capital structure. Because market values change daily due to economic conditions, slight variations will occur in the calculations from one day to the next. It is neither practical nor desirable for a firm to recalculate its optimal capital structure each day.

Also, a company will not want to make adjustments for minor differences between its actual capital structure and its optimal capital structure. For example, if a company has determined that its optimal capital structure is 22.5% debt and 77.5% equity but finds that its current capital structure is 23.1% debt and 76.9% equity, it is close to its target. Reducing debt and increasing equity would require transaction costs that might be quite significant.

Table 17.7 shows the average WACC for some common industries. The calculations are based on corporate information at the end of December 2020. A risk-free rate of 3% and a market-risk premium of 5% are assumed in the calculations. You can see that the capital structure used by firms varies widely by industry. Companies in the online retail industry are financed almost entirely through equity capital; on average, less than 7% of the capital comes from debt for those companies. On the other hand, companies in the rubber and tires industry tend to use a heavy amount of debt in their capital structure. With a debt weight of 63.62%, almost two-thirds of the capital for these companies comes from debt.

Industry Name	Equity Weight	Debt Weight	Beta	Cost of Equity	Tax Rate	After-Tax Cost of Debt	WACC
Retail (online)	93.33%	6.67%	1.16	8.82%	2.93%	2.19%	8.38%
Computers/peripherals	91.45%	8.55%	1.18	8.92%	3.71%	1.88%	8.32%
Household products	87.07%	12.93%	0.73	6.65%	5.06%	2.19%	6.07%
Drugs (pharmaceutical)	84.62%	15.38%	0.91	7.54%	1.88%	2.19%	6.72%

Table 17.7 Capital Structure, Cost of Debt, Cost of Equity, and WACC for Selected Industries (data source: Aswath Damodaran Online)

Industry Name	Equity Weight	Debt Weight	Beta	Cost of Equity	Tax Rate	After-Tax Cost of Debt	WACC
Retail (general)	82.41%	17.59%	0.90	7.49%	12.48%	1.88%	6.51%
Beverages (soft)	82.24%	17.76%	0.79	6.96%	3.32%	2.19%	6.11%
Tobacco	76.74%	23.26%	0.72	6.61%	8.69%	1.88%	5.51%
Homebuilding	75.34%	24.66%	1.46	10.29%	15.91%	2.19%	8.30%
Food processing	75.18%	24.82%	0.64	6.18%	8.56%	2.19%	5.19%
Restaurants/dining	74.79%	25.21%	1.34	9.72%	3.19%	2.19%	7.82%
Apparel	71.74%	28.26%	1.10	8.49%	4.75%	2.19%	6.71%
Farming/agriculture	68.94%	31.06%	0.87	7.37%	6.45%	1.88%	5.67%
Packaging & containers	64.47%	35.53%	0.92	7.61%	15.67%	1.88%	5.57%
Food wholesalers	64.10%	35.90%	1.03	8.17%	0.52%	2.19%	6.02%
Hotels/gaming	63.60%	36.40%	1.56	10.82%	2.02%	2.19%	7.68%
Telecom. services	54.60%	45.40%	0.66	6.30%	3.93%	1.40%	4.07%
Retail (grocery and food)	51.46%	48.54%	0.24	4.21%	13.52%	2.19%	3.23%
Air transport	38.26%	61.74%	1.61	11.04%	6.00%	2.19%	5.58%
Rubber & tires	36.38%	63.62%	1.09	8.47%	5.30%	1.88%	4.28%

Table 17.7 **Capital Structure, Cost of Debt, Cost of Equity, and WACC for Selected Industries** (data source: Aswath Damodaran Online)

Industries that have high betas, such as hotels/gaming and air transport, have high equity costs of capital. More recession-proof industries, such as food processing and household products, have low betas and low equity costs of capital. The WACC for each industry ends up being influenced by the weights of equity and debt the company chooses, the riskiness of the industry, and the tax rates faced by companies in the industry.

17.6 Alternative Sources of Funds

By the end of this section, you will be able to:

- Calculate the required return to preferred shareholders.
- Calculate the WACC of a firm that issues preferred shares.
- Discuss how issuing new equity impacts the cost of equity capital.
- Explain the functionality of convertible debt.

A company can finance its assets in two ways: through debt financing and through equity financing. Thus far, we have treated these sources as two broad categories, each with a single cost of capital. In reality, a company may have different types of debt or equity, each with its own cost of capital. The same principle would apply: the WACC of the firm would be calculated using the weights of each of these types multiplied by the cost of that particular type of debt or equity capital.

Preferred Shares

Although our calculations of WACC thus far have assumed that companies finance their assets only through debt and common equity, we saw at the beginning of the chapter that the basic WACC formula is

$$\text{WACC} = D\% \times r_{\text{d}}(1-T) + P\% \times r_{\text{pfd}} + E\% \times r_{\text{e}}$$

In addition to common stock, a company can raise equity capital by issuing **preferred stock**. Owners of preferred stock are promised a fixed dividend, which must be paid before any dividends can be paid to common stockholders.

In the order of claimants, preferred shareholders stand in line between bondholders and common shareholders. Bondholders are paid interest before preferred shareholders are paid annual dividends. Preferred shareholders are paid annual dividends before common shareholders are paid dividends. Should the company face bankruptcy, the same priority of claimants is followed in settling claims—first bondholders, then preferred stockholders, with common stockholders standing at the end of the line.

Preferred stock shares some characteristics with debt financing. It has a promised cash flow to its holders. Unlike common equity, the dividend on preferred stock is fixed and known. Also, there are consequences if those preferred dividends are not paid. Common shareholders cannot receive any dividends until preferred dividends are paid, and in some cases, preferred shareholders receive voting rights until they are paid the dividends that are due. However, preferred shareholders cannot force the company into bankruptcy as debt holders can. For tax and legal purposes, preferred stock is treated as equity.

The cost of the preferred equity capital is calculated using the formula

$$r_{\text{pfd}} = \frac{Div_{\text{pfd}}}{P_{\text{pfd}}}$$

Suppose that Greene Building Company has issued preferred stock that pays a dividend of $2.00 each year. If this preferred stock is selling for $21.80 per share, then the company's cost of preferred stock is

$$r_{\text{pfd}} = \frac{\$2.00}{\$21.80} = 9.17\%$$

THINK IT THROUGH

Calculating Common Equity Financing

Greene Building Company uses 40% debt, 15% preferred stock, and 45% common stock in its capital structure. The yield to maturity on the company's bonds is 7.2%. The cost of preferred equity is 9.17%. In the most recent year, Greene paid a dividend of $3.15 to its common shareholders. This dividend has been growing at a rate of 3.0% per year, which is expected to continue in the future. The company's common stock is trading for $32.25 per share. Greene pays a corporate tax rate of 21%. Estimate the WACC for Greene.

Solution:

The cost of Greene's common equity financing must be calculated. This can be done using the constant dividend growth model:

$$r_{\text{e}} = \frac{Div_1}{P_0} + g = \frac{(\$3.15 \times 1.03)}{\$32.25} + 0.03 = 0.1006 + 0.03 = 13.06$$

The weights and the costs for each component of capital are placed in the WACC formula:

$$\begin{aligned} \text{WACC} &= D\% \times r_{\text{d}}(1-T) + P\% \times r_{\text{pfd}} + E\% \times r_{\text{e}} \\ &= 40\% \times 0.0702(1-0.21) + 15\% \times 0.0917 + 45\% \times 0.1306 \\ &= 2.218\% + 1.3755\% + 5.8770\% = 9.4705\% \end{aligned}$$

The WACC for Greene Building Company is estimated to be 9.47%. Note that debt financing is the cheapest cost of capital for Greene. The reason for this is twofold. First, because debt holders face the least amount of risk because they are paid first in the order of claimants, they require a lower return. Second, because interest payments are tax-deductible, the interest tax shield lowers the effective cost of debt to the company. Preferred shareholders will require a higher rate of return than debt holders, 9.17%, because they are later in the order of claimants. Common shareholders are the residual claimants, standing at the end of the line to receive payment. After all other claimants are paid, any remaining money belongs to the shareholders. If this residual amount is small, the common shareholders receive a small payment. If there is nothing left after all other claimants have been paid, common shareholders receive nothing. Thus, common shareholders have the greatest amount of risk and require the highest rate of return.

Also, note that the weights for debt, preferred stock, and common stock in the capital structure sum to 100%. The company must finance 100% of its assets.

Issuing New Common Stock

An existing firm can acquire equity capital to expand its assets in two ways: the retention of earnings or the sale of new shares of stock. Thus far in the chapter, the cost of equity capital calculations have assumed that the earnings were being retained for equity capital financing.

The net income that is left after all expenses are paid is the residual income that belongs to the shareholders. Instead of receiving a fixed payment for letting the firm use their capital (like bondholders who receive fixed interest payments), the reward to shareholders for letting the company use their capital varies from year to year. In a good year, net income and the reward to shareholders is high. In a poor year, net income is low or perhaps even negative.

The net income can either be paid immediately and directly to shareholders in the form of dividends or be retained within the company to fund growth. Shareholders are willing to allow the company to retain these earnings because they expect that the money will be used to fund profitable projects, leading to an even larger reward for shareholders in future years.

Although managers do not need to actively solicit the funds that are retained to fund the business, managers cannot view these funds as costless. The shareholders will require a return on those funds to entice them to allow the company to delay paying the dollars to them immediately in terms of a dividend.

Suppose a company has $1 million in net income one year. If it pays $250,000 in dividends and retains $750,000, then it can finance $750,000 more in assets. If the company has a capital structure of 25% debt and 75% equity and wants to maintain that capital structure, it must increase its debt by $250,000 to balance the increase in equity. Thus, the company would be increasing its total financing by $1 million. Of that financing, 25% would be debt financing, and 75% would be equity financing.

To increase its assets by more than $1 million, the company would need to decide to either change its capital structure or issue new stock. Consider the firm represented by the market-value balance sheet in Figure 17.5. The firm has $900 million in assets. These assets are financed by $225 million in debt capital and $675 million in equity capital, resulting in a capital structure of 25% debt and 75% equity.

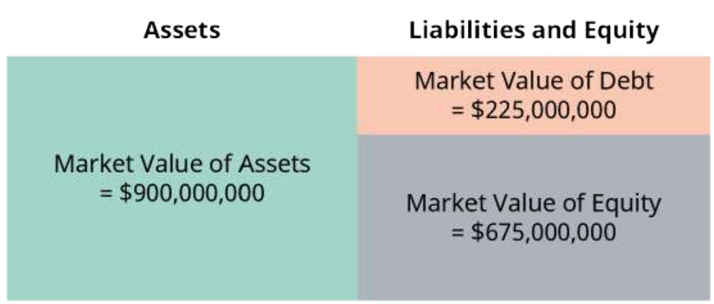

Figure 17.5 Market-Value Balance Sheet for a Company with $900 Million in Assets and a Capital Structure of 25% Debt and 75% Equity

The retained earnings of $750,000 cause the equity on the balance sheet to increase to $675.75 million. The company could sell $250,000 in bonds, increasing its debt to $225.25 million. Figure 17.6 shows the impact on the balance sheet. The company has increased its financing by $1,000,000 and can expand assets by $1,000,000. The capital structure remains 25% debt and 75% equity.

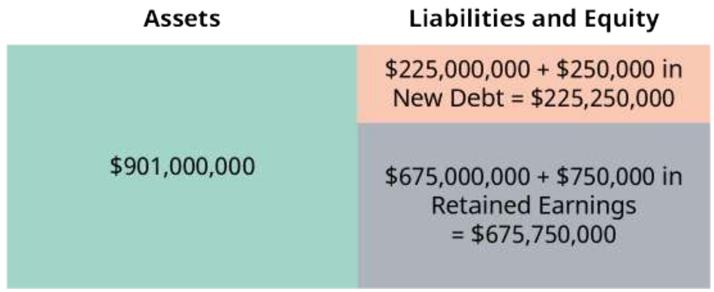

Figure 17.6 Balance Sheet with $1 Million Growth Financed through Retained Earnings and New Debt

What if the economy is in an expansionary period and this company thinks it has the opportunity to grow at a rate of 5%? The company knows that it will need more assets to be able to grow. If it needs 5% more assets, its assets will need to increase to $945 million. To increase the left-hand side of its balance sheet, the company will also need to increase the right-hand side of the balance sheet.

Where does the company get the $45 million in capital? With $750,000 in retained earnings, the company can increase its equity to $675.75 million, but if the remainder of $44.25 million was financed through debt, the company's capital structure would change. Its weight of debt would increase to $\frac{\$225{,}000{,}000 + \$44{,}250{,}000}{\$945{,}000{,}000} = 0.2849 = 28.49\%$.

If the company has determined that its optimal capital structure is 25% debt and 75% equity, financing the majority of the growth through debt would cause it to stray from these levels. Funding the growth while keeping the capital structure the same would require the firm to issue new shares. Figure 17.7 shows how the firm would need to finance $45 million in growth while maintaining its desirable capital structure. The firm would need to increase equity capital to $708.75 million; retained earnings could provide $750,000, but $33 million of new equity would need to be sold.

Figure 17.7 Balance Sheet with $45,000,000 in Financing Coming from Debt, Retained Earnings, and New Stock

Investors who are providing common equity financing require a return to entice them to let the company use their money. If this company has paid $0.50 per share in dividends to shareholders and this dividend is expected to increase by 3% each year, we can use the constant dividend growth model to estimate how much common shareholders require. If the stock is trading for $8.00 per share, the cost of common equity financing is estimated as

$$r_e = \frac{Div_1}{P_0} + g = \frac{\$0.515}{\$8} + 0.03 = 0.0644 + 0.03 = 0.0944 = 9.44\%$$

If, however, the firm must issue more equity, its cost of equity for those additional shares will be higher than 9.44%. Even if shareholders are willing to pay $8.00 per share for the stock, the firm will incur **flotation costs**; this means the firm will not receive the entire $8.00 to use to finance new assets and generate a profit for shareholders. Flotation costs include the costs of filing with the Securities and Exchange Commission (SEC) as well as the fees paid to investment bankers to place the new shares.

When new equity must be issued to finance the company, the flotation costs must be subtracted from the price of the stock to determine the net proceeds the firm will receive. The cost of this new equity capital is calculated as

$$r_{e\,-\,\text{new}} = \frac{Div_1}{P_0 - F} + g$$

where *F* represents the flotation costs of the new stock issue. If, in this example, the flotation cost is $0.25 per share, then the cost of raising new equity capital is

$$r_{e\,-\,\text{new}} = \frac{Div_1}{P_0 - F} + g = \frac{0.515}{\$8 - 0.25} + 0.03 = 0.0665 + 0.03 = 0.09 = 9.65\%$$

Issuing new common equity is the most expensive form of raising capital. Equity capital is already expensive because the common shareholders are the residual claimants who will only be paid if all other claimants are paid. Because of this risk, they require a higher rate of return than providers of capital who have precedence in the order of claimants. Flotation costs must be added to this equity cost when new shares are issued to grow the company.

THINK IT THROUGH

Cost of Issuing New Equity

You are a financial manager for American Motor Works (AMW). The target capital structure for the company is 30% debt and 70% equity. You know that your company's after-tax cost of debt is 4.6%. Your company paid a dividend of $3 per share last year, and it has a policy of increasing its dividend at a rate of 1.5% each year. AMW stock is currently trading for $27.50 per share. You estimate that the company's retained earnings will be $10 million this year. If the company needs to issue new shares of stock, flotation costs are expected to be $0.75 per share.

Given this information, you are tasked with calculating the company's WACC. You need to provide an estimate of WACC if retained earnings are used and an estimate if new equity must be issued.

Solution:

First, calculate the cost of equity capital for AMW using the constant dividend growth model:

$$r_e = \frac{Div_1}{P_0} + g = \frac{\$3.00(1.015)}{\$27.50} + 0.015 = 0.1107 + 0.015 = 0.1257 = 12.57\%$$

Using 12.57% as the equity cost of capital and 4.6% as the after-tax cost of debt, the WACC is calculated as

$$\begin{aligned}\text{WACC} &= D\% \times r_d(1 - T) + E\% \times r_e = 0.30(0.0460) + 0.70(0.1257)\\ &= 0.0138 + 0.0880 = 0.1018 = 10.18\%\end{aligned}$$

The WACC for AMW when it is using retained earnings for equity financing is 10.18%. If the company has $10 million in retained earnings this year, its equity will increase by $10 million. Given its target capital structure of 30% debt and 70% equity, AMW will be able to increase its overall financing by $\frac{\$10{,}000{,}000}{0.70} = \$14{,}285{,}714$ by using its retained earnings and issuing new debt of $4,285,714.

If AMW wants to expand its assets by more than $14,285,714 during the next year, it will need to issue new stock or increase the weight of debt in its capital structure. The company will incur flotation costs of $0.65 per share to issue new stock. The cost of new equity capital will be

$$r_e = \frac{Div_1}{P_0} + g = \frac{\$3.00(1.015)}{\$27.50 - \$0.75} + 0.015 = 0.1138 + 0.015 = 0.1288 = 12.88\%$$

With this more expensive newly issued equity capital, AMW's WACC will become

$$\begin{aligned} \text{WACC} &= D\% \times r_d(1-T) + E\% \times r_e = 0.30(0.0460) + 0.70(0.1288) \\ &= 0.0138 + 0.0902 = 0.1040 = 10.40\% \end{aligned}$$

If AMW wants to take on a large project that requires investment in more than $14,285,714 worth of assets, such as building a new production facility, the company will need to issue more equity and will face a higher WACC than when using retained earnings as its equity financing.

Convertible Debt

Some companies issue **convertible bonds**. These corporate bonds have a provision that gives the bondholder the option of converting each bond held into a fixed number of shares of common stock. The number of common shares the bondholder would receive for each bond is known as the **conversion ratio**.

Suppose that you own a convertible bond issued by Sheridan Sodas with a face value of $1,000 and a conversion ratio of 20 shares that matures today. If you convert the bond today, you will receive 20 shares of Sheridan common stock. If you do not convert, you will receive $1,000. If you convert, you are basically paying $1,000 for 20 shares of Sheridan stock. The **conversion price** is $\frac{\$1,000}{20} = \$50$. If Sheridan is trading for more than $50 per share, you would want to convert. If Sheridan is trading for less than $50 per share, you would not want to convert; you would prefer the $1,000. In other words, you will choose to convert whenever the stock price exceeds the conversion price at maturity.

A convertible bond gives the holder an option; the bondholder is able to choose between the face value cash or receiving shares of stock. Options always have a positive value to holders. It is always preferable to be able to choose $1,000 or shares of stock than to simply be given $1,000. There is a possibility that the shares of stock will be more valuable, and there is no way the choice can put you in a worse position.

Because holders of convertible bonds have the valuable option of conversion that holders of nonconvertible bonds do not have, convertible debt can be offered with a lower interest rate. It might seem as if the firm could lower its weighted average cost of capital by issuing convertible debt rather than nonconvertible debt. However, this is not the case. Remember that holders of convertible bonds choose whether they would prefer to convert the bond and become a stockholder or receive the face value of the bond at maturity.

If a bond has a face value of $1,000, the convertible bond holders will consider whether the stock they can convert to is worth more than $1,000. Only when the price of the stock has increased enough that the value of the stock received is more than $1,000 will the bondholders convert. However, this means that instead of paying $1,000, the firm is paying the bondholder in stock worth more than $1,000. In essence, the firm (and the current shareholders) would be selling an equity position in the company for less than the market price of that equity position. The lower interest rate compensates for the possibility that conversion will occur.

Summary

17.1 The Concept of Capital Structure

Capital structure refers to how a company finances its assets. The two main sources of capital are debt financing and equity financing. A cost of capital exists because investors want a return equivalent to what they would receive on an investment with an equivalent risk to persuade them to let the company use their funds. The market values of debt and equity are used to calculate the weights of the components of the capital structure.

17.2 The Costs of Debt and Equity Capital

The yield to maturity (YTM) on a company's outstanding bonds represents the return that debt holders are requiring to lend money to the company. Because interest expenses are tax-deductible, the cost of debt to the company is less than the YTM. The cost of equity capital is not directly observed, so financial managers must estimate this cost. Two common methods for estimating the cost of equity capital are the constant dividend growth model and the capital asset pricing model (CAPM).

17.3 Calculating the Weighted Average Cost of Capital

Calculate the weighted average cost of capital (WACC) using the formula

$$\text{WACC} = D\% \times r_{\text{d}}(1 - T) + P\% \times r_{\text{pfd}} + E\% \times r_{\text{e}}$$

Remember that the WACC is an estimate; different methods of estimating the cost of equity capital can lead to different estimations of WACC.

17.4 Capital Structure Choices

An unlevered firm uses no debt in its capital structure. A levered firm uses both debt and equity in its capital structure. In perfect financial markets, the value of the firm will be the same regardless of the firm's decision to use leverage. With the tax deductibility of interest expenses, however, the value of the firm can increase through the use of debt. As the level of debt increases, the value of the interest tax shield increases.

17.5 Optimal Capital Structure

A company wants to choose a capital structure that maximizes its value. Although increasing the level of financial leverage, or debt, in the capital structure increases the value of the interest tax shield, it also increases the probability of financial distress. As the weight of debt in the capital structure increases, the return that providers of both debt and equity capital require to entice them to provide money to the firm increases because their risk increases. Trade-off theory suggests that the value of a company that uses debt equals the value of the unlevered firm plus the value of the interest tax shield minus financial distress costs.

17.6 Alternative Sources of Funds

Preferred stock is a type of equity capital; the owners of preferred stock receive preferential treatment over common stockholders in the order of claimants. A fixed dividend is paid to preferred shareholders and must be paid before common shareholders receive dividends. Equity capital can be raised through either retaining earnings or selling new shares of stock. Significant flotation costs are associated with issuing new shares of stock, making it the most expensive source of financing. Convertible debt allows the debt holders to convert their debt into a fixed number of common shares instead of receiving the face value of the stock at maturity.

Key Terms

after-tax cost of debt the net cost of interest on a company's debt after taxes; the firm's effective cost of debt

capital a company's sources of financing

capital structure the percentages of a company's assets that are financed by debt capital, preferred stock capital, and common stock capital
conversion price the face value of a convertible bond divided by its conversion ratio
conversion ratio the number of shares of common stock receivable for each convertible bond that is converted
convertible bonds bonds that can be converted into a fixed number of shares of common stock upon maturity
financial distress when a firm has trouble meeting debt obligations
financial leverage the debt used in a company's capital structure
flotation costs costs involved in the issuing and placing of new securities
interest tax shield the reduction in taxes paid because interest payments on debt are a tax-deductible expense; calculated as the corporate tax rate multiplied by interest payments
levered equity equity in a firm that has debt outstanding
net debt a company's total debt minus any cash or risk-free assets the company holds
preferred stock equity capital that has a fixed dividend; preferred shareholders fall in between debt holders and common stockholders in the order of claimants
trade-off theory a theory stating that the total value of a levered company is the value of the firm without leverage plus the value of the interest tax shield less financial distress costs
unlevered equity equity in a firm that has no debt outstanding
weighted average cost of capital (WACC) the average of a firm's debt and equity costs of capital, weighted by the fractions of the firm's value that correspond to debt and equity

CFA Institute

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Multiple Choice

1. Sandage Auto Parts has debt outstanding with a market value of $2 million. The company's common stock has a book value of $3 million and a market value of $8 million. What weight is equity in Sandage's capital structure?
   a. 11%
   b. 20%
   c. 60%
   d. 80%

2. The capital structure of a company refers to ________.
   a. whether the company purchases assets or liabilities with its equity
   b. the proportion of debt and equity the company uses in financing is assets
   c. the ability of the company to use its assets to generate equity for the owners
   d. whether the company uses short-term assets or long-term assets to create its product

3. Which of the following should be used when calculating the weights for a company's capital structure?
   a. Book values
   b. Current market values
   c. Historic accounting values
   d. Par and face values

4. Two methods for estimating a company's cost of common stock capital are ________.

a. the historic method and the current method
b. the weighted valuation model and the beta model
c. the constant dividend growth model and the CAPM
d. the balance sheet method and the face value method

5. Which of the following would be the most reasonable approach to calculating the cost of debt for a company?
a. Using the coupon rate on the company’s existing bonds
b. Using the interest amount reported on the income statement
c. Using the yield to maturity on the company’s existing bonds
d. Multiplying the amount of debt on the company’s balance sheet by the risk-free rate

6. Net debt equals ________.
a. Debt/Equity
b. Debt × (1 – Tax Rate)
c. total debt minus the cash and risk-free assets the company owns
d. the yield to maturity of a company’s bonds divided by the tax rate

7. *Unlevered equity* refers to ________.
a. the equity in a firm with no debt
b. a firm’s equity minus the firm’s debt
c. the equity in a firm in the absence of taxation and transaction costs
d. the portion of a firm’s capital structure that is financed by its owners

8. In perfect capital markets, ________.
a. a company’s WACC does not change as it changes its capital structure
b. a company can lower its WACC by using more debt in its capital structure
c. a company can lower its WACC by using more equity in its capital structure
d. a company’s cost of debt capital is exactly equal to its cost of equity capital when the company uses 50% debt and 50% equity in its capital structure

9. The interest tax shield occurs because ________.
a. interest payments are a tax-deductible expense
b. interest payments are made from after-tax income
c. investors require a lower rate of return the higher the company’s tax rate
d. investors require a lower rate of return the more debt the company incurs

10. As a company increases the weight of debt in its capital structure, ________.
a. its cost of debt capital falls
b. the weight of equity capital also increases
c. the value of the interest tax shield decreases
d. its possibility of financial distress increases

11. A company is said to be in financial distress if ________.
a. it is not fully exploiting the interest tax shield
b. it needs to raise capital to finance a new project
c. it has difficulty meeting its debt obligations
d. its cost of equity capital exceeds its cost of debt capital

12. Issuing new stock ________.

a. costs the same as retaining earnings
b. will not impact a company's WACC
c. is the most expensive source of capital because of flotation costs
d. is the cheapest source of capital because dividends do not have to be paid each year

13. If a bond with a face value of $1,000 has a conversion ratio of 10 shares, the conversion price is _______.
a. $0.01
b. $10
c. $100
d. $1,000

Review Questions

1. Why does a company's capital have a cost?
2. Why is the rate that debt holders require to entice them to lend money to a company different from the company's effective cost of debt capital?
3. Assume that the corporate tax rate is 21%. Congress is discussing increasing the corporate tax rate to 32%. How might this change the capital structures that companies choose?
4. Describe the order of claimants and how it impacts the returns that various providers of capital require to entice them to provide funding to a company.
5. Explain what is meant by *trade-off theory.*

Problems

1. SodaFizz has debt outstanding that has a market value of $3 million. The company's stock has a book value of $2 million and a market value of $6 million. What are the weights in SodaFizz's capital structure?
2. The yield to maturity on SodaFizz's debt is 7.2%. If the company's marginal tax rate is 21%, what is SodaFizz's effective cost of debt?
3. SodaFizz paid a dividend of $2 per share last year; its dividend has been growing at a rate of 2% per year, and that growth rate is expected to continue into the future. The stock of SodaFizz is currently trading at $19.50 per share. According to the constant dividend growth model, what is the cost of equity capital for SodaFizz?
4. SodaFizz has a beta of 1.1. If the risk-free rate is 3% and the market risk premium is 11%, what is the cost of equity capital for SodaFizz according to the capital asset pricing model?
5. Given the answers to Problems 1, 2, and 3, what is SodaFizz's WACC when the constant dividend growth model is used to calculate its equity cost of capital?
6. Given the answers to Problems 1, 2, and 4, what is SodaFizz's WACC when the CAPM is used to calculate SodaFizz's equity cost of capital?
7. Shirley Manufacturing paid $1 million in interest payments last year. The company is in the 21% tax bracket and has $15 million in debt outstanding. How much was the company's interest tax shield last year?
8. King Medical Supplies has issued preferred stock that pays a yearly dividend of $4 per share. This preferred stock is trading at a price of $47 per share. What is King's cost of preferred stock capital?
9. McPherson Pharmaceutical has common stock that is trading for $75 per share. The company paid a

dividend of $5.25 last year. This dividend is expected to increase at a rate of 3% per year. What is the cost of equity capital for McPherson? If McPherson issues new shares with a flotation cost of $2 per share, what is the company's cost of new equity?

Video Activity

Calculating the Weighted Average Cost of Capital

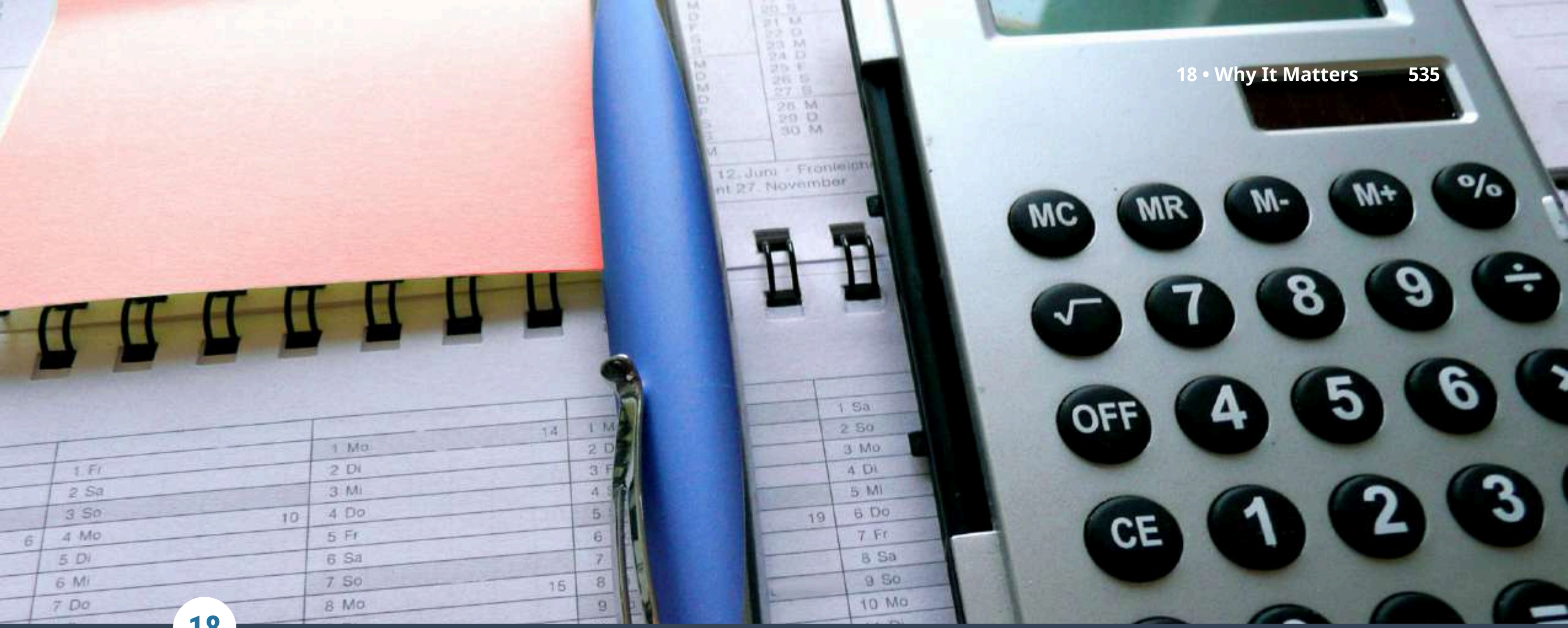
Click to view content (https://openstax.org/r/WACC)

1. What is the formula for calculating WACC? What do each of the components of this formula represent?
2. In the video, the tax rate for Brick and Mortar Co. was 30%. What would your calculation of the company's WACC be if there was a change in the tax code and the tax rate for Brick and Mortar Co. fell to 15%? Why does the tax rate impact a firm's WACC? Do you think the managers of Brick and Mortar Co. should consider making any changes to its capital structure if the tax rate falls to 15%? Why or why not?

Capital Structure for Real Estate Companies

Click to view video content (https://openstax.org/r/optimal-capital)

3. Why doesn't one optimal capital structure exist for commercial real estate businesses?
4. How do you think a family that runs a multigenerational commercial real estate business will think about risk compared to a young entrepreneur who is beginning to build a commercial real estate business? How do you think the capital structures of these two entities are likely to compare? How would those capital structures likely be linked to the risk profiles of the two companies?



18 Financial Forecasting

Figure 18.1 Forecasts are an important financial tool. (credit: modification of “Red Post-It Label, Calculator and Ballpen” by photosteve101/flickr, CC BY 2.0)

Chapter Outline

Why It Matters

Though no one in business has a crystal ball, managers must often do all they can to predict the future as accurately as possible. This is called *forecasting*. Accounting and finance professionals use past performance along with what they know about the business, its competitors, the economy, and the company’s plans for the future to assemble detailed financial forecasts. Forecasts are useful to many individuals for different reasons. A budget, a type of static **forecast**, helps accountants and managers see how their plans for the coming year can be achieved. It outlines sales targets and how much can be spent on cost of goods sold and expenses to achieve the company’s bottom-line (net income) targets. Investors use financial forecasts to help guide their decisions to buy, sell or hold stocks or to estimate future potential income through dividends. Perhaps most importantly, for our purposes in finance, forecasts are used to help predict and manage cash flows.

A business can have all the profit in the world at the end of the year, but if it doesn’t raise enough cash (liquidity) to pay the bills and pay its employees halfway through the year, it could still go bankrupt despite being profitable. Forecasting sales and expenses helps assemble a cash forecast—when sales will be collected and when expenses will be paid—so that financial managers can look forward far enough to have enough time to react accordingly and secure short- or long-term financing to meet gaps in cash flow.

18.1 The Importance of Forecasting

Learning Outcomes

By the end of this section, you will be able to:

- Discuss how to use financial statements in forecasting firm financials.
- Explain why balance sheet items are important in forecasting a firm’s financial result.
- Explain why income statement items are important in forecasting a firm’s financial result.

In this section, we will briefly review some of the basic elements of financial statements and how we can analyze historical statements to help assemble financial forecasts. Financial forecasting is important to short- and long-term firm success. It helps a firm plan for the resources it will need, ensuring it will have enough cash on hand at the right time to cover daily operations and capital expenditures. It helps the firm communicate its future potential and manage its shareholders’ expectations. It also helps management assess future risk and set plans in place to mitigate that risk.

Financial forecasting involves using historical data, analysis tools, and other information we can gather to make an educated guess about the future financial performance of the firm. Historical figures provide a reasonable starting point. We use tools such as ratios, common size, and trend analysis to fine-tune our forecast. And finally, we assess what we know about the firm, its competitors, the economy, and anything else that might impact performance and further fine-tune our forecast from there.

It’s important to take a moment to consider the role of ethics in forecasting. Ethics is a huge issue in the world of accounting and finance in general, and forecasting is no different. There can be tremendous pressure on management to perform, to deliver certain levels of profit, and to meet shareholder expectations.

Forecasting, as you will learn throughout this chapter, is not an exact science. There is a great deal of subjectivity that can come into play when forecasting sales and expenses. Ethical behavior is crucial in this area. Those who create forecasts must have a firm understanding of where their data comes from, how reliable it is, and whether or not their assumptions and projections are reasonably justified.

Financial Statement Foundations

In Financial Statements, you were introduced to a firm called Clear Lake Sporting Goods. You learned about the four key financial statements: the **income statement**, **balance sheet**, **statement of stockholders’ equity**, and **statement of cash flows**. Each one provides a different view of the firm’s financial health and performance.

Clear Lake Sporting Goods is a small merchandising company (a company that buys finished goods and sells them to consumers) that sells hunting and fishing gear. It uses financial statements to understand its profitability and current financial position, to manage cash flow, and to communicate its finances to outside parties such as investors, governing bodies, and lenders. We will use Clear Lake’s company information and historical financial statements in this chapter as we explore its forecasting process. It’s important to note that in this chapter, we are focusing on just one firm and the one method its managers have chosen to forecast financial performance. There are a variety of types of firms in actual application, and they may choose to forecast their financial performance differently. We are demonstrating just one approach here.

The balance sheet shows all the firm’s assets, liabilities, and equity at one point in time. It also supports the accounting equation in a very clear and transparent way. We find one section of the balance sheet contains all current and noncurrent assets that must total the other section of the balance sheet: total liabilities and equity. In Figure 18.2, we see that Clear Lake Sporting Goods has total assets of $250,000 in the current year, which balances with its total liabilities and equity of $250,000.

Clear Lake Sporting Goods Comparative Year-End Balance Sheets		
	Prior Year	**Current Year**
Assets		
Current Assets:		
Cash	$ 90,000	$110,000
Accounts Receivable	20,000	30,000
Inventory	35,000	40,000
Short-Term Investments	15,000	20,000
Total Current Assets	160,000	200,000
Noncurrent Assets:		
Equipment	40,000	50,000
Total Assets	$200,000	$250,000
Liabilities		
Current Liabilities:		
Accounts Payable	60,000	75,000
Unearned Revenue	10,000	25,000
Total Current Liabilities	70,000	100,000
Noncurrent Liabilities:		
Notes Payable	40,000	50,000
Total Liabilities	$110,000	$150,000
Stockholder Equity		
Common Stock	75,000	80,000
Ending Retained Earnings	15,000	20,000
Total Stockholder Equity	90,000	100,000
Total Liabilities and Stockholder Equity	$200,000	$250,000

Figure 18.2 Balance Sheet

The income statement reflects the performance of the firm over a period of time. It includes net sales, cost of goods sold, operating expenses, and net income. In Figure 18.3, we see that Clear Lake had $120,000 in net sales, $60,000 in cost of goods sold, and $35,000 in net income in the current year.

Clear Lake Sporting Goods Comparative Year-End Income Statements		
	Prior Year	**Current Year**
Gross Sales	$105,000	$126,000
Sales Returns & Allowances	5,000	6,000
Net Sales	100,000	120,000
Cost of Goods Sold	50,000	60,000
Gross Profit	50,000	60,000
Rent Expense	5,000	5,500
Depreciation Expense	2,500	3,600
Salaries Expense	3,000	5,400
Utility Expense	1,500	2,500
Operating Income	38,000	43,000
Interest Expense	3,000	2,000
Income Tax Expense	5,000	6,000
Net Income	$ 30,000	$ 35,000

Figure 18.3 Full Income Statement

Finally, the statement of cash flows is used to reconcile net income to cash balances. The statement begins with net income, then reflects adjustments to balance sheet accounts and noncash expenses. The statement of cash flows is broken down into three key categories: operating, investing, and financing. This allows users to clearly see what elements of the business are generating or using cash. In Figure 18.4, we see that Clear Lake had cash flow from **operating activities** of $53,600, cash used for **investing activities** of ($18,600), and cash used for **financing activities** of ($15,000).

Clear Lake Sporting Goods Statement of Cash Flows Indirect Method		
Cash Flow from Operating Activities		
Net Income		$ 35,000
Adjustment to Reconcile Net Income to Net Cash Flow from Operating Activities:		
Depreciation	$3,600	
Accounts Receivable Increase	(10,000)	
Inventory Increase	(5,000)	
Accounts Payable Increase	15,000	
Unearned Revenue Increase	15,000	18,600
Net Cash Flow from Operating Activities		53,600
Cash Flow from Investing Activities		
Purchase of Short-Term Investments	(5,000)	
Cost of New Plant Assets	(13,600)	
Net Cash Flow: Investing Activities		(18,600)
Cash Flow from Financing Activities		
Additional Notes Payable	10,000	
Issuance of Common Stock	5,000	
Payment of Dividends	(30,000)	
Net Cash Flow from Financing Activities		(15,000)
Total Cash Flow Increase/Decrease		20,000
Beginning Cash Balance		90,000
Ending Cash Balance		$110,000

Figure 18.4 Statement of Cash Flows

Another key concept to remember about the financial statements is that the statement of cash flows is necessary to truly understand how the firm is using and generating cash. A common misconception is that if a firm reports net income on its income statement, then it must have plenty of cash, and if it reports a loss, it must be short on cash. Although this can be true, it's not necessarily the case. Historically speaking, we need the statement of cash flows to get the full picture of how cash was used or generated in the past. Looking to the future, we need a cash flow forecast to plan for possible gaps in cash flow and, potentially, how to make the best use of any cash surplus. Throughout this chapter, we will see how to use historical financial statements to help develop the future cash forecast.

It's also important to remember that the four financial statements are tied together. Net income from the income statement feeds into retained earnings, which live on the balance sheet. Equity balances on the balance sheet feed information to the statement of stockholders' equity. And information from both the income statement (net income and noncash expenses) and the balance sheet (changes in working capital accounts) all feed into the statement of cash flows. These relationships will be helpful to understand when using historical statements and preparing forecasts.

Balance Sheet Analysis

Fully understanding the items that are on the balance sheet and how they relate to one another and to other financial statements will help you create a financial forecast. In Financial Statements, you learned that on the classified balance sheet, both assets and liabilities are broken down into current and noncurrent categories. You also know that the balance sheet must live up to its name—it must balance. This means that total assets (what the company owns) must equal total liabilities and equity (what the company owes).

You continued your financial statement development in Measures of Financial Health, where you saw how to use elements of the balance sheet to assess financial health. Ratios based on balance sheet accounts can be useful for understanding relationships between balance sheet items—how they related in the past and then, in forecasting, how those relationships might change or remain the same in the future. Examples of balance sheet ratios include the current ratio, quick ratio, cash ratio, debt-to-assets ratio, and debt-to-equity ratio.

In Financial Statements, you also explored common-size analysis. To prepare a **common-size** analysis of the balance sheet, every item on the statement must be expressed as a percentage of total assets. Seeing each item as a percentage—that is, seeing its relationship to total assets—is also helpful for assessing historical statements and how those percentages or relationships can be used to predict future balances in the forecast. For example, in Figure 18.5, you can see that Clear Lake's current assets represented 80% of its total assets in both the current and prior years.

Clear Lake Sporting Goods Comparative Year-End Balance Sheets				
	Prior Year	Prior Year %	Current Year	Current Year %
Assets				
Current Assets:				
Cash	$ 90,000	45%	$110,000	44%
Accounts Receivable	20,000	10%	30,000	12%
Inventory	35,000	18%	40,000	16%
Short-Term Investments	15,000	8%	20,000	8%
Total Current Assets	160,000	80%	200,000	80%
Noncurrent Assets:				
Equipment	40,000	20%	50,000	20%
Total Assets	$200,000	100%	$250,000	100%
Liabilities				
Current Liabilities:				
Accounts Payable	60,000	30%	75,000	30%
Unearned Revenue	10,000	5%	25,000	10%
Total Current Liabilities	70,000	35%	100,000	40%
Noncurrent Liabilities:				
Notes Payable	40,000	20%	50,000	20%
Total Liabilities	$110,000	55%	$150,000	60%
Stockholder Equity				
Common Stock	75,000	38%	80,000	32%
Ending Retained Earnings	15,000	8%	20,000	8%
Total Stockholder Equity	90,000	45%	100,000	40%
Total Liabilities and Stockholder Equity	$200,000	100%	$250,000	100%

Figure 18.5 Common-Size Balance Sheet

Income Statement Analysis

Like balance sheet analysis, income statement analysis is also quite helpful in preparing for the forecasting process. In Financial Statements, you learned that the income statement is commonly broken down into a few sections. Cost of goods sold is deducted from net sales to arrive at gross margin. Gross margin refers to the profits earned solely on the sale of the product itself, without consideration for the expenses incurred to run the business. Next, operating expenses are deducted to reflect operating income. Operating income reflects the profits of the core business function. Finally, other items, such as interest expense, tax expense, and other gains and losses, are deducted to arrive at net income, a.k.a. the *bottom line*. Each segment of the income statement is helpful for assessing past performance and estimating future expenses for a forecast.

You continued your financial statement development in Measures of Financial Health, where you saw how to use elements of the income statement to assess historical financial performance. Ratios based on the income statement can be useful for understanding relationships between net sales and expenses—how they related in the past and then, in forecasting, how those relationships might change or remain the same. Examples of income statement ratios include gross margin, operating margin, and profit margin. Common ratios that incorporate items from both the balance sheet and the income statement include return on assets (ROA), return on equity (ROE), inventory turnover, accounts receivable turnover, and accounts payable turnover.

LINK TO LEARNING

Performance Trends

Review the most recent annual report for Big 5 Sporting Goods (https://openstax.org/r/annual_report_for_Big_5_Sporting-Goods). Review the company's sales and gross margins for the current and past two years. How is their performance? Are their sales trending up or down? Why might the contribution margin have increased or decreased?

In Financial Statements, you also explored common-size analysis. To prepare a common-size analysis of the income statement, every item on the statement must be expressed as a percentage of net assets. Seeing each item as a percentage, in terms of its relationship to total sales, is also helpful for assessing historical statements and how those percentages or relationships can be used to predict future balances in the forecast. For example, in Figure 18.6, you can see that Clear Lake's cost of goods sold represented 50% of its net sales in both the current and prior years.

Clear Lake Sporting Goods
Comparative Year-End Income Statements

	Prior Year	Prior Year %*	Current Year	Current Year %*
Gross Sales	$105,000		$126,000	
Sales Returns & Allowances	5,000		6,000	
Net Sales	100,000	100%	120,000	100%
Cost of Goods Sold	50,000	50%	60,000	50%
Gross Profit	50,000	50%	60,000	50%
Rent Expense	5,000	5%	5,500	5%
Depreciation Expense	2,500	3%	3,600	3%
Salaries Expense	3,000	3%	5,400	5%
Utility Expense	1,500	2%	2,500	2%
Operating Income	38,000	38%	43,000	36%
Interest Expense	3,000	3%	2,000	2%
Income Tax Expense	5,000	5%	6,000	5%
Net Income	$ 30,000	30%	$ 35,000	29%

**Some figures are rounded to the nearest whole percent, which may alter the total percentage to plus or minus 100%.*

Figure 18.6 Common-Size Income Statement

18.2 Forecasting Sales

Learning Outcomes

By the end of this section, you will be able to:

- Explain how sales are the main driver for a financial forecast.
- Determine a past time period to formulate the basis for a financial forecast.
- Explain the advantages and disadvantages of using past data to forecast future financial performance.
- Calculate past sales growth averages.
- Justify adjusting relationships when forecasting future financial performance.

In this section of the chapter, you will begin to explore the first step of creating a forecast: forecasting sales. We will discuss common time frames for sales forecasts and why we use historical data in our forecasts (but only with caution), and we will work through the process of forecasting future sales. We will be using the percent-of-sales method to forecast some expenses for Clear Lake Sporting Goods, the example used throughout the chapter. This method relies on sales data, further highlighting why accuracy in forecasting sales is crucial.

Sales as the Driver

A significant portion of a business's costs are driven by how much it sells. Thus, the sales forecast is the necessary first step in preparing a financial forecast. Common costs driven by sales include direct product costs, direct labor costs, and other key variable costs (i.e., costs that vary proportionately to sales), such as sales commissions.

Looking to the Past

Forecasting sales is not always an easy task, as no one knows the future. We can, however, use the information we do have to forecast future sales with the greatest accuracy possible. Most firms start by looking at the past. A firm may look at past sales from a variety of prior periods. It's common to look at the past 12 months to estimate the coming 12 months. Looking at 12 consecutive months helps identify seasonality of sales trends, what time of year sales tend to drop off and when they increase, possible sales spikes that might reoccur, and any other trends that tend to appear over a 12-month period. In Figure 18.7, we see Clear Lake's sales by month for the past 12 months.

Past data is often used in conjunction with probabilities and weighted average calculations derived from probabilities. Though used in several areas of forecasting, this approach is particularly common in drafting the sales forecast. Using multiple scenarios and the probability of each scenario occurring is a common approach to estimating future sales.

Clear Lake Sporting Goods Monthly Sales													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year
Gross Sales	9,000	11,000	9,000	10,000	14,000	19,000	18,000	12,000	8,000	6,000	5,000	5,000	$126,000

Figure 18.7 Historical Sales Data

We can see at first glance that sales remain fairly steady from January to April. Sales then goes up significantly in April and May, seem to peak in June, taper off a bit in July, then decline steeply from August to the end of the year, with the lowest sales being in November and December. Though not exact, it's easy to quickly see that sales follow a seasonal pattern. We will focus on just one year of data here to keep things simple. However, it's important to note that when a firm has a seasonal sales pattern, it normally uses more than one year of data to detect and evaluate the pattern. It's not uncommon for firms to have a seasonal sales pattern that fluctuates based on an external factor such as weather patterns, patterns in business or demand, or other factors such as holidays. Common examples might include farm-based businesses that function on a weather pattern for harvesting and selling crops or a toy company that fluctuates around gift-giving holidays.

This knowledge is helpful when assembling a first pass at the next year's sales forecast. Using common-size and horizontal (trend) analyses on sales is also helpful, as shown in Figure 18.8. We can see the exact percentages that sales went up or down each month:

- In January, the company had sales of $9,000, which was 7.1% ($\$9.000/\$126{,}000$) of the total annual sales.
- In June, the company had $19,000 sales, which was 15.1 ($\$19{,}000/\$126{,}000$) of the total annual sales and 211% ($\$19{,}000/\$9{,}000$) of January sales.

Clear Lake Sporting Goods Monthly Sales as Percentages													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year
Gross Sales	9,000	11,000	9,000	10,000	14,000	19,000	18,000	12,000	8,000	6,000	5,000	5,000	$126,000
% of Annual Sales	7.1%	8.7%	7.1%	7.9%	11.1%	15.1%	14.3%	9.5%	6.3%	4.8%	4.0%	4.0%	100.0%
% Change from January Baseline	100%	122%	100%	111%	156%	211%	200%	133%	89%	67%	56%	56%	

Figure 18.8 Historical Sales Data as Percentages

Once a baseline in the 12-month period is assessed, it can also be helpful to look for trends in other ways. For example, the past several years might be assessed to see if there is a trend in total growth or decline for those years on a summary basis or by period. Clear Lake Sporting Goods had sales in the current year of $126,000, in the prior year of $105,000, and two years ago of $89,000. This reflects a 20% increase and an 18% increase, respectively. It might be reasonable to expect a roughly 18 to 20% increase in total sales in the future with only this information in mind. Keep in mind that we will learn about many other factors to consider in the forecast, so the 18 to 20% increase is a good general guideline to consider along with other factors.

THINK IT THROUGH

Sales Forecast for Big 5 Sporting Goods

Review the 2020 annual report for Big 5 Sporting Goods (https://openstax.org/r/2020_annual_report_for_Big_5_Sporting_Goods). Locate the consolidated statements of operations on page F-7. Using the company's net sales figures for the current and prior years, what percentage might you recommend for their sales forecast for the next year?

Solution:

Big 5's sales for 2020 and 2019 were $1,041,212,000 and $996,495,000, respectively. This represents a 4.5% growth from the prior year. Forecasted sales, based solely on this information, might be appropriate at 4.5% growth for the next year, keeping in mind that many other factors should also be considered along with this information. Historical sales are only one set of data to use as a starting point.

Looking at Figure 18.9, assume that Clear Lake Sporting Goods decides to take its first pass at a forecast using the more conservative estimate of 18% total sales growth. The company could consider last year's sales of $126,000 and increase them by 18% to arrive at total forecasted sales for next year of $\$148{,}680$ ($\$126{,}000 \times 118\%$). Next, to get the monthly sales, the company could use the same percent of the total for each month that it did for the previous year. For example, sales in January of last year were 7.1% of the full year's sales. To find the forecast for the next year, the company would take the forecasted sales of $148,680 for the year and multiply that by 7.1% to get $10,620 for January. The process is repeated for each month to get the full year.

Clear Lake Sporting Goods Forecasted Monthly Income Statements													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Next Year
Gross Sales	10,620	12,980	10,620	11,800	16,520	22,420	21,240	14,160	9,440	7,080	5,900	5,900	$148,680
% of Annual Sales	7.1%	8.7%	7.1%	7.9%	11.1%	15.1%	14.3%	9.5%	6.3%	4.8%	4.0%	4.0%	100.0%
% Change from January Baseline	100%	122%	100%	111%	156%	211%	200%	133%	89%	67%	56%	56%	

Figure 18.9 Forecasted Sales Data

Keep in mind that this is only a starting point. These estimates will be reviewed, assessed, and updated as more information and other factors are taken into consideration.

It can also be helpful to look at a shorter period, perhaps just the last few months, on a more detailed basis (by department, by customer, etc.) to see if there are any possible new trends beginning to develop that might be an indicator of performance in the coming year. For example, Clear Lake Sporting Goods might look at detailed sales records for October, November, and December and see that it had an old product line that was discontinued in early October, which contributed to a 2% reduction in monthly sales. This reduction in monthly sales will likely continue into the new year until the new line the company has signed on begins arriving in stores. Thus, the management team feels they should reduce their first quarter monthly estimates by 2%, as reflected in Figure 18.10. January is now $\$10{,}408\ (\$10{,}620 \times 98\%)$, for example.

Clear Lake Sporting Goods Forecasted Monthly Income Statements													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gross Sales	10,408	12,720	10,408	11,800	16,520	22,420	21,240	14,160	9,440	7,080	5,900	5,900	$147,996

Figure 18.10 Adjusted Forecasted Sales Data

Changes for the Future

It's important to note that the past is not always a reliable predictor of the future. Circumstances can often change to make the future quite different from the past. The business itself may change, the economy can change, the customer base may undergo a shift in demographics or a change in buying habits, new competition may emerge, and so on. So while past performance is helpful, it is only one step in the process of forecasting sales.

LINK TO LEARNING

Big 5 Sporting Goods MD&A Report

Review the most recent annual report for Big 5 Sporting Goods (https://openstax.org/r/annual_report_for_Big_5_Sporting_Goods). Review the management's discussion and analysis (MD&A) report (Item 7). What information does the report share about the firm, the economy, and other factors that might be useful for forecasting sales growth for next year?

Most firms first look to the past to target some form of baseline estimate for the coming year; then, managers begin making adjustments based on what they know about the future. Assume that Clear Lake Sporting Goods will be adding a new brand to its collection of fishing supplies in March. The manufacturer plans to begin running its commercials in late February, which managers anticipate will increase Clear Lake's monthly sales by about $500 in March, $1,000 in April, $1,400 in May, and $2,000 per month in June, July, and August. We see the monthly adjustments to Clear Lake's latest sales forecast in Figure 18.11. March, for example, is now $10,908 ($10,408 prior estimate plus $500 increase from new brand).

Clear Lake Sporting Goods Forecasted Monthly Income Statements													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gross Sales	10,408	12,720	10,908	12,800	18,020	24,420	23,240	16,160	9,440	7,080	5,900	5,900	$156,996

Figure 18.11 Forecasted Sales Data with New Brand

What we have discussed here are only some brief examples of the myriad factors that might impact a sales budget for the coming year. It's critical that all members of the team take the time and effort to research their customers and the factors that impact their business in order to effectively assess the impact of these factors on future sales. Though only two adjustments were made here, it's likely that a large firm would have to consider many, many factors that would ultimately impact monthly sales figures before arriving at a conclusion.

18.3 Pro Forma Financials

Learning Outcomes

By the end of this section, you will be able to:

- Define pro forma in the context of a financial forecast.
- Describe the factors that impact the length of a financial forecast.
- Explain the risks associated with a financial forecast.

In this section of the chapter, we will move beyond the sales forecast and look at the general nature, length, and timeline of forecasts and the risks associated with using them. We'll look at why we use them, how long they generally are, what the key variables in a forecast are, and how we pair those variables with common-size analysis to develop the forecast.

Purpose of a Forecast

As mentioned earlier in the chapter, forecasts serve different purposes depending on who is using them. Our focus here, however, is the world of finance. In this realm, the key purpose of **pro forma** (future-looking) financial statements is to manage a firm's cash flow and assess the overall value that the firm is generating through future sales growth. Growing just for the sake of growing doesn't always yield favorable income for the firm. A larger top-line sales figure that results in lower net income doesn't make sense in the grand scheme of things. The same is true of profitable sales that don't generate enough cash flows at the right time. The firm may make a profit, but if it doesn't manage the timing of its cash flows, it could be forced to shut down if it can't cover the costs of payroll or keep the lights on. Forecasting helps assess both cash flow and the profitability of future growth. Managers can forecast cash flow using data from forecasted financial statements; this allows them to identify potential gaps in cash and plan ahead in order to either alter collection and payment policies or obtain funding to cover the gap in the timing of cash flows.

LINK TO LEARNING

Pro Forma Financial Statements

Review the video Business Plan and Pro-Forma Financial Statements (https://openstax.org/r/Business_Plan_and_Pro-Forma_Financial_Statements) to learn about the basics of pro forma financial statements and why they are helpful.

Length of a Forecast

Forecasts can generally be for any length of time. The length generally depends on the user's needs. A one-year forecast, broken down by month, is quite typical. A firm will often go through a formal budgeting process near the end of its calendar or fiscal year to project financial plans and goals for the coming year. Once that is done, a rolling financial forecast is then done monthly to adjust as time moves on, more information becomes available, and circumstances change.

To be useful, the future forecast for financial planning purposes is almost always calculated as monthly increments rather than one total figure for the next 12 months. Breaking the data down by month allows finance managers to more clearly see fluctuations in cash flows in and out, identify potential gaps in cash flow, and plan ahead for their cash needs.

Forecasts can also be done for several years into the future. In fact, they commonly are. However, once the firm is looking out beyond 12 months, it gets difficult to forecast items with a great degree of accuracy. Often, forecasts beyond a year will be completed only to quarterly or even annual figures rather than monthly. Forecasts that far into the future are often strategic in nature, made more to communicate future plans for the firm than for more detailed decision-making and cash flow planning.

Common-Size Financials

As we saw earlier in the chapter, common-size analysis involves using historical financial statements as a basis for future forecasts. Financial statements provide a great starting point for analysis, as we can see the relationships between sales and costs on the income statement and the relationships between total assets and line items on the balance sheet.

For example, in Figure 18.6, we saw that for the past two years, cost of goods sold has been 50% of sales. Thus, in the first draft of a forecast for Clear Lake, it's likely that managers would estimate cost of goods sold at 50% of their forecasted sales. We can begin to see why forecasting sales first is crucial and why doing so as accurately as possible is also important.

Select Variables to Use

A simple way to begin a full financial statement forecast might be to simply use the common-size statements and forecast every item using historical percentages. It's a logical way to begin a very rough draft of the forecast. However, several variables should be taken into consideration. First, managers must address the cost of an account and determine if it's a variable or fixed item. Variable costs tend to vary directly and proportionally with production or sales volume. Common examples include direct labor and direct materials. Fixed costs, on the other hand, do not change when production or sales volume increases or decreases within the relevant range. Granted, if production were to increase or decrease by a large amount, fixed costs would indeed change. However, in normal month-to-month changes, fixed costs often remain the same. Common examples of fixed costs include rent and managerial salaries.

So, if we were to approach our common-size income statement, for example, we would likely use the percentage of sales as a starting point to forecast variable items such as cost of goods sold. However, fixed costs may not be accurately forecast as a percentage of sales because they won't actually change with sales. Thus, we would likely look at the history of the dollar values of fixed costs in order to forecast them.

CONCEPTS IN PRACTICE

COVID-19 Makes Forecasting Difficult for Big 5 Sporting Goods

Big 5 Sporting Goods announced record earnings in the third quarter of 2020, attributing its huge success that quarter to the impact of people's reactions to the COVID-19 pandemic. With so many people in quarantine still wanting to make healthy lifestyle choices, sporting goods stores were making record sales. Record-breaking sales, however, are not certain in the future. The impacts of the pandemic are extremely difficult to predict, making it a challenge for Big 5 Sporting Goods and other companies to assemble pro forma financial statements.

(sources: https://www.globenewswire.com/news-release/2020/10/27/2115470/0/en/Big-5-Sporting-Goods-Corporation-Announces-Record-Fiscal-2020-Third-Quarter-Results.html; https://finance.yahoo.com/news/investors-want-big-5-sporting-054658521.html; https://www.cpapracticeadvisor.com/accounting-audit/news/21206691/four-ways-covid19-will-impact-2021-financial-forecasting-and-planning)

Determine Potential Changes in Variables

So far, we have focused on using historical common-size statements to create a draft (not a final version) of the forecast. This is because the past isn't always a perfect indicator of the future, and our finances don't always follow a linear pattern. We use the past as a good starting point; then, we must assess what else we know to fine-tune and make adjustments to the forecast.

Many items impact the forecast, and they will vary from one organization to another. The key is to do research, gather data, and look around at the market, the economy, the competition, and any other factors that have the potential to impact the future sales, costs, and financial health of the company. Though certainly not an exhaustive list, here are a few examples of items that may impact Clear Lake Sporting Goods.

- It has an old product line that was discontinued in early October, contributing to a 2% reduction in monthly sales that will likely continue into the new year until a new line begins arriving in stores.
- It will be adding a new brand to its collection of fishing supplies in March. The manufacturer plans to begin running commercials in late February. Managers anticipate that this will increase Clear Lake's monthly sales by about $500 in March, $1,000 in April, $1,400 in May, and $2,000 per month in June, July, and August.
- The company has just finished updating its employee compensation package. It goes into effect in January of the new year and will result in an overall 4% increase in the cost of labor.
- The landlord indicated that rent will increase by $50 per month starting July 1.
- Some fixed assets will be fully depreciated by the end of March. Thus, depreciation expense will go down by $25 per month beginning in April.
- There are rumors of new regulations that will impact the costs of importing some of the more difficult-to-obtain hunting supplies. Managers aren't entirely sure of the full impact of the new legislation at this time, but they anticipate that it could increase cost of goods sold for the affected product line when the new legislation goes into effect in the last quarter. Their best estimate is that it could increase the overall cost of goods sold by up to 2%.

We will use all of this data later in the chapter when we are ready to compile a complete forecast for Clear Lake.

18.4 Generating the Complete Forecast

Learning Outcomes

By the end of this section, you will be able to:

- Generate a forecasted income statement that incorporates pertinent sales, functional, and policy variables.
- Generate a forecasted balance sheet.
- Connect the balance sheet and income statement forecasts with appropriate feedback linkages.

In this section of the chapter, we will tie together what we have learned so far about forecasting sales, common-size analysis, and using what we know about the company and its environment to create a full set of pro forma (forward-looking or forecasted) financial statements.

Forecast the Income Statement

To arrive at a fully forecasted income statement, we use historical income statements, common-size income statements, and any additional information we have about future sales and costs, such as the effects of the economy and competition. As we saw earlier in the chapter, we begin with forecasted sales because they are the basis for many of the forecasted costs.

Let's begin with the sales forecast for Clear Lake Sporting Goods that we saw earlier in the chapter, in Figure 18.9, and use it along with the prior year income statement by month shown in Figure 18.12. We will consider other data we have about the business to begin creating a full income statement (see Figure 18.13).

Clear Lake Sporting Goods
Prior Year Monthly Income Statements

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year	Current Year %
Gross Sales	9,000	11,000	9,000	10,000	14,000	19,000	18,000	12,000	8,000	6,000	5,000	5,000	$126,000	
% of Annual Sales	7.1%	8.7%	7.1%	7.9%	11.1%	15.1%	14.3%	9.5%	6.3%	4.8%	4.0%	4.0%	100.0%	
% Change from January Baseline	100%	122%	100%	111%	156%	211%	200%	133%	89%	67%	56%	56%		
Sales Returns & Allowances	300	400	400	600	800	1,000	800	600	400	300	200	200	6,000	
Net Sales	8,700	10,600	8,600	9,400	13,200	18,000	17,200	11,400	7,600	5,700	4,800	4,800	120,000	100%
Cost of Goods Sold	4,785	5,830	4,730	4,700	5,940	8,100	7,740	5,700	3,800	2915	2,880	2,880	60,000	50%
Gross Margin	3,915	4,770	3,870	4,700	7,260	9,900	9,460	5,700	3,800	2,785	1,920	1,920	60,000	50%
Rent Expense	458	458	458	458	458	458	458	458	458	458	458	458	5,500	5%
Depreciation Expense	300	300	300	300	300	300	300	300	300	300	300	300	3,600	3%
Salaries Expense	450	450	450	450	450	450	450	450	450	450	450	450	5,400	5%
Utility Expense	179	218	179	198	278	377	357	238	159	119	99	99	2,500	2%
Operating Income	2,528	3,343	2,483	3,293	5,774	8,315	7,895	4,254	2,433	1,458	612	612	43,000	36%
Interest Expense	167	167	167	167	167	167	167	167	167	167	167	167	2,000	2%
Income Tax Expense	353	467	346	460	806	1,160	1,102	594	339	203	85	85	6,000	5%
Net Income	2,009	2,710	1,970	2,667	4,802	6,988	6,626	3,493	1,927	1,088	360	360	$ 35,000	29%

Figure 18.12 Prior Year Monthly Income Statement by Month

The first two key points regarding product lines have already been built into the sales forecast. Notice that the cost of goods sold was 50% in the prior year. However, based on possible future legislation, to be conservative, we should increase the cost of goods sold by 2% in the last quarter of the year. Thus, we will forecast cost of goods sold at 50% of sales in the first nine months and increase it to 52% in the last three months of the year.

Rent is a fixed cost that historically amounts to $458 per month. However, we know that the landlord is increasing rent by $50 starting on July 1. Thus, we will forecast rent at the same fixed cost of $458 per month for the first six months and increase it to $508 per month for the second half of the year.

Depreciation, also a fixed cost, was historically $300 per month. However, we know that depreciation expense will go down by $25 beginning in April. Thus, we forecast depreciation at $300 for the first three months and at $275 for the last 9 months.

Salaries expense has historically been $450 per month. However, we know that the company is implementing a new compensation program on January 1 that will increase salaries expense by 4% ($18). Thus, we will forecast salaries for the whole year at $468.

Utilities expense seems to vary somewhat by sales from month to month, as shops are open longer hours during their busy season. However, the total utilities expense is not expected to change for the coming year. Thus, the forecast for utilities expense remains at $2,500, broken down by month as a percentage of sales.

Interest expense is a fixed cost and isn't anticipated to change. Thus, the same $167 interest expense per month is forecast for the coming year.

Finally, income tax expense is forecasted as a percentage of operating income because tax liability is incurred as a direct result of operating income. Figure 18.13 shows the next 12 months' forecast for Clear Lake Sporting Goods using all of this data.

Clear Lake Sporting Goods
Forecasted Monthly Income Statements

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gross Sales	$10,408	$12,720	$10,908	$12,800	$18,020	$24,420	$23,240	$16,160	$9,440	$7,080	$5,900	$5,900	$156,996
% of Annual Sales	7.1%	8.7%	7.1%	7.9%	11.1%	15.1%	14.3%	9.5%	6.3%	4.8%	4.0%	4.0%	100%
% Change from January Baseline	100%	122%	105%	123%	173%	235%	223%	155%	91%	68%	57%	57%	
Sales Returns & Allowances	300	400	400	600	800	1,000	800	600	400	300	200	200	6,000
Net Sales	10,108	12,320	10,508	12,200	17,220	23,420	22,440	15,560	9,040	6,780	5,700	5,700	150,996
Cost of Goods Sold	5,054	6,160	5,254	6,100	8,610	11,710	11,220	7,780	4,520	3,526	2,964	2,964	75,861
Gross Margin	5,054	6,160	5,254	6,100	8,610	11,710	11,220	7,780	4,520	3,254	2,736	2,736	75,134
Rent Expense	458	458	458	458	458	458	508	508	508	508	508	508	5,798
Depreciation Expense	300	300	300	275	275	275	275	275	275	275	275	275	3,375
Salaries Expense	468	468	468	468	468	468	468	468	468	468	468	468	5,616
Utility Expense	175	214	183	215	303	411	391	272	159	119	99	99	2,640
Operating Income	3,652	4,720	3,844	4,683	7,106	10,098	9,578	6,257	3,110	1,884	1,386	1,386	57,705
Interest Expense	167	167	167	167	167	167	167	167	167	167	167	167	2,000
Income Tax Expense	510	659	536	654	991	1,409	1,336	873	434	263	193	193	8,052
Net Income	$ 2,976	$ 3,895	$ 3,141	$ 3,863	$ 5,948	$ 8,522	$ 8,075	$ 5,218	$2,510	$1,455	$1,026	$1,026	$ 47,653

Figure 18.13 Forecasted Income Statement

Forecast the Balance Sheet

Now that we have a reasonable income statement forecast, we can move on to the balance sheet. The balance sheet, however, is entirely different from the income statement. It requires a bit more research and additional assumptions. Just like the income statement, it's often a work in progress. A first draft is a good starting point, but adjustments must be made once it is created, and all the interrelationships between the statements, cash flow in particular, are taken into consideration.

The balance sheet is a bit more difficult to forecast because the statement reflects balances at just a given point in time. Account balances change daily, so forecasting just one snapshot in time for each month can be a challenge. A good starting point is to assess general company financial policies or rules of thumb. For example, assume that Clear Lake pays most of its vendors on net 30-day terms. A good way to forecast accounts payable on the balance sheet might be to add up the cost of goods sold from the forecasted income statement for the prior month. For example, in Figure 18.14, we see that Clear Lake has forecasted its accounts payable for March as the cost of goods sold in March from its forecasted income statement.

For accounts receivable, Clear Lake generally receives payment from customers within net 90-day terms. Thus, it uses the sum of the current and prior two months' forecasted sales to estimate its accounts receivable balance.

Inventory will vary throughout the year. For the first six months, the company tries to build inventory for four months of sales. Once the busy season hits, inventory goes down to three months' worth of future sales, then finally drops to only two months of sales in December. Thus, managers use their sales forecast by month to estimate their inventory ending balance each month.

The equipment balance is forecasted by reducing the prior month's balance by the forecasted depreciation expense on the forecasted income statement.

Unearned revenue is historically around 50% of the current month's sales. Thus, Clear Lake estimates its unearned revenue balance each month by taking the current month's net sales from the forecasted income statement and multiplying it by 50%.

Short-term investments, notes payable, and common stock are not anticipated to change, so the current balance is forecasted to remain the same for the next 12 months.

To forecast the ending balance for retained earnings for each month, managers add the monthly net income from the forecasted balance sheet to the prior balance and subtract a quarterly $10,000 dividend.

Once all of these accounts are completed, the balance sheet is out of balance. Given that all of these events are somewhat related but are not tied together dollar for dollar, it's not surprising when the forecasted balance sheet is finished and does not balance. To complete the first draft (see Figure 18.14), the cash account is used as a variable and plugged in to make the balance sheet balance. Notice that by the end of the year, the company has $59,905 in cash. However, look at what happens midyear—the cash account falls to only $8,782. In the next section, we will generate a cash flow forecast, which will allow Clear Lake to update its balance sheet forecast once it estimates what it will do to cover the cash flow gaps.

Clear Lake Sporting Goods
Forecasted Monthly Balance Sheets

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Assets												
Current Assets:												
Cash	$42,581	$38,259	$19,083	$11,150	$12,345	$8,782	$16,175	$20,842	$21,733	$40,099	$60,834	$59,905
Accounts Receivable	25,408	32,028	37,736	45,136	52,248	63,348	75,280	78,640	70,460	53,820	37,080	27,220
Inventory	22,568	26,124	31,674	37,640	39,320	35,230	23,520	15,826	11,010	9,454	5,928	8,018
Short-Term Investments	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Total Current Assets	110,557	116,411	108,493	113,925	123,913	127,360	134,975	135,308	123,202	123,373	123,842	115,142
Noncurrent Assets:												
Equipment	50,000	49,700	49,400	49,100	48,825	48,550	48,275	48,000	47,725	47,450	47,175	46,900
Total Assets	160,557	166,111	157,893	163,025	172,738	175,910	183,250	183,308	170,927	170,823	171,017	162,042
Liabilities												
Current Liabilities:												
Accounts Payable	5,054	6,160	5,254	6,100	8,610	11,710	11,220	7,780	4,520	3,526	2,964	2,964
Unearned Revenue	2,527	3,080	2,627	3,050	4,305	5,855	5,610	3,890	2,260	1,695	1,425	1,425
Total Current Liabilities	7,581	9,240	7,881	9,150	12,915	17,565	16,830	11,670	6,780	5,221	4,389	4,389
Noncurrent Liabilities:												
Notes Payable	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Total Liabilities	57,581	59,240	57,881	59,150	62,915	67,565	66,830	61,670	56,780	55,221	54,389	54,389
Stockholder Equity												
Common Stock	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000
Ending Retained Earnings	22,976	26,871	20,012	23,875	29,823	28,345	36,420	41,638	34,147	35,602	36,628	27,653
Total Stockholder Equity	102,976	106,871	100,012	103,875	109,823	108,345	116,420	121,638	114,147	115,602	116,628	107,653
Total Liabilities and Stockholder Equity	$160,557	$166,111	$157,893	$163,025	$172,738	$175,910	$183,250	$183,308	$170,927	$170,823	$171,017	$162,042

Figure 18.14 Forecasted Balance Sheet Draft

Linkages between the Forecasted Balance Sheet and the Income Statement

Notice that in the discussion in the prior section on the balance sheet forecast, a lot of the information in the forecasted income statement was used to generate the forecasted balance sheet. The balance sheet accounts generally depend on activity reported in the income statement. For example, for many firms, the balance in their accounts receivable account is tied to their sales. Looking at historical balances in the accounts receivable account and how those relate to historical sales will help determine how to use the forecasted future sales to estimate the future balance of accounts receivable.

The same is true of accounts payable. Looking at past balances, past expenses (normally cost of goods sold), and the firm's payment terms for its vendors allows managers to use forecasted cost of goods sold or other expenses to estimate the balance in the accounts payable account.

We learned in Financial Statements that net income flows into retained earnings. Thus, the net income from the forecasted income statement can be used to help estimate the ending balance in retained earnings. If the firm intends to issue any dividends in the coming year, managers should also estimate that reduction in their forecast.

It's also common to find other general policies or procedures that help drive performance and aid in forecasting balances. For example, if the company has a goal of maintaining a certain level of inventory or a minimum balance in its cash account, that information can be used to guide the estimate for those accounts.

18.5 Forecasting Cash Flow and Assessing the Value of Growth

Learning Outcomes

By the end of this section, you will be able to:

- Generate a cash flow forecast.
- Assess a cash flow forecast to determine future cash funding needs.
- Use pro forma financial statements and cash flow forecasts to assess the value of growth to the firm.

In this section of the chapter, we will use the forecasted income statement, forecasted balance sheet, and other information we know about the firm's policies and goals for the coming year to generate and assess a cash flow forecast.

Create a Cash Flow Forecast

A cash flow forecast isn't overly complex, yet it is not easy to assemble because it requires making many assumptions about the future. A **cash forecast** begins with the beginning cash balance, adds anticipated cash inflows, and deducts anticipated cash outflows. This identifies cash surpluses and shortages.

For Clear Lake Sporting Goods, for example, we see in Figure 18.15 that the company begins with cash of $42,581,000 in January of the new year. Next, it lists the cash inflows, or cash received from customers. Given the assumption that customers pay in 90-day terms, the cash flow is filled in by plugging in the sales forecast for the three prior months. For example, the cash flow from customers of $10,508 for June is the same as the net sales forecast for March (see Figure 18.13).

Clear Lake Sporting Goods
Cash Forecast

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beginning Cash Balance	$42,581	$44,394	$43,039	$35,038	$35,782	$40,861	$35,030	$35,133	$35,766	$36,658	$53,444	$64,383
Cash Inflows:												
Accounts Receivable Collected	5,700	4,800	4,800	10,108	12,320	10,508	12,200	17,220	23,420	22,440	15,560	9,040
Total Cash Inflows:	$ 5,700	$ 4,800	$ 4,800	$10,108	$12,320	$10,508	$12,200	$17,220	$23,420	$22,440	$15,560	$ 9,040

Figure 18.15 Forecasted Cash Inflows

Next, Clear Lake identifies cash outflows, which include accounts payable, salaries, rent, utilities, dividends, and interest payments. Accounts payable are normally paid within 30 days, so the forecast for cost of goods sold for the prior month is used as an estimate of amount paid for payables. For example, in Figure 18.16, we see that the accounts payable settled in June of $8,610 is the cost of goods sold for May from the forecasted income statement.

Salaries are paid monthly and thus represent the same recurring monthly cash outflow, as does rent. Utilities, like accounts payable, are assumed to be paid within 30 days. Thus, the cash outflow for utilities is the utilities expense for the prior month from the forecasted income statement.

Management intends to pay a quarterly dividend of $10,000. Thus, in Figure 18.16, we see $10,000 cash outflows forecasted for March, June, September, and December. Interest on the long-term liability is paid quarterly. Thus, the $500 cash outflows in March, June, September, and December are simply the monthly interest expense of $167 from the income statement, summed for each quarter.

Clear Lake Sporting Goods Cash Forecast	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beginning Cash Balance	$42,581	$44,394	$43,039	$35,038	$35,782	$40,861	$35,030	$35,133	$35,766	$36,658	$53,444	$64,383
Cash Inflows:												
Accounts Receivable Collected	5,700	4,800	4,800	10,108	12,320	10,508	12,200	17,220	23,420	22,440	15,560	9,040
Total Cash Inflows:	5,700	4,800	4,800	10,108	12,320	10,508	12,200	17,220	23,420	22,440	15,560	9,040
Cash Outflows:												
Accounts Payable Paid	2,880	5,054	6,160	5,254	6,100	8,610	11,710	11,220	7,780	4,520	3,526	2,964
Salaries	450	468	468	468	468	468	468	468	468	468	468	468
Rent	458	458	458	458	458	458	508	508	508	508	508	508
Utilities	99	175	214	183	215	303	411	391	272	159	119	99
Dividends	0	0	10,000	0	0	10,000	0	0	10,000	0	0	10,000
Interest Payments	0	0	500	0	0	500	0	0	500	0	0	500
Total Cash Outflows:	$ 3,888	$ 6,155	$17,800	$ 6,364	$ 7,242	$20,339	$13,097	$12,587	$19,528	$ 5,655	$ 4,621	$14,539

Figure 18.16 Forecasted Cash Inflows and Outflows

Using a Cash Forecast to Determine Additional Funds Needed

Finally, at the end of the cash flow forecast, cash outflows are subtracted from the cash inflows. This identifies whether a **cash surplus** (extra) or **cash deficit** (not enough) exists for each month. For example, in Figure 18.17, we see that in March, Clear Lake is forecasting $4,800 of cash inflows and $17,800 of total cash outflows, which results in a cash deficit of $13,000.

Clear Lake has a general policy to not let its cash balance fall below $35,000. Thus, managers need to assess their monthly balances and potential deficits and identify months when financing is necessary. For example, the deficit of $13,000 in March is enough to push the cash balance lower than $35,000. Thus, it's estimated that the company will need $5,000 in short-term financing in March. It has an estimated surplus in April, so $3,000 of the borrowing is returned.

Clear Lake Sporting Goods Cash Forecast	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beginning Cash Balance	$42,581	$44,394	$43,039	$35,038	$35,782	$40,861	$35,030	$35,133	$35,766	$36,658	$53,444	$64,383
Cash Inflows:												
Accounts Receivable Collected	5,700	4,800	4,800	10,108	12,320	10,508	12,200	17,220	23,420	22,440	15,560	9,040
Total Cash Inflows:	5,700	4,800	4,800	10,108	12,320	10,508	12,200	17,220	23,420	22,440	15,560	9,040
Cash Outflows:												
Accounts Payable Paid	2,880	5,054	6,160	5,254	6,100	8,610	11,710	11,220	7,780	4,520	3,526	2,964
Salaries	450	468	468	468	468	468	468	468	468	468	468	468
Rent	458	458	458	458	458	458	508	508	508	508	508	508
Utilities	99	175	214	183	215	303	411	391	272	159	119	99
Dividends	0	0	10,000	0	0	10,000	0	0	10,000	0	0	10,000
Interest Payments	0	0	500	0	0	500	0	0	500	0	0	500
Total Cash Outflows:	3,888	6,155	17,800	6,364	7,242	20,339	13,097	12,587	19,528	5,655	4,621	14,539
Cash Surplus or Deficit	1,812	(1,355)	(13,000)	3,744	5,079	(9,832)	(897)	4,633	3,892	16,785	10,939	(5,499)
Short-Term Financing Borrowed (Repaid)	0	0	5,000	(3,000)	0	4,000	1,000	(4,000)	(3,000)	0	0	0
Ending Cash Balance	$44,394	$43,039	$35,038	$35,782	$40,861	$35,030	$35,133	$35,766	$36,658	$53,444	$64,383	$58,884

Figure 18.17 Forecasted Cash Surplus or Deficit

Assessing the Value of Growth

It's a fairly common assumption that most, if not all, businesses want to grow. While it certainly can be good as a firm to grow in size, growth just for the sake of growth isn't necessarily a good goal. A firm can grow in size based on customers, employees, locations, or simply sales. However, that doesn't mean that the growth will increase profits. Growth may increase profits, but this is not a safe assumption. Scaling up operations takes careful planning, which includes monitoring the profitability of the sales and, of course, the cash flow it would require. Growing a business can require more inventory, more locations, more equipment, and more manpower, all of which cost money. Even if the forecasted growth is profitable, it may pose problems from a cash flow perspective. It’s important that the firm review not only its forecasted income statement and balance sheet but also its cash forecast, as this can reveal some serious gaps in funding depending on the extent, timing, and nature of the planned growth.

For example, assume that Clear Lake Sporting Goods intends to run a large-scale ad campaign to boost sales in its busy season. Historically, the store relied primarily on its prime location for high volumes of retail foot traffic. Managers felt, however, that given the increase in competition, they could boost sales significantly by running the ad campaign in the first quarter. The campaign would cost $30,000. Forecasts already reflect a cash deficit at the end of the first quarter of $13,000, so the additional $30,000 ad campaign, which would require payment up front, would create a much larger need for funding. It’s also important that managers look at the increased cost of doing business along with the increased cost in advertising to ensure that the move would be profitable. Fortunately, Excel or other forecasting software can be used to create a forecast with formulas that tie together, making **scenario analysis** such as this a much easier process.

Scenarios in Forecasting

Forecasting is almost never a linear process. In other words, we don’t do one forecast and call it good. The first draft is completed using historical data, and then changes are made a bit at a time as all potential variables are assessed for their impact on the forecast. It’s quite common to then use the work-in-progress forecast to complete scenario analysis. This is particularly true when the forecast is completed in Excel or other budgeting or forecasting software. Elements of the forecast can be changed to see what the overall impact would be to the firm. Assuming the forecast is set up using formulas in Excel or other software, a change to one figure or one variable would then “ripple” through the forecast to reflect the overall impact.

Often, a firm may complete an initial forecast (scenario) under the assumption that the economy is in a “normal state.” The firm can then alter the initial forecast for different scenarios, such as the economy in a recession or the economy in a state of expansion. This helps the firm understand different possible future states and highlights how changes in the economy such as inflation may cause revenue and expenses to increase.

Assume that Clear Lake’s initial forecast is created under the assumption that the economy will remain average. Management also wants to know the worst-case scenario. What will their financial results look like if the economy were in a recession, for example? If management assumes their sales would drop to only 60% of the prior year sales in a recessionary economy, they could alter the formula in Excel driving their sales and variable costs, resulting in a new pro forma income statement. In Figure 18.18, we can see that net income would drop to $16,391 under this assumption, compared to the net income of $47,653 forecasted under average economy assumptions in Figure 18.13.

Clear Lake Sporting Goods
Forecasted Monthly Income Statements: Worst-Case Scenario

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gross Sales	$5,292	$6,468	$5,792	$7,000	$9,900	$13,400	$12,800	$9,200	$4,800	$3,600	$3,000	$3,000	$84,252
% of Annual Sales	7.1%	8.7%	7.1%	7.9%	11.1%	15.1%	14.3%	9.5%	6.3%	4.8%	4.0%	4.0%	100%
% Change from January Baseline	100%	122%	109%	132%	187%	253%	242%	174%	91%	68%	57%	57%	
Sales Returns & Allowances	300	400	400	600	800	1,000	800	600	400	300	200	200	6,000
Net Sales	4,992	6,068	5,392	6,400	9,100	12,400	12,000	8,600	4,400	3,300	2,800	2,800	78,252
Cost of Goods Sold	2,496	3,034	2,696	3,200	4,550	6,200	6,000	4,300	2,200	1,716	1,456	1,456	39,304
Gross Margin	2,496	3,034	2,696	3,200	4,550	6,200	6,000	4,300	2,200	1,584	1,344	1,344	38,948
Rent Expense	458	458	458	458	458	458	508	508	508	508	508	508	5,798
Depreciation Expense	300	300	300	275	275	275	275	275	275	275	275	275	3,375
Salaries Expense	468	468	468	468	468	468	468	468	468	468	468	468	5,616
Utility Expense	175	214	192	231	327	443	423	304	159	119	99	99	2,786
Operating Income	1,095	1,594	1,278	1,767	3,021	4,556	4,326	2,745	790	214	(6)	(6)	21,373
Interest Expense	167	167	167	167	167	167	167	167	167	167	167	167	2,000
Income Tax Expense	153	222	178	247	422	636	604	383	110	30	(1)	(1)	2,982
Net Income	$ 775	$1,205	$ 933	$1,354	$2,433	$ 3,753	$ 3,555	$2,195	$ 513	$ 17	$(172)	$(172)	$16,391

Figure 18.18 Forecasted Cash Surplus or Deficit

Though creating a full forecast in Excel can be a bit complex, it is a powerful tool that is useful for analysis. Elements can be used to vary just about anything, from something small such as a 1% increase in the cost of a product to a company-wide increase in salaries, the introduction of an entire new product line, or the purchase of a new production machine, among other possibilities.

For example, assume that Clear Lake has completed a first pass at its forecast and is reviewing the forecasted profit for the next 12 months. Managers feel the profit is currently low, as they always want to target a certain percentage. They might tinker with variables in the forecast file to see the impact on profits of potential changes they are considering. They may reduce the new salaries package by a percentage point to see if it gets them closer to their goal. They may adjust cost of goods sold by a certain percentage if they feel they can negotiate with vendors to work down their costs. They may adjust rent and see if they can find a better retail location to either reduce costs or increase sales due to increased foot traffic in a new location. They may save an entirely new version of the forecast and change it drastically to see what investing in opening a second retail location would do.

As you can see, the list of possibilities is endless. Though the main goal of financial managers may be cash planning, the power of a well-developed forecast is tremendous. It can help assess potential growth, new opportunities, and even small changes in the business as well.

Sensitivity Analysis in Forecasting

Sensitivity analysis will often look at the change in just one variable rather than the entire scenario. It examines how sensitive a particular output (commonly net income) will be to a change in a particular underlying input (sales or costs, for example). What if sales are 10% more or less than forecasted? What if the prices the firm can charge its customers are 10% more or less? What if the cost of goods sold increases by 10%? The purpose is to see which variables are crucial to "get right." It isn't worth spending a lot of research dollars to make sure you are accurately predicting a variable if that variable won't notably change the outcome. However, a slight change in other variables may have significant impact.

Using pro forma financial statements created in Excel allows management to quickly generate new pro forma financials and see the impact that each possible variable might have on the overall financial results.

18.6 Using Excel to Create the Long-Term Forecast

Learning Outcomes

By the end of this section, you will be able to:

- Generate a financial statement forecast using spreadsheet tools.
- Connect the balance sheet and income statement using appropriate formula referencing.
- Use spreadsheet functions to generate appropriate iterations that balance financial forecasts.

Throughout this chapter, we have seen forecasted financial statements for Clear Lake Sporting Goods along with its forecasted cash flow. These statements could all have been generated by hand, of course, but that wouldn't be an effective use of time. As mentioned in prior sections, several different types of software can be quite effective in making the forecasting process faster and more flexible. In this section, we will review just one common option, Microsoft Excel.

Download the spreadsheet file (https://openstax.org/r/spreadsheet_file) containing key Chapter 18 Excel exhibits.

Using the "Sheet"

Creating a budget in Excel can be very simple or extremely complex, depending on the size and complexity of the business and the number of formulas and dependencies that are written into the Excel workbook.

Creating the forecast in Excel follows the same steps and flow we just explored in this chapter but with the power of a software program to do the math for you. We begin with the sales forecast, which uses several key formulas in Excel.

1. First, sales are projected to be 18% higher than the prior year. Thus, a total projection for the year is calculated using a simple link and multiplication function tied to last year's total sales. In Figure 18.19, you can see the formula in cell O4 is "='Figure 18.12'!N4*1.18". This formula simply does the math to increase the prior year's sales by 18%.
2. Next, the sales are distributed by month. In Figure 18.19, we see in cell B5 that the forecasted income statement sheet is linked to the percent of annual sales from the Prior Year Income Statement (Figure 18.12) sheet. Then, in cell B4, January sales are estimated with a formula that multiplies the total forecasted sales in O4 by the percent of annual sales for January of the prior year. Notice that the formula then multiplies that product by 0.98. This is because Clear Lake discontinued a product line in the last quarter of the prior year, and management feels that this will reduce sales in the first quarter of the new year by roughly 2%.

	A	B	O
1	**Clear Lake Sporting Goods**		
2	**Forecasted Monthly Income Statements**		
3		**Jan**	**Next Year**
4	Gross Sales	=($O4*B5)*0.98	='Figure 18.12'!N4*1.18
5	% of Annual Sales	='Figure 18.12'!B5	=O4/$O4

Figure 18.19 Forecasted Sales Formulas in Excel

3. As Clear Lake continues to fill out its forecasted income statement, the next formula we see is a simple sum formula to calculate net sales in B8 (see Figure 18.20). It's a simple formula that subtracts sales returns and allowances in B7 from gross sales in B4. Similar formulas are also found in B10 for gross margin and B18 for net income.
4. In cell B9, we see a multiplication formula that multiplies sales from B4 by 0.5, or 50%. This is because

management feels that cost of goods sold will remain the same as last year, in most quarters at least, and last year's percentage was 50%.

5. Rent, depreciation, and salaries are all simply typed in, as they are fixed expenses that remain the same as last year.
6. The utilities calculation, found in cell B14, is somewhat similar to the sales calculation. The total utilities expense from O14 is multiplied by the current month's sales in B4 divided by the total annual sales in O4. This spreads out the utility cost by month based on the percentage of annual sales.

	A	B
3		**Jan**
4	Gross Sales	=($O4*B5)*0.98
5	% of Annual Sales	='Figure 18.12'!B5
6	% Change from January Baseline	=B4/$B4
7	Sales Returns & Allowances	300
8	Net Sales	=B4-B7
9	Cost of Goods Sold	=B8*0.5
10	Gross Margin	=B8-B9
11	Rent Expense	458
12	Depreciation Expense	300
13	Salaries Expense	468
14	Utility Expense	=$O14*(B4/$O4)
15	Operating Income	=B10-SUM(B11:B14)
16	Interest Expense	=2000/12
17	Income Tax Expense	=$O17*(B15/$O15)
18	Net Income	=B15-B16-B17

Figure 18.20 Forecasted Income Statement Formulas

Clear Lake's forecasted balance sheet ties very closely to both the forecasted income statement and the prior year's income statement. In Figure 18.21, we see in C7 an addition formula using the sum of the current month and three months of prior sales as an estimate of the ending accounts receivable balance. The formula for inventory is similar but forward looking. In C8, inventory is estimated by adding the cost of goods sold for the current month and next three months from the forecasted income statement.

Total current assets in C10 is calculated with a SUM formula that adds together the values in all the selected cells. Amounts such as short-term investments and common stock that are not anticipated to change are simply typed as a number in the cell. Much like in the income statement, subtotals are found in C13 for total assets, C17 for current liabilities, C24 for total equity, and C25 for total liabilities and equity. Retained earnings in C23 pulls the ending retained earnings balance from the end of last year (hidden in column B) and adds the net income for January in the forecasted income statement to get the current month’s ending balance.

	A	C
3		**Jan**
4	**Assets**	
5	**Noncurrent assets:**	
6	Cash	42581.4534883721
7	Accounts Receivable	='Figure 18.13'!B8+'Figure 18.12'!M8+'Figure 18.12'!L8+'Figure 18.12'!K8
8	Inventory	='Figure 18.13'!B9+'Figure 18.13'!C9+'Figure 18.13'!D9+'Figure 18.13'!E9
9	Short -Term Investments	20000
10	**Total Current Assets**	=SUM(C6:C9)
11	**Noncurrent Assets:**	
12	Equipment	50000
13	**Total Assets**	=C10+C12
14	**Current Liabilities:**	
15	Accounts Payable	='Figure 18.13'!B9
16	Unearned Revenue	=0.25*'Figure 18.13'!B8
17	**Total Current Liabilities**	=C15+C16
18	**Noncurrent Liabilities:**	
19	Notes Payable	50000
20	**Total Liabilities**	=C17+C19
21	**Stockholder Equity**	
22	Common Stock	80000
23	Ending Retained Earnings	=B23+'Figure 18.13'!B18
24	Total Stockholder's Equity	=C22+C23
25	**Total Liabilities and Stockholder Equity**	=C24+C20

Figure 18.21 Forecasted Balance Sheet Formulas

Much like the balance sheet, the cash forecast also relies heavily on data from the forecasted income statement as well as the forecasted balance sheet. To begin the year, in Figure 18.22, we see that the formula in B4 pulls the cash balance from the forecasted balance sheet. In B6, the formula pulls the sales for the three months prior from the previous year’s income statement. This is because it’s assumed that cash is collected from customers 90 days after the sale. The same approach is used for accounts payable, rent, salaries, and utilities. The formulas pull the expenses from a prior month depending on the assumed timing for payment. Utilities, for example, are assumed to be paid within 30 days, so the cash outflow in February is assumed to be the utilities expense for January from the forecasted income statement. Note that interest payments are assumed to be zero in January and February, but in March, the formula in D14 sums the interest expenses on the forecasted income statement for January, February, and March. This is because interest is paid quarterly.

Finally, note the formula in C4. The beginning cash balance for a given month is the same as the ending cash balance from the prior month; thus, the figure in B18 is linked to C4 to start the new month.

	A	B	C	D
3		**Jan**	**Feb**	**Mar**
4	Beginning Cash Balance	='Figure 18.21'!C6	=B18	=C18
5	**Cash Inflows:**			
6	Accounts Receivable Collected	='Figure 18.12'!K8	='Figure 18.12'!L8	='Figure 18.12'!M8
7	Total Cash Inflows:	=SUM(B6:B6)	=SUM(C6:C6)	=SUM(D6:D6)
8	**Cash Outflows:**			
9	Accounts Payable paid	='Figure 18.12'!M9	='Figure 18.13'!B9	='Figure 18.13'!C9
10	Salaries	='Figure 18.12'!M13	='Figure 18.13'!B13	='Figure 18.13'!C13
11	Rent	='Figure 18.13'!B11	='Figure 18.13'!C11	='Figure 18.13'!D11
12	Utilities	='Figure 18.12'!M14	='Figure 18.13'!B14	='Figure 18.13'!C14
13	Dividends	0	0	10000
14	Interest Payments	0	0	=SUM('Figure 18.13'!B
15	Total Cash Outflows:	=SUM(B9:B14)	=SUM(C9:C14)	=SUM(D9:D14)
16	**Cash surplus or deficit**	=B7-B15	=C7-C15	=D7-D15
17	Short term financing borrowed (repaid)	0	0	5000
18	Ending Cash Balance	=B4+B16+B17	=C4+C16+C17	=D4+D16+D17

Figure 18.22 Cash Forecast Formulas

Using Excel Functions to Balance

Once we get a draft of the forecasts outlined, then the tinkering starts. Additional information can be used to adjust the formulas, as we saw with the 2% reduction in January sales for the forecasted income statement. Because we have linked most (though not all) of our expenses, subtotals, and statements together using formulas, management can also use the forecast workbook to perform scenario and sensitivity analyses, essentially asking “what if?” and looking at the results. When completed, however, before finalizing the forecast, it’s important that the financial statements are in balance (particularly the *balance sheet*, just as the name implies).

Notice that throughout, we used formulas to calculate subtotals to ensure they are correct and change as needed. We also linked figures, such as the ending and beginning cash balances, to ensure they are in balance. Perhaps the easiest but most important thing to do is to ensure that the balance sheet balances. We can do this with a simple formula that compares total assets to total liabilities and equity. We can see in Figure 18.23 that subtracting one from the other in cell C27 should result in $0. If there is a difference, the formula will highlight it, forcing us to investigate and correct the sheet so that it balances.

	A	C
10	**Total Current Assets**	=SUM(C6:C9)
11	**Noncurrent Assets:**	
12	Equipment	50000
13	**Total Assets**	=C10+C12
14	**Current Liabilities:**	
15	Accounts Payable	='Figure 18.13'!B9
16	Unearned Revenue	=0.25*'Figure 18.13'!B8
17	**Total Current Liabilities**	=C15+C16
18	**Noncurrent Liabilities:**	
19	Notes Payable	50000
20	**Total Liabilities**	=C17+C19
21	**Stockholder Equity**	
22	Common Stock	80000
23	Ending Retained Earnings	=B23+'Figure 18.13'!B18
24	Total Stockholder's Equity	=C22+C23
25	**Total Liabilities and Stockholder Equity**	=C24+C20
26		
27	**Balance**	=C13-C25

Figure 18.23 Forecasted Balancing Formula

Summary

18.1 The Importance of Forecasting

Forecasting financial statements is important to different users for different reasons. In finance, it's most important for assessing the value of future growth plans and planning for future cash flow needs.

18.2 Forecasting Sales

The sales forecast is the foundation on which much of the rest of the forecast is built. Thus, the sales forecast is completed first. Historical sales data and any other information on the firm, its products, the economy, its customers, and its competitors are all used to create the most accurate sales forecast possible.

18.3 Pro Forma Financials

Pro forma financial statements are forward looking in nature. They use the sales forecast, historical data, financial statement analyses, relationships between accounts and statements, and any other information known about the firm, the environment, and the future to create the most accurate financial statement forecast possible.

18.4 Generating the Complete Forecast

Interrelationships among historical data, the forecasted income statement, and the forecasted balance sheet are all used to estimate each line item in the financial statements.

18.5 Forecasting Cash Flow and Assessing the Value of Growth

Once the income statement and balance sheet forecasts are complete, data from those statements, information on company policies, and account relationships are used to generate a cash forecast. The cash forecast is important for identifying any gaps in cash flow so that financial managers can plan for cash needs. It's also important to review not only the cash forecast but all forecasted financial statements to assess the overall impact and value of proposed firm growth.

18.6 Using Excel to Create the Long-Term Forecast

Excel can be a powerful tool for creating financial forecasts. Formulas that complete mathematical functions and tie accounts and financial statements together are used to create the statements, ensure that they balance, and facilitate scenario and sensitivity analyses.

Key Terms

balance sheet a financial statement that reflects a firm's asset, liability, and equity account balances at a given point in time

cash deficit an excess of cash outflows over cash inflows for a given period

cash forecast a financial statement that estimates a firm's future cash inflows and outflows

cash surplus an excess of cash inflows over cash outflows for a given period

common-size describes a financial statement in which each element is expressed as a percentage of a base amount

financing activities cash business transactions reported on the statement of cash flows that reflect the use of financed funds

forecast an estimate of future performance based on historical performance and other contextual information

income statement a financial statement that measures a firm's financial performance over a given period of time

investing activities cash business transactions reported on the statement of cash flows that reflect the acquisition or disposal of long-term assets

operating activities cash business transactions reported on the statement of cash flows that relate to ongoing day-to-day operations
pro forma in the context of financial statements, forward-looking
scenario analysis analysis of how various situations and circumstances would impact the financial forecast
sensitivity analysis analysis of the sensitivity of an output variable to a change in an input variable
statement of cash flows a financial statement that lists a firm's cash inflows and outflows over a given period of time
statement of stockholders' equity a financial statement that reports the difference between the beginning and ending balances of each of the stockholders' equity accounts during a given period

Multiple Choice

1. Which type of financial statement analysis is most commonly used to create a baseline estimate for a financial forecast?
  a. Trend analysis
  b. Common-size analysis
  c. Ratio analysis
  d. Liquidity analysis

2. What key element of the income statement is used to estimate several other key income statement lines?
  a. Cost of goods sold
  b. Gross margin
  c. Sales
  d. Fixed costs

3. Jamal wants to forecast sales for the first quarter of next year. His first assumption is that sales will likely grow by 3% in the coming year. If Jamal's monthly sales were $10,000, $9,000, and $11,000 in the first quarter of this year, what should his sales forecast be for the first quarter of next year?
  a. $30,000
  b. $30,900
  c. $33,000
  d. $33,500

4. In the context of a firm's financial statements, what does *pro forma* mean?
  a. Forward looking
  b. Historical
  c. Board approved
  d. Audited

5. What is the most common length of a forecast if the goal is to forecast cash and assess possible short-term growth?
  a. 3 months
  b. 12 months
  c. 3 years
  d. 5 years

6. When completing a first pass at a forecasted income statement, which type of costs are assumed to be tied directly to sales?
  a. Fixed costs
  b. Period costs

c. Variable costs
d. Sunk costs

7. In the cash forecast, if cash inflows exceed cash outflows, what does this create?
   a. A cash surplus
   b. A cash deficit
   c. A long-term liability
   d. An undeclared dividend

8. Amelia wants to use a formula in Excel to estimate her utilities expense for each month. She normally pays her utilities within 30 days. What formula or link might she use in Excel to estimate her cash outflow for utilities?
   a. Sum the past three months' cost of goods sold from the forecasted income statement
   b. Link to the prior month's accounts payable from the forecasted balance sheet
   c. Link to the prior month's utilities expense from the forecasted balance sheet
   d. Link to the prior month's ending cash balance from the cash flow forecast

9. Amelia wants to use a formula in Excel to estimate her sales for each month. She believes her sales for the next year will be about 7% higher than this year's. She also has a big new ad campaign running late this year that she thinks will add another $5,000 to January sales. Which of the following is an appropriate Excel formula for Amelia's January sales?
   a. =(lastyearsalesA2*1.07)+5000
   b. =(lastyearsales+5000*1.07)
   c. =lastyearsalesA2+5000*.07
   d. =lastyearsalesA2*5000*1.07

Review Questions

1. Javier's firm has created a forecasted income statement that shows the firm with a net profit of $25,000 for the coming year. What can we assume about Javier's cash flows?

2. Lulu's firm's sales grew by 9%, 11%, and 10% over the past three years, respectively. Lulu wants to take her first pass at forecasting sales for next year. What percent sales growth would you recommend she use, and why?

3. Aria wants to create a set of pro forma financial statements. Her goal is to plan for future cash flows and operations as well as help envision her long-term strategy. What time frames should Aria consider for her operations and cash flows versus her long-term strategy?

4. What information might you use to calculate the ending balance for retained earnings on a forecasted balance sheet?

5. Damon estimates his beginning cash balance for June to be $10,000, with cash inflows of $4,000 and cash outflows of $6,000 for the month. What is Damon's forecasted ending balance for June?

6. Tanneh wants to use an Excel formula to help her estimate sales for January in her forecasted income statement. She already has her sales estimate for the full year. Assuming she wants to use the past year's income statement percentages to forecast next year's sales, how would she calculate estimated sales for January?

Problems

1. ABC Company has the following data for its monthly sales. Complete the % of Annual Sales row.

ABC Company Monthly Income Statements													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gross Sales	$40,000	$42,000	$47,000	$56,000	$60,000	$71,000	$53,000	$53,000	$46,000	$37,000	$39,000	$31,000	**$575,000**
% of Annual Sales													

2. Using the same data as in Problem 1, assume that ABC Company expects a 10% increase in sales in the coming year (10% more than the $575,000 it had in the past year). Prepare its sales forecast, assuming the company breaks its sales down by month using the same percentages as the actual sales from the past year, which you calculated in the first problem.

ABC Company Monthly Income Statements													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gross Sales													
% of Annual Sales													

3. ABC Company anticipates its sales being a bit lower than normal in January and February of the coming year due to major road construction on the street where it is located, which will draw away foot traffic from the store. The company anticipates that this will reduce its sales in these two months by 5%. Use the information from Problems 1–2 to update the sales forecast.

4. ABC Company's cost of goods sold last year was 60%. It anticipates that this will be the same in the coming year. Its sales returns and allowances are small, normally 1% of sales. Use the information from Problems 1–3 to estimate the company's sales returns and allowances, net sales, and cost of goods sold and calculate its gross margin.

ABC Company Monthly Income Statements													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gross Sales	$41,800	$43,890	$51,700	$61,600	$66,000	$78,100	$58,300	$58,300	$50,600	$40,700	$42,900	$34,100	**$627,990**
% of Annual Sales	7.0%	7.3%	8.2%	9.7%	10.4%	12.3%	9.2%	9.2%	8.0%	6.4%	6.8%	5.4%	**100.0%**
Sales Returns & Allowances													
Net Sales													
Cost of Goods Sold													
Gross Margin													

5. Use the partial income statement generated in Problem 4 along with the following additional information to complete ABC Company's forecasted income statement in Excel.
   a. Rent expense is $1,000 per month. However, the landlord has indicated that rent will go up to $1,250 in the fourth quarter.
   b. Depreciation expense is $2,250 per month and does not change throughout the year.
   c. Salaries expense is $1,500 per month and is expected to go up by 10% in the second half of the year, when a new compensation plan will be implemented.
   d. Utilities expense is $5,000 for the entire year and should be allocated to each month based on that month's percentage of annual sales.
   e. Interest expense is $500 per month.
   f. Income tax is 25% of operating income less interest expense.

ABC Company Monthly Income Statements													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Gross Sales	$41,800	$43,890	$51,700	$61,600	$66,000	$78,100	$58,300	$58,300	$50,600	$40,700	$42,900	$34,100	**$627,990**
% of Annual Sales	7.0%	7.3%	8.2%	9.7%	10.4%	12.3%	9.2%	9.2%	8.0%	6.4%	6.8%	5.4%	**100.0%**
Sales Returns & Allowances	$ 418	$ 439	$ 517	$ 616	$ 660	$ 781	$ 583	$ 583	$ 506	$ 407	$ 429	$ 341	**$ 6,280**
Net Sales	41,382	43,451	51,183	60,984	65,340	77,319	57,717	57,717	50,094	40,293	42,471	33,759	**621,710**
Cost of Goods Sold	24,829	26,071	30,710	36,590	39,204	46,391	34,630	34,630	30,056	24,176	25,483	20,255	**373,026**
Gross Margin	16,553	17,380	20,473	24,394	26,136	30,928	23,087	23,087	20,038	16,117	16,988	13,504	**248,684**
Rent Expense													
Depreciation Expense													
Salaries Expense													
Utility Expense													
Operating Income													
Interest Expense													
Income Tax Expense													
Net Income													

Video Activity

What Is a Pro Forma?

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1. What is a pro forma financial statement? What are some scenarios in which you might find a pro forma financial statement helpful?
2. Why might someone compile a pro forma financial statement that is intentionally inaccurate? What factors contribute to the accuracy of a pro forma?

Cash Flow Forecasting Explained: How to Complete a Cash Flow Forecast Example

Click to view content (https://openstax.org/r/Cash_Flow_Forecasting)

3. Assume you are the financial manager for a large electronics retailer. What benefits could you gain from preparing a cash forecast?
4. Assume you are the financial manager for a large electronics retailer. You are going to prepare a cash forecast. What key cash inflows and outflows do you anticipate will be in your forecast?

19 The Importance of Trade Credit and Working Capital in Planning

Figure 19.1 Working capital describes the resources that are needed to meet the daily, weekly, and monthly operating cash flow needs. (credit: modification of "Sealey Power Products Warehouse" by Mark Hunter/flickr, CC BY 2.0)

Chapter Outline

Why It Matters

During the COVID-19 pandemic, many families and small businesses realized the importance of financial resiliency. In personal finance, financial resiliency is the ability to overcome financial difficulties such as sudden job loss or significant unexpected expenses—to spring back quickly.

To help promote resiliency, personal financial planners advise clients to maintain liquid assets equal to three to six months of living expenses, keep debt levels low, manage the household budget, keep insurance in force (health, property, and life), establish a solid credit history, and make wise use of credit cards and home equity lines of credit.

In business finance, financial resiliency is not important only during pandemics but is important through the ups and downs of seasonal cycles and economic downturns. Managing cash, accounts receivable, and inventory while making optimal use of trade credit (accounts payable) makes for a business that meets its operating needs and pays its debts when due.

Working capital management is also critical during good times. Even though profits might be rising, a business with growing demand for its products and services still needs to have working capital management tools to pay its bills. Growth in sales and profits do not immediately mean sufficient cash flow, so planning ahead with tools such as a cash budget is key.

19.1 What Is Working Capital?

By the end of this section, you will be able to:

- Define working capital.
- Calculate a firm's operating cycle and cash cycle.
- Compute inventory days, accounts receivable days, and accounts payable days.

The concept of business capital is often associated with the cash and assets (such as land and equipment) that the owners contributed to the business. Early political economists like Adam Smith and Karl Marx identified this concept of capital, along with labor and entrepreneurship, to be the factors of production.

That general idea of capital is important and critical to a company's productive capacity. This chapter is about a specific type of capital— **working capital**—that is just as important as long-term capital. Working capital describes the resources that are needed to meet the daily, weekly, and monthly operating cash flow needs. Employees are paid out of working capital as well as cash from operations, the fulfillment of merchandise orders is possible because of working capital, and the liquidity of a company hinges upon how well management plans and controls working capital.

Understanding working capital begins with the concept of **current assets**—those resources of a business that are cash, near cash, or expected to be turned into cash within a year through the normal operations of the business. Current assets are necessary for the everyday operation of the firm, and they are synonymous with term **gross working capital**.

Cash is needed to pay the bills and meet the payroll. Excess cash is invested in cash alternatives such as **marketable securities**, creating **liquidity** that can be tapped when operating cash flow needs exceed the amount of cash on hand (checking account balances). Investment in inventory is necessary to meet the demand for products (sales), and if the firm extends credit to its customers so that a sale can be made, the balance sheet will also show accounts receivable—a very common current asset that derives its value from the probability that customers will pay their bills.

Working capital is often spoken about in two versions: *gross working capital* and *net working capital*. As was previously stated, gross working capital is equivalent to current assets, particularly those that are cash, cash-like, or will be converted to cash within a short period of time (i.e., in less than one year).

Net working capital (NWC) is a more refined concept of working capital. It is best understood by examining its formula:

$$\text{Current Assets} - \text{Current Liabilities} = \text{Net Working Capital}$$

Goal of Working Capital Management

The goal of working capital management is to maintain adequate working capital to

- meet the operational needs of the company;
- satisfy obligations (current liabilities) as they come due; and
- maintain an optimal level of current assets such as cash (provides no return), accounts receivable, and inventory.

Working capital management encompasses all decisions involving a company's current assets and current liabilities. One very important aspect of working capital management is to provide enough cash to satisfy both maturing short-term obligations and operational expenditures—keeping the company sufficiently liquid.

In summary, working capital management helps a company run smoothly and mitigates the risk of illiquidity. Well-run companies make effective use of current liabilities to finance an optimal level of current assets and maintain sufficient cash balances to meet short-term operating goals and to satisfy short-term obligations. Working capital management is accomplished through

- cash management;
- credit and receivables management;
- inventory management; and
- accounts payable management.

Components of Working Capital Management

In contrast to net working capital, gross working capital is synonymous with current assets, particularly those current assets that are either cash or cash equivalents or that will be converted to cash within a short period of time (i.e., in less than one year).

Below is a list of the components of gross working capital.

- Cash and cash equivalents
- Marketable securities
- Accounts receivable
- Inventory

Here is an example. On December 31, a company has the following balances and gross working capital:

Cash and Equivalents	$ 100,000
Marketable Securities	250,000
Accounts Receivable	330,000
Inventory	425,000
Gross Working Capital	$1,105,000

Think of the $1,105,000 of gross working capital as a source of funds for the most pressing obligations (i.e., current liabilities) of the company. Gross working capital is available to pay the bills. However, some of the current assets would need to be converted to cash first. Accounts receivable need to be collected, and inventory would need to be sold before it too can become cash. What if the company had $600,000 of current liabilities? That amount of current obligations could not be paid out of cash until the marketable securities were sold and a significant portion of accounts receivable were collected.

The second, more refined and useful concept of working capital is **net working capital**:

$$\text{NWC} = \text{Current Assets} - \text{Current Liabilities}$$

For example, if a company has $1,000,000 of current assets and $750,000 of current liabilities, its net working capital would be $250,000 ($1,000,000 less $750,000).

NWC provides a better picture because it takes into account the liability “coverage” provided by the current assets. As the above example shows, the current assets would “cover” the current liabilities with an excess of $250,000. Think of it this way: if the current assets could be converted to cash, they could be used to meet the current obligations with another $250,000 of cash leftover.

Current liabilities include

- accounts payable;
- dividends payable;
- notes payable (due within a year);
- current portion of deferred revenue;
- current maturities of long-term debt;
- interest payable;
- income taxes payable; and
- accrued expenses such as compensation owed to employees.

Net working capital possibilities can be thought of as a spectrum from negative working capital to positive, as explained in Table 19.1.

Negative Net Working Capital	Zero Net Working Capital	Positive Net Working Capital
Current liabilities are greater than current assets.	Current assets equal current liabilities.	Current assets are greater than current liabilities.
Could indicate a liquidity problem. There is difficulty satisfying current obligations.	Indicates that current assets could cover current obligations. However, there is no positive margin (safety cushion) or "liquid reserve" to satisfy unexpected cash needs.	Indicates that the company can meet its current obligations. However, excessively high net working capital could mean too little cash and therefore an opportunity cost (forgoing rates of return on alternative investment).

Table 19.1 Spectrum of Net Working Capital

Measures of Financial Health provides information on a variety of financial ratios to help users of financial statements understand the strengths and weakness of companies' financial statements. Three of the financial ratios covered in that chapter are brought back into this chapter's discussion to demonstrate how financial managers examine working capital and liquidity. Liquidity is the ease with which an asset can be converted into cash. Those **ratios** are the current ratio, the quick ratio, and the cash ratio. A higher ratio indicates a greater level of liquidity.

The formulas for the three liquidity ratios are:

$$\begin{aligned} \text{Current Ratio} &= \frac{\text{Current Assets}}{\text{Current Liabilities}} \\ \text{Quick Ratio (Acid Test)} &= \frac{\text{Current Assets} - \text{Inventory}}{\text{Current Liabilities}} \\ \text{Cash Ratio} &= \frac{(\text{Cash} + \text{Marketable Securities})}{\text{Current Liabilities}} \end{aligned}$$

Notice how the current ratio includes the two elements of net working capital—current assets and current liabilities. It makes for a quick comparison of relative size or proportion.

THINK IT THROUGH

Current Ratio

A company has $2,000,000 of current assets, while its current liabilities are $1,000,000. What is the current ratio, and what does it mean?

Solution:

The current ratio would be $2 = \$2{,}000{,}000/\$1{,}000{,}000$, which is a 2:1 proportion of current asset value to the amount of the current liabilities. This means that if all the current assets could be converted to cash, then the current liabilities could be satisfied two times.

There are two drawbacks to the current ratio: (1) it is a working capital analytic as of a point in time but is not indicative of future liquidity or future cash flows and (2) as an indicator of liquidity, it can be deceptive if a significant proportion of the current assets are inventory, supplies, or prepaid expenses. Inventory is not very liquid as it can take an extended time period to convert to cash, and assets such as supplies and prepaid expenses never become cash and therefore are not a source of funds to pay bills.

The quick ratio is considered a more conservative indication of liquidity since it does not include a firm's inventory: $(\text{Current Assets} - \text{Inventory})/\text{Current Liabilities}$.

THINK IT THROUGH

Quick Ratio

A company's current assets total $2,000,000, but $500,000 of that is inventory and the current liabilities total $1,000,000. What is the quick ratio, and what does it mean?

Solution:

The quick ratio would be $1.5 = \$1{,}500{,}500/\$1{,}000{,}000$ and would indicate a smaller cushion of net working capital.

THINK IT THROUGH

Cash Ratio

The cash ratio is even more conservative in that it presents a picture of liquidity by excluding all current assets except cash and marketable securities.

A company's total current assets are $2,000,000, but only $1,100,000 of the current assets consist of cash and marketable securities. Assuming $1,000,000 of current liabilities, what would be the cash ratio and what does it mean?

Solution:

The cash ratio would be $1.1 = \$1{,}100{,}000/\$1{,}000{,}000$, and the amount of cash is enough to pay the current bills by $100,000.

Working capital ratios, like any financial ratio, are most valuable when examined in light of trends and in comparison to industry/peer averages. For example, a deteriorating current ratio over several quarters (a decline in the company's current ratio) could indicate a reduced ability to pay bills.

Working capital ratios are also compared to industry averages, which are available in databases produced by such financial publishers as Dun & Bradstreet, Dow Jones Company, and the Risk Management Association (RMA). These information services are available via subscriptions and through many libraries. For example, if a company's current ratio is 0.9 while the industry average is 2.0, then the company is less liquid than the average company in its industry and strategies, and techniques need to be considered to change things and to better compete with peer groups. Industry averages can be aspirational, motivating management to set liquidity goals and best practices for working capital management.

It is common to think about working capital with a simple assumption: current assets are being "financed" by current liabilities. However, such an assumption may be an oversimplification. Some level of current assets is often necessary to meet longer-term obligations, and in that way, you could think of some amount of current assets as a permanent based of working capital that may need to be financed with longer-term sources of capital.

Think of a company with seasonal business. During busy times, more working capital will be needed than during certain other portions of the year, such as less busy times. But there will always be some level—a permanent base—of working capital needed. Think of it this way: the total working capital of many companies will ebb and flow depending on many variables such as the operating cycle, production needs, and the growth of revenue. Therefore, working capital can be thought of as having a permanent base that is always needed and a total working capital amount that increases when activity levels (i.e., production and sales volume) are higher (see Figure 19.2).

The Cash Cycle

The **cash cycle**, also called the **cash conversion cycle**, is the time period between when a business begins production and acquires resources from its suppliers (for example, acquisition of materials and other forms of inventory) and when it receives cash from its customers. This is offset by the time it takes to pay suppliers (called the payables deferral period).

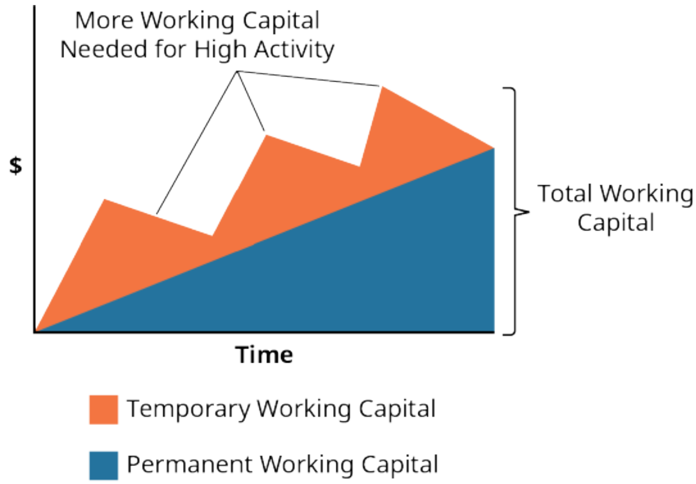

Figure 19.2 Working Capital Needs Can Vary: Temporary and Permanent Working Capital

The cash cycle is measured in days, and it is best understood by examining its formula:

$$\begin{aligned}\text{Cash Cycle} = \ &\text{Inventory Conversion Period } + \\ &\text{Receivables Collection Period } - \text{ Payables Deferral Period}\end{aligned}$$

The inventory conversion period is also called the days of inventory. It is the time (days) it takes to convert inventory to sales and is calculated by following these steps:

1. First, calculate the Inventory Turnover Ratio using this formula:

$$\text{Inventory Turnover Ratio } = \frac{\text{Cost of Goods Sold}}{\text{Average Inventory}}$$

   The Average Inventory is arrived at as follows:

$$\text{Average Inventory } = \frac{(\text{Beginning Inventory} + \text{Ending Inventory})}{2}$$

2. Then, use the Inventory Turnover Ratio to calculate the Inventory Conversion Period:

$$\text{Inventory Conversion Period } = \frac{365}{\text{Inventory Turnover}}$$

The receivables collection period, also called the days sales outstanding (DSO) or the average collection period, is the number of days it typically takes to collect cash from a credit sale. It is calculated by following these steps:

1. First, calculate the Accounts Receivable Turnover using this formula:

$$\text{Accounts Receivable Turnover} = \frac{\text{Credit Sales}}{\text{Average Accounts Receivable}}$$

   The Average Accounts Receivable is arrived at as follows:

$$\text{Average Accounts Receivable } = \frac{(\text{Beginning Accounts Receivable } + \text{ Ending Accounts Receivable})}{2}$$

2. Then, use the Accounts Receivable Turnover to calculate the Receivables Collection Period:

$$\text{Receivables Collection Period} = \frac{365}{\text{Accounts Receivable Turnover}}$$

The payables deferral period, also known as days in payables, is the average number of days its takes for a company to pay its suppliers. It is calculated by following these steps:

1. First, calculate the Accounts Payable Turnover using this formula:

$$\text{Accounts Payable Turnover} = \frac{\text{Cost of Goods Sold}}{\text{Average Accounts Payable}}$$

The Average Accounts Payable is arrived at as follows:

$$\text{Average Accounts Payable} = \frac{(\text{Beginning Accounts Payable} + \text{Ending Accounts Payable})}{2}$$

2. Then, use the Accounts Payable Turnover to calculate the Payables Deferral Period:

$$\text{Payables Deferral Period} = \frac{365}{\text{Accounts Payable Turnover}}$$

THINK IT THROUGH

Periods of the Cash Cycle

Scenario 1: King Sized Products (KSP) Inc. has annual credit sales of $40,000,000. The average inventory is $3,000,000, and the company has average accounts receivable of $6,000,000 and average accounts payable of $2,800,000. The cost of goods sold for KSP Inc. is $30,000,000. The cash cycle for the company is 57.2 days. Calculate the inventory conversion, receivables collection, and payable deferral periods.

Solution:

Inventory conversion period:

- $\text{Inventory Turnover Ratio} = \frac{\$30{,}000{,}000}{\$3{,}000{,}000} = 10 \text{ times}$
- $\text{Inventory Conversion Period} = \frac{365}{10} = 36.5 \text{ days}$

Receivables collection period:

- $\text{Accounts Receivable Turnover} = \frac{\$40{,}000{,}000}{\$6{,}000{,}000} = 6.67 \text{ times}$
- $\text{Receivables Collection Period} = \frac{365}{6.67} = 54.7 \text{ days}$

Payables deferral period:

- $\text{Accounts Payable Turnover} = \frac{\$30{,}000{,}000}{\$2{,}800{,}000} = 10.71 \text{ times}$
- $\text{Payables Deferral Period} = \frac{365}{10.71} = 34 \text{ days}$

$$\text{Cash Conversion Cycle} = 36.5 \text{ days} + 54.7 \text{ days} - 34 \text{ days} = 57.2 \text{ days}$$

The solution (the entire cash conversion cycle) is also illustrated in a chart, Figure 19.3.

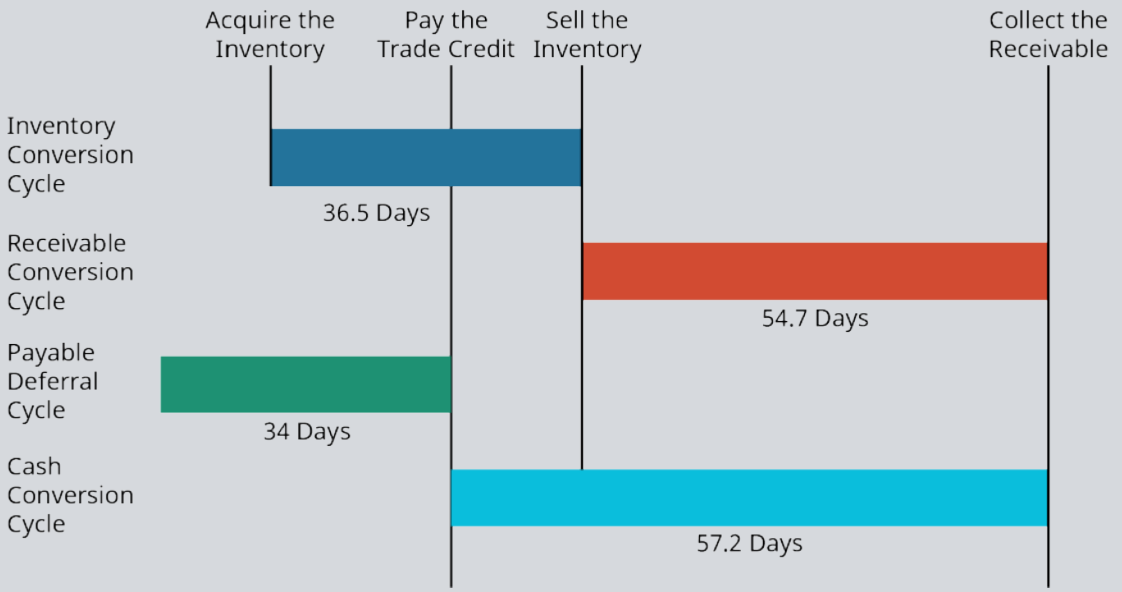

Figure 19.3 Cash Conversion Cycle

Shortening the inventory conversion period and the receivables collection period or lengthening the payables deferral period shortens the cash conversion cycle. Financial managers monitor and analyze each component of the cash conversion cycle. Ideally, a company's management should minimize the number of days it takes to convert inventory to cash while maximizing the amount of time it takes to pay suppliers.

Quickly converting inventory to sales speeds up cash inflows and shortens the cash cycle, but it also could help reduce inventory losses as a result of obsolescence. Inventory becomes obsolete because of a variety of factors including time—inventory that has not been sold for a long period of time and is not expected to be sold in the future has to be written down or written off according to accounting rules. Write-offs of inventory can result in significant losses for a company. In the food business, inventory conversion periods take on great importance because of spoilage of perishable goods; in retailing, seasonal items lose value the longer they stay on the shelves.

Various inventory management techniques are used to shorten production time in manufacturing, and in retailing, strategies are used to reduce the amount of time a product sits on the shelf or is stored in the warehouse. Production techniques such as **just-in-time inventory** systems and marketing and pricing strategies can have an impact on the number of days in the inventory conversion cycle.

For the receivables collection period, a relatively long receivables collection period means that the company is having trouble collecting cash from its customers and so whatever can be done to speed up collections while still offering competitive credit terms should be pursued by financial managers. For example, companies that converted paper invoicing to e-invoicing most likely reduce the average collection period by some number of days, as it makes sense that if a bill is transmitted electronically, lag time is cut (no delays because of "snail mail") and collections (payments back to the company from customers) may happen sooner. Other credit management techniques, some of which are explained in subsequent sections, can help minimize and control the receivables collection period.

The payables deferral period is the one element that probably cannot be optimized without violating credit terms. Certainly, cash balances can be conserved by delaying payments to vendors for as long as possible; however, payments on trade credit need to be made on time or the company's relationship with the supplier can suffer. In a worst-case scenario, the company's **credit rating** could also deteriorate.

A credit rating, also called a credit score, is a measure produced by an independent agency indicating the likelihood that a company will meet its financial obligations as they come due; it is an indication of the company's ability to pay its creditors. Three business credit rating services are Equifax Small Business, Experian Business, and Dun & Bradstreet.

THINK IT THROUGH

The Cash Conversion Cycle

Considering the previous Think It Through (Scenario 1), what if you could reduce inventory levels, hold lower accounts receivable balances, and rely more heavily on accounts payable while maintaining the same sales level?

Here's Scenario 2. Because of better inventory management, credit and collections management, and negotiation of longer payment periods with vendors, King Sized Products (KSP) Inc. needs less investment in inventory and accounts receivable and is able to utilize a greater amount of trade credit financing.

Annual credit sales are $40,000,000, average inventory is $2,800,000, average accounts receivable are $5,500,000, average accounts payable are $3,300,000, and cost of goods sold is $30,000,000. What is the cash conversion cycle?

Solution:

Inventory conversion period:

- $\text{Inventory Turnover Ratio} = \frac{\$30{,}000{,}000}{\$2{,}800{,}000} = 10.71 \text{ times}$
- $\text{Inventory Conversion Period} = \frac{365}{10.71} = 34.07 \text{ days}$
- $\text{Inventory Conversion Period} = \frac{365}{10.71} = 34.07 \text{ days}$

Receivables collection period:

- $\text{Accounts Receivable Turnover} = \frac{\$40{,}000{,}000}{\$5{,}500{,}000} = 7.27 \text{ times}$
- $\text{Receivables Collection Period} = \frac{365}{7.27} = 50.21 \text{ days}$

Payables deferral period:

- $\text{Accounts Payable Turnover} = \frac{\$30{,}000{,}000}{\$3{,}300{,}000} = 9.09 \text{ times}$
- $\text{Payables Deferral Period} = \frac{365}{9.09} = 40.15 \text{ days}$

$$\text{Cash Conversion Cycle} = 34.07 \text{ days} + 50.21 \text{ days} - 40.15 \text{ days} = 44.13 \text{ days}$$

Notice that the investment in inventory and accounts receivable is less and the average accounts payable is more with no change in credit sales and cost of goods sold—you would certainly anticipate a reduction in the cash conversion cycle. The improvement would be about 13 days (from 57.2 in Scenario 1 to 44.1 days in Scenario 2). Figure 19.4 shows a bar chart comparison of the two scenarios.

	Scenario 1	Scenario 2
Inventory Conversion Period	36.50	34.07
Receivables Collection Period	54.75	50.21
Payables Deferral Period	34.07	40.15
Cash Conversion Cycle	57.18	44.10

Table 19.2

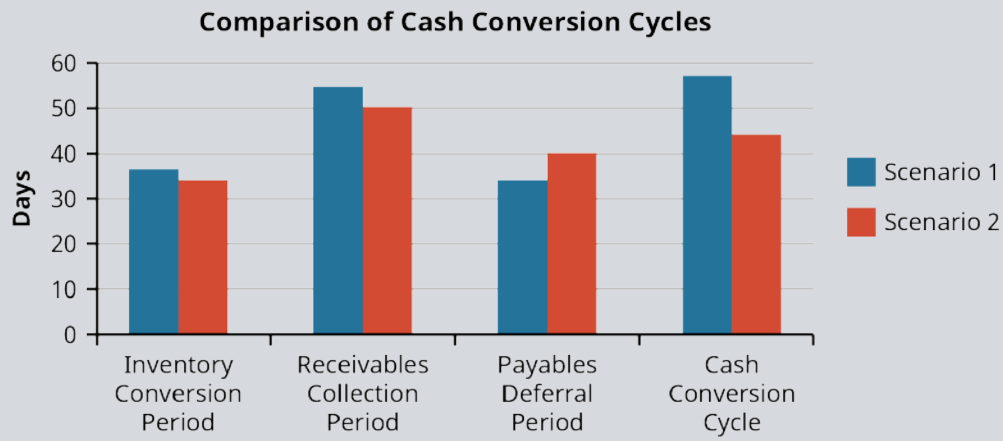

Figure 19.4 Scenario 1 and 2 Comparison: Shortening the Cash Conversion Cycle

LINK TO LEARNING

A Harvard Business School blog post, [How Amazon Survived the Dot-Com Bubble (https://openstax.org/r/how-amazon-survived)](https://openstax.org/r/how-amazon-survived), discusses how Amazon managed its cash conversion cycle to the point where it was receiving payment for the things it sold before Amazon had to pay for them. In that way, Amazon had a negative cash conversion cycle (which is really a huge positive for a company trying to manage positive cash flow!).

Working Capital Needs by Industry

When comparing working capital needs by industry, you can see some variation. For example, some companies in the grocery business can have very low cash conversion cycles, while construction companies can have very high cash conversion cycles. And some companies, like those in the restaurant business, can have very low numbers and even have negative cash conversion cycles.

Working capital can also differ from one industry to another. An often cited general rule is that a current ratio of 2 is considered optimal. However, general rules of thumb must be treated with caution. A better **benchmarking** approach is to compare a firm's ratios—current ratio and quick ratios—to the average of the industry in which the subject company operates.

Take, for example, a home construction company. Such as firm has a long **operating cycle** because of the production process (building homes), and the "storage of finished goods" can result in very high current ratios—such as 11 or 12 times current liabilities—whereas a retailer like Walmart or Target would have much lower current ratios.

In recent years, Walmart Stores Inc. (NYSE: WMT) has had a current ratio of around 0.9 and has been able to manage its working capital needs by efficient management of its supply chain, quick turnover of inventory, and a very small investment in accounts receivables.[1] Big retailers like Walmart are effective at negotiating favorable payment terms with their vendors. The ability to generate consistent positive cash flow from operations allows a retailer like Walmart to operate with relatively low amounts of working capital.

The credit policies of a company also affect working capital. A company with a liberal credit policy will require a greater amount of working capital, as collection periods of accounts receivable are longer and therefore tie up

1 Walmart Inc. "2020 Annual Report." 2020. https://corporate.walmart.com/media-library/document/2020-walmart-annual-report/_proxyDocument?id=00000171-a3ea-dfc0-af71-b3fea8490000

more dollars in receivables.

Almost all businesses will have times when additional working capital is needed to pay bills, meet the payroll (salaries and wages), and plan for accrued expenses. The wait for the cash to flow into the company's treasury from the collection of receivables and cash sales can be longer during tough times.

During the COVID-19 pandemic, the US government made paycheck protection program (PPP) loans available to help alleviate working capital problems for small and large business when the economy slowed because of shutdowns and social distancing. And although 60 percent of the PPP loan proceeds were to go to cover payroll-related costs, 40 percent could be used to bolster working capital to meet rent, utilities costs, and some interest expense while companies were "treading water"—waiting for positive cash flow to pick up under a recovery.[2]

It isn't just during downturns that working capital is strained. Growing companies, even if they are extremely profitable, need additional working capital as they ramp up operations by acquiring raw materials, component parts, supplies, or other forms of inventory; hiring temporary or additional employees; and taking on new projects. Whenever additional resources are needed, working capital is also needed.

Some of the current assets and expenditures needed in a growing company may need to be financed from sources that are not spontaneous financing—**trade credit** (accounts payable). Such forms of external financing such as lines of credit, short-term bank loans, inventory-based loans (also called **floor planning**), and the **factoring** of accounts receivables might have to be relied upon.

19.2 What Is Trade Credit?

By the end of this section, you will be able to:

- Compute the cost of trade credit.
- Define cash discount.
- Define discount period.
- Define credit period.

Trade credit, also known as *accounts payable*, is a critical part of a business's working capital management strategy. Trade credit is granted by vendors to creditworthy companies when those companies purchase materials, inventory, and services.

A company's purchasing system is usually integrated with other functions such production planning and sales forecasting. Purchasing managers search for and evaluate vendors, negotiate order quantities, and prepare purchase orders. In carrying out the purchasing process, credit terms are granted by the company's vendors and purchases of inventory and services can be made on trade credit accounts—allowing the purchaser time to pay. The purchaser carries an accounts payable balance until the account is paid.

Trade credit is referred to as spontaneous financing, as it occurs spontaneously with the gearing up of operations and the additional investment in current assets. Think of it this way: If sales are increasing, so too is production. Increased sales mean more current assets (accounts receivable and inventory), and increased sales mean increases in accounts payable (financing happening spontaneously with increased sales and inventory purchases). Compared to other financing arrangements, such as lines of credit and bank loans, trade credit is convenient, simple, and easy to use.

Once a company is approved for trade credit, there is no paperwork or contracts to sign, as is the case with various forms of bank financing. Invoices specify the credit terms, and there is usually no interest expense associated with trade credit. Accounts payable is a type of obligation that is interest-free and is distinguished from debt obligations, such as notes payable, that require the creditor to pay back principal and interest.

2 US Small Business Administration. "PPP Loan Forgiveness." n.d. https://www.sba.gov/funding-programs/loans/covid-19-relief-options/paycheck-protection-program/ppp-loan-forgiveness

How Trade Credit Works

Trade credit is common in B2B (business to business) transactions and is analogous to consumer spending using a credit card. With a credit card, a consumer opens an account with a credit limit. Most trade credit is offered to a company with an open account that has a credit limit up to which the company can purchase goods or services without having to pay the cash up front. As long as the payments are made in accordance with the terms of the agreement (also called credit terms), no interest or additional fees are charged on the credit balance except possibly for a fee for late payment.

Initially, the vendor's credit department approves both a trade credit limit and credit payment terms (i.e., number of days after the invoice date that payment is due). Timely payments on accounts payable (trade credit) helps create a credit history for the purchasing firm.

Trade Credit Terms

Trade credit arrangements often carry credit terms that offer an incentive, called a discount, for a company (the buyer) to pay its bill within a relatively short period of time. **Net terms**, also referred to as the full **credit period**, are the number of days that a business (purchaser) has before they must pay their invoice. A common net term is Net 30, with payment due in full within 30 days of the invoice.

Many vendors also offer **cash discounts** to customers that pay their bill early. A company's invoice that specifies payment terms of "2/10 n/30" (stated as: "two ten net 30") would allow a 2 percent discount if the buyer's account balance is paid within 10 days of the invoice date; otherwise, the net amount owed would be due in 30 days. The "10 days" in the example is the **discount period**—the number of days the buyer has to take advantage of the cash discount for an early payment, also known as **quick payment**.

For example, Jackson's Premium Jams Inc. received a $10,500 invoice for the purchase of jelly jars. The invoice has payment terms of 2/10 n/30. Jackson's pays the bill within 10 days of the invoice date. Jackson's payment would be $\$10{,}290 = (\$10{,}500 \times (100\% - 2\%))$. The effect of taking a discount because of a quick payment is a lowering of the cost of inventory in the case of purchases of materials (for a manufacturer), merchandise (for a retailer or wholesaler), and operating expenses (for any company that "buys" services using trade credit). In Cost of Trade Credit, there is an example that shows the high annualize opportunity cost (36.73 percent) of not taking advantage of cash discounts.

CONCEPTS IN PRACTICE

Trade Credit of International Trade

When international trade occurs, two important documents are commonly required: a **letter of credit** and a **bill of lading**. A letter of credit is issued by a financial institution on behalf of the foreign buyer (importer). The bill of lading is a legal document that gives proof of a contract between a transportation company and the buyer and is one important piece of documentation that allows the buyer to draw on the letter of credit. A bill of lading serves as a document of title and proof of receipt of goods by the shipper.

The letter of credit secures a promise of payment to the seller (exporter) provided that the terms of the sale are met. For an international trade transaction, the letter of credit is the main mechanism that establishes a liability for the buyer. Instead of a trade payable, the buyer uses a line of credit from a bank.

Cost of Trade Credit

Trade credit is often referred to as a no-cost type of financing. Unlike with other credit arrangements (e.g., bank loans, lines of credit, and commercial paper), there is usually no interest expense associated with trade credit, and as long as your account does not become delinquent, there are no special fees. Some accounts payable arrangements specify an interest penalty or a late fee when the account goes delinquent, but as long as payments are made on time, trade credit is thought of as a low-cost source of working capital.

However, there is one possible cost associated with trade credit for companies that don't take advantage of cash discounts when offered by sellers. Using accounts payable to purchase goods and services can involve an **opportunity cost**—a cost of the forgone opportunity of making a quick payment and benefiting from a cash discount. A business that does not take advantage of a cash discount for early payment of trade credit will pay more for goods and services than a business that routinely takes advantage of discounts.

The annual percentage rate of forgoing quick payment discounts can be estimated with the following formula:

$$\text{APR of Forgoing Quick Payment Discounts} = \frac{360}{\text{Full Credit Period} - \text{Discount Period}} \times \frac{\text{Discount}}{100 - \text{Discount }\%}$$

Example: Novelty Accessories Inc. (NAI) purchases products from a vendor that offers credit payment terms of 2/10, net 30. The annual cost to NAI of not taking advantage of the discount for quick payment is 36.73 percent.

$$\text{APR of Quick Payment Discounts} = \frac{360}{30 - 10} \times \frac{2\%}{100\% - 2\%} = \frac{360}{20} \times \frac{2\%}{98\%} = 36.73\%$$

19.3 Cash Management

By the end of this section, you will be able to:

- Explain why firms hold cash.
- List instruments available to a financial manager for investing cash balances.

Cash management means efficiently collecting cash from customers and managing cash outflows. To manage cash, the **cash budget**—a forward-looking document—is an important planning tool. To understand cash management, you must first understand what is meant by cash holdings and the motivations (reasons) for holding cash. A cash budget example is covered in Using Excel to Create the Short-Term Plan.

Cash Holdings

The cash holdings of a company are more than the currency and coins in the cash registers or the treasury vault. Cash includes currency and coins, but usually those amounts are insignificant compared to the cash holdings of checks to be deposited in the company's bank account and the balances in the company's checking accounts.

Motivations for Holding Cash

The initial answer to the question of why companies hold cash is pretty obvious: because cash is how we pay the bills—it is the medium of exchange. The **transactional motive** of holding cash means that checks and electronic funds transfers are necessary to meet the payroll (pay the employees), pay the vendors, satisfy creditors (principal and interest payments on loans), and reward stockholders with dividend payments. Cash for transaction is one reason to hold cash, but there is another reason—one that stems from uncertainty and the precautions you might take to be ready for the unexpected.

Just as you keep cash balances in your checking and savings accounts and even a few dollars in your wallet or purse for unexpected expenditures, cash balances are also necessary for a business to provide for unexpected events. Emergencies might require a company to write a check for repairs, for an unexpected breakdown of equipment, or for hiring temporary workers. This motive of holding cash is called the **precautionary motive**.

Some companies maintain a certain amount of cash instead of investing it in marketable securities or in upgrades or expansion of operations. This is called the **speculative motive**. Companies that want to quickly take advantage of unexpected opportunities want to be quick to purchase assets or to acquire a business, and a certain amount of cash or quick access to cash is necessary to jump on an opportunity.

Sometimes cash balances may be required by a bank with which a company conducts significant business. These balances are called **compensating balances** and are typically a minimum amount to be maintained in the company's checking account.

For example, Jack's Outback Restaurant Group borrowed $500,000 from First National Bank and Trust. As part of the loan agreement, First National Bank required Jack's to keep at least $50,000 in its company checking account as a way of compensating the bank for other corporate services it provides to Jack's Outback Restaurant Group.

Cash Alternatives

Cash that a company has that is in excess of projected financial needs is often invested in short-term investments, also known as cash equivalents (cash alternatives). The reason for this is that cash does not earn a rate of return; therefore, too much idle cash can affect the profitability of a business.

Table 19.3 shows a list of typical investment vehicles used by corporations to earn interest on excess cash. Financial managers search for opportunities that are safe and highly liquid and that will provide a positive rate of return. Cash alternatives, because of their short-term maturities, have low interest rate risk (the risk that an investment's value will decrease because of changes in market interest rates). In that way, prudent investment of excess cash follows the risk/return trade-off; in order to achieve safe returns, the returns will be lower than the possible returns achieved with risky investments. Cash alternative investments are not committed to the stock market.

Security	Description
US Treasury bills	Obligations of the US government with maturities of 3 and 6 months
Federal agency securities	Obligations of federal government agencies such as the Federal Home Loan Bank and the Federal National Mortgage Association
Certificates of deposit	Issued by banks, a type of savings deposit that pays interest
Commercial paper	Short-term promissory notes issued by large corporations with maturities ranging from a few days to a maximum of 270 days

Table 19.3 Typical Cash Equivalents

Figure 19.5 shows a note within the 2021 Annual Report (Form 10-K) of Target Corporation. The note discloses the amount of Target's cash and cash equivalent balances of $8,511,000,000 for January 30, 2021, and $2,577,000,000 for February 1, 2020.

8. Cash and Cash Equivalents

Cash equivalents include highly liquid investments with an original maturity of three months or less from the time of purchase. Cash equivalents also include amounts due from third-party financial institutions for credit and debit card transactions. These receivables typically settle in five days or less.

Cash and Cash Equivalents (millions)	January 30, 2021	February 1, 2020
Cash	$ 307	$ 326
Short-term investments	7,644	1,810
Receivables from third-party financial institutions for credit and debit card transactions	560	441
Cash and cash equivalents *(a)*	$8,511	$2,577

(*a*) We have access to these funds without any significant restrictions, taxes or penalties.

Figure 19.5 Note from Target Corporation 2021 10-K Filing (source: US Securities and Exchange Commission/EDGAR)

In that note, which is a supplement to the company's balance sheet, receivables from third-party financial institutions is also considered a cash equivalent. That is because purchases by Target's customers who use their credit cards (e.g., VISA or MasterCard) create very short-term receivables—amounts that Target is waiting to collect but are very close to a cash sale. So instead of being reported as accounts receivable—a line item on the Target balance sheet that is separate from cash and cash equivalents—these amounts receivable from third-party financial institutions are considered part of the cash and cash equivalents and are a very liquid asst. For example, the amount of $560,000,000 for January 30, 2021, is considered a cash equivalent since the settlement of these accounts will happen in a day or two with cash deposited in Target's bank accounts. When a retailer sells product and accepts a credit card such as VISA, MasterCard, or American Express, the cash collection happens very soon after the credit card sale—typically within 24 to 72 hours.[3]

Companies also invest excess funds in marketable securities. These are debt and equity investments such as corporate and government bonds, preferred stock, and common stock of other entities that can be readily sold on a stock or bond exchange. Ford Motor Company has this definition of marketable securities in its 2019 Annual Report (Form 10-K):

"Investments in securities with a maturity date greater than three months at the date of purchase and other securities for which there is more than an insignificant risk of change in value due to interest rate, quoted price, or penalty on withdrawal are classified as *Marketable securities*."[4]

19.4 Receivables Management

By the end of this section, you will be able to:

- Discuss how decisions on extending credit are made.
- Explain how to monitor accounts receivables.

For any business that sells goods or services on credit, effective accounts receivable management is critical for cash flow and profitability planning and for the long-term viability of the company. Receivables management begins before the sale is made when a number of factors must be considered.

- Can the customer be approved for a credit sale?

3 Creditcardprocessing.com. "How Long Does it Take for a Merchant to Receive Funds?" n.d. https://www.creditcardprocessing.com/resource/article/long-take-merchant-receive-funds/#:~:text=The%20time%20that%20it%20takes,days%20to%20process%20the%20payment

4 Ford Motor Company. "2019 Annual Report." n.d. https://s23.q4cdn.com/725981074/files/doc_downloads/Ford-2019-Printed-Annual-Report.pdf

- If the credit is approved, what will be the credit terms (i.e., how long do we give customers to pay their bills)?
- Will there be a cash discount for quick payment?
- How much credit should be extended to each customer (credit limit)?

Accounts receivable is not about accepting credit cards. Credit card sales are not technically accounts receivable. When a credit card is accepted, it means that the credit card company (e.g., VISA, MasterCard, or American Express) will guarantee the payment. The cash will be deposited in the merchant's bank account in a very short period of time.

When a business makes a sale on account, management (e.g., a credit manager or analyst) does its best to distinguish between customers who have a high likelihood of paying and customers who have a low likelihood. Customers with low credit risk are approved; the decision is based on an effective analysis of creditworthiness.

Creditworthiness is judged by looking at a number of factors including an evaluation of the customer's financial statements, financial ratios, and credit reports (credit scores) based on a customer's payment history on credits owed to other firms. If a company has a prior relationship with a customer seeking trade credit, the customer's payment history with the firm is also carefully evaluated before additional credit is granted.

LINK TO LEARNING

Corporate Finance Institute

Credit managers use various tools and techniques to evaluate creditworthiness of customers. The Corporate Finance Institute's website states that "the '5 Cs of Credit' is a common phrase used to describe the five major factors [character, capacity, collateral, capital, and conditions] used to determine a potential borrower's creditworthiness." It goes on to say that "a credit report provides a comprehensive account of the borrower's total debt, current balances, credit limits, and history of defaults and **bankruptcies**, if any."[5] More on the 5 Cs of credit can be found on the Corporate Finance Institute's website (https://openstax.org/r/corporate-finance).

Determining the Credit Policy

A company's credit policy encompasses rules of credit granting and procedures for the collections of accounts. It's how a company will process credit applications, utilize credit scoring and credit bureaus, analyze financial statements, make credit limit decisions, and conduct collection efforts when accounts become *delinquent* (still outstanding after their due date).

Establishing Credit Terms

Trade credit terms were discussed earlier. Recall that part of the terms and conditions of a sale are the **credit terms**—elements of a sales agreement (contract) that indicate when payment is due, possible discounts (for quick payments), and any late fee charges.

If open credit is for a sales transaction, an agreement is made as to the length of time for which credit is to be granted (payment period) and a discount for early payment. Although companies are free to establish credit terms as they see fit, most companies look to the practice of the particular industry in which they operate. The credit terms offered by the competition are a factor. Net terms usually range between 30 days and 90 days, depending on the industry. Discounts for early payments also differ and are typically from 1 to 3 percent.

Establishing credit terms offered can be thought of as a decision process similar to setting a price for products and services. Just as a price is the result of a market forces, so too are credit terms. If credit terms are not

5 Corporate Finance Institute. "What Are the 5 Cs of Credit?" n.d. https://corporatefinanceinstitute.com/resources/knowledge/credit/5-cs-of-credit/

competitive within the industry, sales can suffer. Typically, companies follow standard industry credit terms. If most companies in an industry offer a discount for early payments, then most companies will follow suit and also offer an equal discount.

Once credit terms are established, they can be changed based on both marketing strategies and financial management goals. For example, discounts for early payments can be more generous, or the full **credit period** can be extended to stimulate additional sales. Both discount periods and full credit periods can be tightened to try to speed up collections. The establishment of and changes to credit terms are usually made in consultation with the sales and financial management departments.

Monitoring Accounts Receivables

Financial managers monitor accounts receivables using some basic tools. One of those tools is the **accounts receivable aging schedule** (report). To prepare the aging schedule, a classifying of customer account balances is performed with age as the sorting attribute.

An account receivable begins its life as a credit sale. The age of a receivable is the number of days that have transpired since the credit sale was made (the date of the invoice). For example, if a credit sale was made on June 1 and is still unpaid on July 15, that receivable is 45 days old. Aging of accounts is thought to be a useful tool because of the idea that the longer the time owed, the greater the possibility that individual accounts receivable will prove to be uncollectible.

An aging schedule is a report that organizes the outstanding (unpaid) receivable balances into age categories. The receivables are grouped by the length of time they have been outstanding, and an uncollectible percentage is assigned to each category. The length of uncollectible time increases the percentage assigned. For example, a category might consist of accounts receivable that are 0–30 days past due and is assigned an uncollectible percentage of 6 percent. Another category might be 31–60 days past due and is assigned an uncollectible percentage of 15 percent. All categories of estimated uncollectible amounts are summed to get a total estimated uncollectible balance.

The aging of accounts is useful to the credit and collection managers, both from a global view—estimating how much of the accounts receivable asset might be bad debts—and on a micro basis—being able to drill down to see which specific customers are slow paying or delinquent so as to implement collection tactics.

Accountants and auditors also find the aging of accounts to determine a reasonable amount to be reported as **bad debt expense** and to establish a sufficient balance in the **allowance for doubtful accounts**. Bad debt expense is the cost of doing business because some customers will not pay the amounts they owe (accounts receivable), while the allowance for doubtful accounts is a **contra-asset** (it will be deducted from accounts receivable on the balance sheet) that contains management’s best guess (management’s estimate) as to how much of its accounts receivable will never be collected.

In Figure 19.6, Foodinia Inc.’s accounts receivable aging report shows that the total receivables balance is $189,000. The company splits its accounts into four age categories: not due, 30 to 60 days past due, 61 to 90 days past due, and more than 90 days past due. Of the $189,000 owed to Foodinia by its customers, $75,500 ($189,000 less $113,500) of invoices have been outstanding (not paid yet) beyond their due dates.

Customer Name	Not Due	30 to 60 Days Past Due	61 to 90 Days Past Due	More than 90 Days Past Due	Total Receivables
Arithmio	$ 15,000				$ 15,000
Bakely Inc.		$16,000	$ 5,000	$4,000	25,000
Bakeville	30,000				30,000
Boxfully		27,000			27,000
City Shop	5,000				5,000
Deskmeter		5,000			5,000
Flavorica	6,000				6,000
Merchain	7,000				7,000
Mshops	8,500				8,500
Next Dessert			12,000		12,000
Pichets				5,000	5,000
Shopahoo	19,000				19,000
SportsBuzz Ltd	2,000	1,500			3,500
Wearsy USA	21,000				21,000
Totals	**$113,500**	**$49,500**	**$17,000**	**$9,000**	**$189,000**

Figure 19.6 Foodinia Inc. Aging of Accounts Receivable Schedule

In addition to preparing aging schedules, financial managers also use financial ratios to monitor receivables. The accounts receivable turnover ratio determines how many times (i.e., how often) accounts receivable are collected during an operating period and converted to cash. A higher number of times indicates that receivables are collected quickly. In contrast, a lower accounts receivable turnover indicates that receivables are collected at a slower rate, taking more days to collect from a customer.

Another receivables ratio is the number of days' sales in receivables ratio, also called the receivables collection period—the expected days it will take to convert accounts receivable into cash. A comparison of a company's receivables collection period to the credit terms granted to customers can alert management to collection problems. Both the accounts receivable turnover ratio and receivables collection period are covered, including the formulas for calculating the ratios, in the previous section of this chapter.

Accounts Receivables and Notes Receivable

An accounts receivable is an informal arrangement between a seller (a company) and customer. Accounts receivable are usually paid within a month or two. Accounts receivable don't require any complex paperwork, are evidenced by an invoice, and do not involve interest payments. In contrast, a note receivable is a more formal arrangement that is evidence by a legal contract called a promissory note specifying the payment amount and date and interest.

The length of a note receivable can be for any time period including a term longer than the typical account receivable. Some notes receivable have a term greater than a year. The assets of a bank include many notes receivable (a loan made by a bank is an asset for the bank).

A note receivable can be used in exchange for products and services or in exchange for cash (usually in the case of a financial lender). Sometimes a company might request that a slow-paying customer sign a note promissory note to further secure the receivable, charge interest, or add some type of collateral to the arrangement, in which case the receivable would be called a secured promissory note. Several characteristics of notes receivable further define the contract elements and scope of use (see Table 19.4).

Accounts Receivable	Notes Receivable
• An informal agreement between customer and company • Receivable in less than one year or within a company's operating cycle • Does not include interest	• A legal contract with established payment terms • Receivable beyond one year and outside of a company's operating cycle • Includes interest • Could stipulate collateral

Table 19.4 Key Feature Comparison of Accounts Receivable and Notes Receivable

19.5 Inventory Management

By the end of this section, you will be able to:

- Outline the costs of holding inventory.
- Outline the benefits of holding inventory.

Financial managers must consider the impact of inventory management on working capital. Earlier in the chapter, the concept of the inventory conversion cycle was covered. The number of days that goods are held by a business is one of the focal points of inventory management.

Managers look to minimize inventory balances and raise inventory turnover ratios while trying to balance the needs of operations and sales. Purchasing personnel need to order enough inventory to "feed" production or to stock the shelves. The sales force wants to meet or surpass their sales budgets, and the operations people need inventory for the factories, warehouses, and e-commerce sites.

The days in inventory ratio measures the average number of days between acquiring inventory (i.e., purchasing merchandise) and its sale. This ratio is a metric to be watched and monitored by inventory managers and, if possible, minimized. A high days in inventory ratio could mean "aging" inventory. Old inventory could mean obsolesce or, in the case of perishable goods, spoilage. In either case, old inventory means losses.

Imagine a company selling high-tech products such as consumer electronics. A high days in inventory ratio could mean that technologically obsolete products will be sold at a discount. There are similar issues with older inventory in the fashion industry. Last year's styles are not as appealing to the fashion-conscious consumer and are usually sold at significant discounts. In the accounting world, *lower of cost or market value* is a test of inventory value to determine if inventory needs to be "written down," meaning that the company takes an expense for inventory that has lost significant value. Lower of cost or market is required by Generally Accepted Accounting Principles (GAAP) to state inventory valuations at realistic and conservative values.

Inventory is a very significant working capital component for many companies, such as manufacturers, wholesalers, and retailers. For those companies, inventory management involves management of the entire **supply chain**: sourcing, storing, and selling inventory. At its very basic level, inventory management means having the right amount of stock at the right place and at the right time while also minimizing the cost of inventory. This concept is explained in the next section.

Inventory Cost

Controlling inventory costs minimizes working capital needs and, ultimately, the cost of goods sold. Inventory management impacts profitability; minimizing cost of goods sold means maximizing gross profit (Gross Profit = Net Sales Less Cost of Goods Sold).

There are four components to inventory cost:

- Purchasing costs: the invoice amount (after discounts) for inventory; the initial investment in inventory

- **Carrying costs**: all costs of having inventory in stock, which includes storage costs (i.e., the cost of the space to store the inventory, such as a warehouse), insurance, inventory obsolescence and spoilage, and even the opportunity cost of the investment in inventory
- **Ordering costs**: the costs of placing an order with a vendor; the cost of a purchase and managing the payment process
- **Stockout costs**: an opportunity cost incurred when a customer order cannot be filled and the customer goes elsewhere for the product; lost revenue

Minimizing total inventory costs is a combination of many strategies, the scope and complexity of which are beyond the scope of this text. Concepts such as *just-in-time (JIT)* inventory practices and *economic order quantity (EOQ)* are tools used by inventory managers, both of which help keep a company lean (minimizing inventory) while making sure the inventory resources are in place in time to complete the sale.

Benefit of Holding Inventory

Brick-and-mortar stores need goods in stock so that the customer can see and touch the product and be able to acquire it when they need it. Customers are disappointed if they cannot see and touch the item or if they find out upon arrival at the store that it is out of stock.

Customers of all kinds don’t want to wait for the delivery of a purchase. We have become accustomed to Amazon orders being delivered to the door the next day. Product fulfillment and availability is important. Inventory must be in stock, or sales will be lost.

In manufacturing, the inventory of materials and component parts must be in place at the start of the value chain (the conversion process), and finished goods need to be ready to meet scheduled shipments. Holding sufficient inventory meets customer demand, whether it is products on the shelves or in the warehouse that are ready to move through the supply chain and into the hands of the customer.

19.6 Using Excel to Create the Short-Term Plan

By the end of this section, you will be able to:

- Create a one-year budget.
- Create a cash budget.

A cash budget is a tool of cash management and therefore assists financial managers in the planning and control of a critical asset. The cash budget, like any other budget, looks to the future. It projects the cash flows into and out of the company. The budgeting process of a company is a really an integrated process—it links a series of budgets together so that company objectives can be achieved. For example, in a manufacturing company, a series of budgets such as those for sales, production, purchases, materials, overhead, selling and administrative costs, and planned capital expenditures would need to be prepared before cash needs (cash budget) can be predicted.

Just as you might budget your earnings (salary, business income, investment income, etc.) to see if you will be able to cover your expected living expenses and planned savings amounts, to be successful and to increase the odds that sufficient cash will be available in the months ahead, financial managers prepare cash budgets to

- meet payrolls;
- allocate dollars for contingencies and emergencies;
- analyze if planned collections and disbursements policies and procedures result in adequate cash balances; and
- plan for borrowings on lines of credit and short-term loans that might be needed to balance the cash budget.

A cash budget is a model that often goes through several iterations before managers can approve it as the plan going forward. Changes in any of the “upstream” budgets—budgets that are prepared before the cash budget, such as the sales, purchases, and production budgets—may need to be revised because of changing assumptions. New economic forecasts and even cost-cutting measures will require a revision of the cash budget.

Although a budget might be prepared for each month of a future 12-month period, such as the upcoming fiscal year, a rolling budget is often used. A rolling budget changes often as the planning period (e.g., a fiscal year) plays out. When one month ends, another month is added to the end (the next column) of the budget. For example, if in your budget January is the first month of the planning period, once January is over, next January’s cash budget column would be added—right after December’s column (at the far right of the budget).

Sample One-Year (Annual) Operating Budget

Preparing an annual operating budget can be a complex task. In essence, a company budget is a series of budgets, many of which are interrelated.

The sales budget is prepared first and has an impact on many other budgets. Take the example of a production budget of a manufacturer. The sales budget impacts what needs to be produced (production budget), and the production budget influences planned purchases of material (purchases budget), overhead resources (overhead budget), and the amount of labor costs for the year ahead (direct labor budget.)

For a merchant (such as a wholesaler or retailer), the annual budget would be less complex than that of a manufacturing firm but would still require an inventory purchases budget and an operating expense budget (such as selling and administrative expenses). For a service firm, a purchase budget for inventory would not be necessary, but an operating budget would be. All businesses need a cash budget, which is the topic of the next section of this chapter.

The example operating budget presented here is of a merchandising company. Budgets are prepared following a process that begins with a sales (or revenue) forecast. The sales forecast is normally based on information obtained from both internal and external sources and predicts the amount of units to be sold in the planning period—usually one year into the future.

A company’s management, in consultation with its marketing and sales executives, would prepare a sales budget by making assumptions about the number of units that are expected to be sold and the prices that will be charged. From the sales budget, projections are made as to cash receipts each month, and therefore assumptions have to be made as to how much of each month’s sales will be cash sales and how much cash will flow into the company from the collection credit sales (including cash flow in from the prior month’s sales). Figure 19.7 provides an example of a sales budget and projected accounts receivable collections and cash sales for the months of January through December. Keep in mind that projected monthly sales amounts are not equal to cash collected from sales. Because of sales on credit, some cash from sales lags credit sales as collections can extend beyond the month of sale. Credit terms such terms such as net 30 (net amount owed to be paid in 30 days) have to be considered when developing a forecasted cash collection pattern.

	A	B	C	D	E	F	G
10		**January**	**February**	**March**	**April**	**May**	**June**
11	**Total Sales**	$ 460,000	$ 500,000	$ 600,000	$ 540,000	$ 486,000	$ 534,600
12	Accounts Receivable Collections/Cash Sales	400,000	460,300	513,000	568,000	518,700	491,130
13							
14		**July**	**August**	**September**	**October**	**November**	**December**
15	**Total Sales**	580,000	667,000	653,000	640,000	576,000	460,000
16	Accounts Receivable Collections/Cash Sales	$ 532,828	$ 587,880	$ 645,810	$ 637,390	$ 611,850	$ 538,680

Figure 19.7 Example of a Sales and Collections Budget

Download the spreadsheet file (https://openstax.org/r/spreadsheet-file1) containing key Chapter 19 Excel exhibits.

Sales budgets "drive" the preparation of other budgets. If sales are expected to increase, purchases of inventory and some operating expenses would also increase. To meet the demand for goods and services (as defined in the sales budget), a purchases (inventory) budget would be prepared. In this example (Figure 19.8), the purchases budget shows projected purchases of inventory (merchandise) and the projected payments (also called disbursements) for each month.

Cash outflows as a result of purchases often do not equal the projected purchase amount. That is because payments for purchases are usually on credit (accounts payable), and so purchases for one month typically get spread out over a period of time that encompasses the current month and the month (or months) thereafter. To keep this example simple, the assumption is that the purchases are paid for in the following month (an average days payable outstanding of 30 days). However, in other cases, payment patterns may be based on other payment periods such as 45, 60, or even 90 days, depending on the trade credit terms.

	A	B	C	D	E	F	G
1		**January**	**February**	**March**	**April**	**May**	**June**
2	**Purchases**	$ 225,000	$ 270,000	$ 243,000	$ 219,000	$ 241,000	$ 260,000
3	Payments	190,000	225,000	270,000	243,000	219,000	241,000
4							
5		**July**	**August**	**September**	**October**	**November**	**December**
6	**Purchases**	300,000	293,000	288,000	259,000	207,000	200,000
7	Payments	$ 260,000	$ 300,000	$ 293,000	$ 288,000	$ 259,000	$ 207,000

Figure 19.8 Purchases Budget

An operating expense budget is prepared next and is basically a prediction of the selling and administrative expenditures of the company. Notice in Figure 19.9 that in the operating expense budget, cost of goods sold (an expense) is not included, nor are noncash expenses such as depreciation. The cash outlays related to goods sold, at least in a merchandising operation, are accounted for in the purchases budget (payments for purchases of inventory.)

With the sales, purchases, and operating expense budgets prepared, the cash budget can be prepared. Some of the "inputs" to the cash budget are from the sales (collections of cash), purchases (payments), and the operating expense budget (cash expenditures for selling and administrative expenses). A sample cash budget and a discussion of its preparation follows in the next section of this chapter.

Sample Cash Budget

A cash budget is the last budget to be prepared and is often part of the financial budget (cash budget, budgeted income statement, and budgeted balance sheet). The purpose of the cash budget is to estimate cash flows, to help ensure sufficient cash balances are maintained during the planning period, and to plan for external financing during periods of cash deficits.

When a budget is prepared in Excel, cash budget analysts can play “what if” with different scenarios to see when cash surpluses and deficits are expected. Cash surpluses means that funds can be invested in marketable securities to earn a rate of return, while cash deficits mean that financing, such as a line of credit, will be necessary (assuming forecasts are accurate).

Although the example shown in Figure 19.10 is a monthly cash budget, a cash budget could be prepared using any useful time elements: weekly, monthly, or quarterly.

One common practice is to use a rolling cash budget. A rolling cash budget is continually updated to add a new budget period, such as a month’s amount of cash flow activity, as the most recent budgeted month expires. For example, assume that a 12-month cash budget is prepared for a period covering January 20X1 to December 20X1. Once the month of January 20X1 has concluded, a 12-month planning period continues by add January 20X2 to the last column of the budget. The rolling cash monthly budget is an extension of the initial cash budget model, adding one month and thereby always extending cash flow projections one year into the future.

	A	B	C	D	E	F	G
1		**January**	**February**	**March**	**April**	**May**	**June**
2	**Wages and Salaries**	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
3	Payroll Taxes	20,000	20,000	20,000	20,000	20,000	20,000
4	Advertising and Marketing	50,000	50,000	50,000	50,000	50,000	50,000
5	Repairs and Maintenance	12,000	12,000	12,000	12,000	12,000	12,000
6	Rent	3,000	3,000	3,000	3,000	3,000	3,000
7	Shipping	5,520	6,000	7,200	6,480	5,832	6,415
8	Utilities	1,500	1,500	1,500	1,500	1,500	1,500
9	Insurance	2,050	2,050	2,050	2,050	2,050	2,050
10	Supplies	400	400	400	400	400	400
11	Taxes	7,000	7,000	7,000	7,000	7,000	7,000
12	**Total**	**$301,470**	**$301,950**	**$303,150**	**$302,430**	**$301,782**	**$302,365**
13							
14		**July**	**August**	**September**	**October**	**November**	**December**
15	**Wages and Salaries**	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
16	Payroll Taxes	20,000	20,000	20,000	20,000	20,000	20,000
17	Advertising and Marketing	50,000	60,000	60,000	55,000	50,000	50,000
18	Repairs and Maintenance	12,000	12,000	12,000	12,000	12,000	12,000
19	Rent	3,000	3,000	3,000	3,000	3,000	3,000
20	Shipping	6,960	8,004	7,836	7,680	6,912	5,520
21	Utilities	1,500	1,500	1,500	1,500	1,500	1,500
22	Insurance	2,050	2,050	2,050	2,050	2,050	2,050
23	Supplies	400	400	400	400	400	400
24	Taxes	7,000	7,000	7,000	7,000	7,000	7,000
25	**Total**	**$302,910**	**$313,954**	**$313,786**	**$308,630**	**$302,862**	**$301,470**

Figure 19.9 Operating Expenses Budget

	A	B	C	D	E	F	G
1		**January**	**February**	**March**	**April**	**May**	**June**
2	**Beginning Cash Balance**	$350,000	$258,530	$191,880	$131,730	$154,300	$152,218
3	Cash Collections	400,000	460,300	513,000	568,000	518,700	491,130
4	Cash Disbursements	491,470	526,950	573,150	545,430	520,782	543,365
5	Net Cash Flow	(91,470)	(66,650)	(60,150)	22,570	(2,082)	(52,235)
6	Preliminary Ending Cash Balance	258,530	191,880	131,730	154,300	152,218	99,983
7	Less: Minimum Cash Balance	50,000	50,000	50,000	50,000	50,000	50,000
8	Cash Surplus (Deficiency)	$208,530	$141,880	$81,730	$104,300	$102,218	$49,983
9	**Ending Cash Balance**	**$258,530**	**$191,880**	**$131,730**	**$154,300**	**$152,218**	**$99,983**
10							
11		**July**	**August**	**September**	**October**	**November**	**December**
12	**Beginning Cash Balance**	$99,983	$69,901	$50,000	$89,024	$129,784	$179,772
13	Cash Collections	532,828	587,880	645,810	637,390	611,850	538,680
14	Cash Disbursements	562,910	613,954	606,786	596,630	561,862	508,470
15	Net Cash Flow	(30,082)	(26,074)	39,024	40,760	49,988	30,210
16	Preliminary Ending Cash Balance	69,901	43,827	89,024	129,784	179,772	209,982
17	Less: Minimum Cash Balance	50,000	50,000	50,000	50,000	50,000	50,000
18	Cash Surplus (Deficiency)	$19,901	($6,173)	$39,024	$79,784	$129,772	$159,982
19	**Ending Cash Balance**	**$69,901**	**$50,000**	**$89,024**	**$129,784**	**$179,772**	**$209,982**

Figure 19.10 Sample Cash Budget

Using Figure 19.9 as an example, Table 19.5 shows the formulas that form the skeleton of a monthly cash budget.

Beginning Cash Balance	This is the amount of cash the company expects to have on the first day of the month. For example, in Figure 19.10, cell B2 is the amount of cash on Jan. 1 to start the year (the planning period). The remaining beginning cash balances for the months February through December are the ending cash balances of the previous month. For example, February's beginning cash balance (C2) is referenced from cell B9 (ending cash balance for January).
Cash Collections	These are the projected cash inflows from collections from customers (accounts receivable), cash sales, and any other significant cash inflows, such as dividends and interest on investments or sale of fixed assets. For example, the Cash Collections shown in the Sample Cash Budget (Figure 19.10) are referenced from the Sales and Collections Budget (Figure 19.7). January's Cash Collections (cell B3) in the Sample Cash Budget are from cell B12 of the Sales and Collection Budget.
Cash Disbursements	Cash disbursements are the projected cash outflows, such as those for operating expenses and payment of payables. For example, Cash Disbursements in the Sample Cash Budget for January (Figure 19.10) are the sum of January's payments for purchases in the Purchases Budget (Figure 19.8, cell B3) and the January operating expenses (Operating Expenses Budget, Figure 19.9, cell B12).
Net Cash Flow	The formula for net cash flow is For example, in Figure 19.10, the January Net Cash Flow is calculated in cell B5.
Preliminary Ending Cash Balance	Beginning Cash Balance + or - Net Cash Flow. This is the projected cash balance before taking into account the target cash balance to be maintained (minimum cash balance). In the Sample Cash Budget (Figure 19.10), the preliminary ending cash balance formula for January is =B2+B5 (B2 is the Beginning Cash Balance and B5 is the Net Cash Flow for the month).
Less: Minimum Cash Balance	This is a target cash balance that management sets; it is the minimum amount of cash that should be maintained by the company (in Figure 19.10, cells B2:G7 and B17:G17).

Table 19.5 Excel Formulas for Monthly Cash Budget

Cash Surplus (Deficiency)	A cash surplus means that cash can be invested in marketable securities. A cash deficiency means that some type of financing, such as a line of credit or bank loan, will be needed to provide enough cash for operations and to maintain a minimum cash balance. This number is found by subtracting the minimum cash balance from the preliminary ending cash balance. For example, the cash surplus for January in Figure 19.10 is calculated with this formula: =B6-B7. Notice that all months in the Sample Cash Budget show a surplus except for August's forecast of a deficit, which may require drawing on a line of credit to provide enough cash to meet obligations in August.

Table 19.5 Excel Formulas for Monthly Cash Budget

Summary

19.1 What Is Working Capital?

Working capital is not only necessary to run a business; it is a resource that will expand and contract with business cycles and must be carefully managed and monitored. The daily, weekly, and monthly needs of business operations are met by cash. Financial managers understand the significance of net working capital (current assets – current liabilities) and various liquidity ratios as they attempt to ensure that bills can be paid. The cash conversion cycle and the cash budget provide additional working capital management tools.

19.2 What Is Trade Credit?

Trade credit is very prevalent in the business world, especially in B2B (business-to-business) transactions. Many business exchanges (sales) could not take place without trade credit and the credit terms that are offered. Like any component of working capital, trade credit must be planned and managed. The creditor (the company granting the credit) does so based on an analysis of creditworthiness and must monitor payments and manage slow-paying accounts. The debtor (accounts payable) needs to make payments on time to keep a clean credit history and to take advantage of discounts.

19.3 Cash Management

Cash management is simply making sure you have enough cash to meet expected obligations and for contingencies (unexpected or emergency cash needs). Excess cash should be invested low-risk and highly liquid marketable securities. The cash budget is a critical tool of cash management.

19.4 Receivables Management

Accounts receivables are monitored by management with tools such as the ratios accounts receivable turnover and average collection period and the aging of receivables. The credit managers' mantra rings true: "The older the receivable, the greater the likelihood that the account will not be collected."

19.5 Inventory Management

Inventory, usually the least liquid of the current assets, presents its own set of management challenges. Finding the optimal level of inventory is probably more of an art than a science. JIT helps to reduce the investment in inventory and lower the costs of storage, but stockout costs can be very damaging to profitability.

19.6 Using Excel to Create the Short-Term Plan

Short-term plans of a business are funded with cash, with cash budgets being a critical tool of planning. The cash budget takes into account a target amount of cash, factoring in all the motives for holding cash. A cash budget looks ahead—predicting cash inflows and outflows, allocating for minimum cash balances to be maintained, and helping management determine short-term financing needed. Although it is the last budget prepared, the preparation of the cash budget is an important financial planning exercise of companies small and large.

Key Terms

accounts receivable aging schedule a report that shows amounts owed by customers by the age of the account, as measured by the number of days since the sale

allowance for doubtful accounts an account that contains the estimated amount of accounts receivable that will not be collected

bad debt expense an expense that a business incurs as a result of uncollectible accounts receivables

bankruptcies federal court procedures that protect distressed businesses from creditor collection efforts while allowing the debtor firm to liquidate its assets or devise a reorganization plan

benchmarking the process of performance analysis that involves comparing financial condition and operating results against a standard, called a benchmark

bill of lading a document that is a detailed list of a goods that have been shipped; a receipt given by the carrier (shipping company) to the seller as evidence that the goods have been shipped to the buyer

carrying costs all costs associated with having inventory in stock including storage costs, insurance, inventory obsolescence, and spoilage

cash budget a report that shows an estimation of cash inflows, outflows, and cash balances over a specific period of time, such as monthly, quarterly, or annually

cash cycle or cash conversion cycle the time period (measured in days) between when a business begins production and acquires resources from its suppliers (for example, acquisition of materials and other forms of inventory) and when it receives cash from its customers; offset by the time it takes to pay suppliers (called the payables deferral period)

cash discount discount granted to a customer who has purchased goods or services on account (credit) and pays the invoice within a certain number of days as specified by credit terms

compensating balance minimum balance of cash that a business must deposit and maintain in a bank account to obtain a loan

contra-asset an account with a balance that is used to offset (reduce) its related asset on the balance sheet (for example, allowance for doubtful accounts reduces the value of accounts receivable reported on the balance sheet)

credit period the number of days that a business purchaser has before they must pay their invoice

credit rating a type of score that indicates a business's creditworthiness

credit terms the terms that are part of a sales credit agreement that indicate when payment is due, possible discounts, and any fees that will be charged for a late payment

current assets assets that are cash or cash equivalents or are expected to be converted to cash in a short period of time and will be consumed, used, or expire through business operations within one year or the business's operating cycle, whichever is shorter

discount period the number of days the buyer has to take advantage of the cash discount for an early payment

factoring the process of selling accounts receivables to a financial institution or, in some cases, using the accounts receivables as security for a loan from a financial institution

floor planning a type of inventory financing whereby a financial institution provides a loan so that the company can acquire inventory with proceeds from the sale of inventory used to pay down the loan; a common method of financing inventory for automobile dealers and sellers of other big-ticket (high-priced) items

gross working capital synonymous with the current assets of a company, those assets that include cash and other assets that can be converted into cash within a period of 12 months

just-in-time inventory inventory management method in which a company maintains as little inventory on hand as possible while still being able to satisfy the demands of its customers

letter of credit a letter issued by a bank that is evidence of a guarantee for payments made to a specified entity (such as a supplier) under specified conditions; common in international trade transactions

liquidity ability to convert assets into cash in order to meet primarily short-term cash needs or emergencies

marketable securities investments that can be converted to cash quickly; short-term liquid securities that can be bought or sold on a public exchange (market) and tend to mature in a year or less

net terms also referred to as the full credit period; the number of days that a business purchaser has before they must pay their invoice

net working capital the difference between current assets and current liabilities (Current Assets – Current Liabilities = Net Working Capital)

operating cycle the time it takes a company to acquire inventory, sell inventory, and collect the cash from the sale of said goods; synonymous with cash cycle

opportunity cost the cost of a forgone opportunity

ordering costs costs associated with placing an order with a vendor or supplier

precautionary motive a reason to hold cash balances for unexpected expenditures such as repairs, costs associated with unexpected breakdown of equipment, and hiring temporary workers to meet unexpected production demands

quick payment a payment made on an account payable during a period of time that falls within the discount period

ratios numerical values taken from financial statements that are used in formulas to examine financial relationships and create metrics of performance, strengths, weaknesses; help analysts gain insight and meaning

speculative motive a reason for holding an amount of cash—to be able to take advantage of investment opportunities

stockout costs an opportunity cost (lost revenue) incurred when a customer order cannot be filled because the item is out of stock and the customer goes elsewhere for the product

supply chain the network of participants and activities between a company and its suppliers and the company and its customers; exists to distribute a product or to provide a service to the final buyer

trade credit credit granted to a business, also called accounts payable; allows a business to buy goods and services on account and pay the cash at some point in the future

transactional motive holding an amount of cash to meet operational expenditures such as payroll, payments to vendors, and loan payments

working capital the resources that are needed to meet the daily, weekly, and monthly operating cash flow needs

Multiple Choice

1. The term *working capital* is synonymous with _______.
   a. accounts payable
   b. current assets
   c. equity
   d. current liabilities

2. The formula for net working capital is _______.
   a. Current Assets – Current Liabilities
   b. Fixed Assets – Current Assets
   c. Assets – Liabilities
   d. Current Assets – Liabilities

3. When sales are made on credit, which current assets typically increase at the time of the sale?
   a. cash
   b. notes receivable
   c. accounts receivable
   d. marketable securities

4. Which of the following is NOT a goal of working capital management?
   a. meet the operational needs of the company
   b. satisfy obligations (current liabilities) as they come due
   c. maintain an optimal level of current assets
   d. maximize the investment in current assets

5. Accelerated Growth Inc. has the following account balances at year-end.

Property, Plant, and Equipment	$500,000
Accounts Payable	6,000
Intangible Assets	5,000
Cash	10,000
Marketable Securities (maturing in 6 months or less)	30,000
Retained Earnings	25,000
Interest Payable	2,000
Notes Payable (due in 24 months)	10,000
Accounts Receivable	20,000
Notes Payable (due in 6 months)	20,000
Common Stock	45,000
Dividends Payable	3,000
Inventory	$ 50,000

What is the cash ratio?

a. 1.29
b. 1.43
c. 1.71
d. .088

6. Which of the following is true of these credit terms: 3/15, n/30?
   a. 15 percent discount if the payable is paid within 3 days of the invoice date
   b. 3 percent discount if the payable is paid in the period between 15 days and 30 days after the invoice date
   c. 3 percent discount if the payable is paid within 15 days of the invoice date
   d. 30 percent discount if cash is paid on the sale date and 15% discount if paid 3 days after the invoice date

7. When reviewing its budgets, including the cash budget, management of Transcend Inc. have considered best-case and worst-case scenarios. As they completed their analysis, it was decided because of the possibility of unexpected repairs and unanticipated higher labor costs to add another $30,000 to the amount of the target cash balance to maintain throughout the year. The reason for this action would be which of these motives for holding cash?
   a. transaction motive
   b. opportunity cost mitigation motive
   c. precautionary motive
   d. speculative motive

8. A large retailer has more than $100 million of cash and cash equivalents on its balance sheet. Which of the following would not be part of the cash equivalents?
   a. cash in banks (checking account balances)
   b. US Treasury bond maturing in two years
   c. receivables from a bank that processes credit card payments
   d. commercial paper

9. An account receivable is created when ________.
   a. a customer pays its bill
   b. a company accepts a credit card, such as VISA or MasterCard
   c. a company sells to a customer on an open account
   d. a company sells to a customer only on a cash basis

10. Jackson's Moonshine LLC has a receivables collection period of 47 days. Which the following would be reasonable conclusions?
  a. Jackson's Moonshine LLC is most likely experiencing serious liquidity issues.
  b. Jackson's Moonshine LLC is most overinvested in marketable securities.
  c. If the industry average is 31 days, Jackson's management should attempt strategies that will lower their receivables collection period.
  d. If the industry average is 53 days, Jackson's management should attempt strategies that will raise their receivables collection period.

11. Two Way Power Ltd. (2WP) stocks an inventory item, BB3, that is projected to be in great demand over the next 12 months. In discussing its sales forecasts with its suppliers, a reasonable estimate shows that 2WP could lose about $30,000 of sales in month 3 due to inventory financing difficulties. Which, if any, of the following inventory costs would be affected by this development?
  a. purchase cost
  b. carrying costs
  c. ordering costs
  d. stockout costs
  e. none of these costs because loss of sales is not an inventory cost

12. If a company has significant inventory in each element of the value chain, it most likely is descriptive of ________.
  a. the cost of goods sold of a retailer
  b. the inventory balances held by wholesalers and service firms
  c. the materials, work in process, and finished goods of a manufacturer
  d. the inventory on the shelves of an e-commerce retailer

Review Questions

1. Intelligent Cookies Inc. (ICI) sold $30,000,000 of product in a year that had a cost of goods sold of $10,000,000. The average inventory carried by ICI was $500,000. On average, it takes 35 days for ICI's customers, such as grocery stores and restaurants, to pay on their accounts. ICI buys ingredients, including flour, spices, and eggs, from its vendors on credit, and ICI takes about 40 days to pay its suppliers. How many days is ICI's cash conversion cycle?

2. Shown below are account balances for Electra Engines Inc., a manufacturer. The accounts are shown in a random order. What is the amount of net working capital?

Net Working Capital $__________	
Property, Plant, and Equipment	$500,000
Accounts Payable	6,000
Intangible Assets	5,000
Cash	10,000
Marketable Securities (maturing in 6 months or less)	30,000
Retained Earnings	25,000
Interest Payable	2,000
Notes Payable (due in 24 months)	10,000
Accounts Receivable	20,000
Notes Payable (due in 6 months)	20,000
Common Stock	45,000
Dividends Payable	3,000
Inventory	$ 50,000

3. Shown below are account balances for Electra Engines Inc., a manufacturer. The accounts are shown in a random order. What is the current ratio and the quick ratio?

Property, Plant, and Equipment	$500,000
Accounts Payable	9,000
Intangible Assets	5,000
Cash	12,000
Marketable Securities (maturing in 6 months or less)	25,000
Retained Earnings	25,000
Interest Payable	2,500
Notes Payable (due in 24 months)	10,000
Accounts Receivable	25,000
Notes Payable (due in 6 months)	20,000
Common Stock	45,000
Dividends Payable	3,000
Inventory	55,000

4. Imagine that these are the cash collection cycles for some well-run companies:

Company	Cash Conversion Cycle
Grocery Chain	6.20
Building/Construction Company	162.69
Restaurant Chain	(4.06)
Department Store	63.60

What types of conclusions can you reach when you see this kind of variability?

Imagine that those cash conversion cycles are based on this information:

Company Type	Inventory Turnover	Accounts Receivable Turnover	Accounts Payable Turnover
Grocery Chain	14.60	91.00	16.00
Building/Construction Company	2.00	121.67	16.00
Restaurant Chain	150.00	100.00	36.00
Department Store	2.78	91.00	3.00

What would be your analysis of the cash conversion cycles based on the above information (inventory turnover, accounts receivable turnover, and accounts payable turnover)? Use the worksheet below to summarize your conclusions.

Worksheet

Company	Cash Conversion Cycle	Analysis
Grocery Chain	6.20	
Building/Construction Company	162.69	
Restaurant Chain	(4.06)	
Department Store	63.60	

5. What is the estimated annual percentage rate (APR) of not taking advantage of the early payment discount based on these terms: 4/15, n/45?

6. If you were a credit manager reviewing a potential customer's request for a $20,000 line of credit, what would you analyze? Generally, how would the 5Cs of Credit guide your analysis and help lead you to a prudent decision to accept or reject the request?

7. Aspire Excellent Inc. is a book publisher. On March 1, Aspire sells $25,000 of books to Get Your Books Inc. (YBI), a large bookstore chain. The sale is made on account with terms net 60. Aspire's customers usually take the full 60 days to pay their invoices. The books cost Aspire $10,000 to manufacture. Below, summarize the effect on the accounts on March 1 from the standpoint of the seller, Aspire Excellent Inc., and the buyer, YBI.

Aspire's Accounts	Change (Amount and Direction of Change: + or –) in the Account
Accounts Receivable	
Inventory	
Sales	
YBI's Accounts	**Change (Amount and Direction of Change: + or –) in the Account**
Accounts Payable	
Inventory	

8. The financial manager of New England Blissful Dairies, a distributor of milk, cream, and ice cream products, has finished the 12-month operating budget. For the month of June, the following projections were made:

June 1 Cash Balance $90,000
Cash Receipts $300,000
Cash Disbursement $350,000

Taking into account an amount of cash that the firm likes to maintain as a target (minimum cash balance) of $75,000, prepare the cash budget for June using the format below. Assume that, if necessary, the company will draw upon a preestablished line of credit with their bank to be able to maintain the target cash balance.

	June
Beginning Cash Balance	
Cash Collections	
Cash Disbursements	
Net Cash Flow	
Preliminary Ending Cash Balance	
Less: Minimum Cash Balance	
Cash Surplus (Deficiency)	
Ending Cash Balance	

Will the company need short-term financing?

9. The sales for Re-Works Inc., a company that fabricates iron fencing from recycled metals, are all on account. For the first three months of the year, Re-Works management expects the following sales:

	Sales
January	$120,000
February	$130,000
March	$140,000

Based on past collection patterns, management expects the following:

Month of Sale	10%
Month after Sale	50%
Remainder - Second Month after Sale	40%

Also, based on past experience, management forecasts that 5 percent of accounts receivable will be uncollectible and will eventually be written off.

What are the expected cash receipts for March?

10. With the same sales forecasts as in question 9, Re-Works Inc. management would like to implement some changes to credit policy and credit terms that they believe would change the collection pattern going forward and would lower the uncollectible accounts prediction to 3 percent.

What would be the expected cash receipts for March?

Month of Sale	15%
Month after Sale	55%
Remainder	30%
Bad Debt Expense	3%

Video Activity

How Companies Report Cash Flow

Click to view content (https://openstax.org/r/how-companies-report-cash-flow)

1. Why isn't the net income reported on a corporate balance sheet a good estimate of the increase in cash that occurred during the year?

2. What is the difference between a corporate cash budget and a projected statement of cash flows?

Trade Credit and Interest Rates on Short-Term Borrowing

Click to view content (https://openstax.org/r/cost-of-trade-credit)

3. Explain this statement: Accounts payable and accounts receivables are essentially financial opposites.
4. Accounts payable is often called “interest-free financing.” As such, explain why a company would choose to pay the amount owed on its purchases of inventory 50 days early. Base your answer on these facts:
   - The annualized cost of forgoing an early payment discount is approximately 16 percent.
   - The company’s cost of borrowing short-term on a bank line of credit is 9 percent.

20 Risk Management and the Financial Manager

Figure 20.1 Financial managers must consider prudent ways to manage economic volatility and the risk it poses to a company. (credit: modification of “Risk text on Dollar banknotes” by Marco Verch/flickr CC BY 2.0)

Chapter Outline

Why It Matters

Each year, American Airlines consumes approximately four billion gallons of jet fuel.[1] In the spring of 2018, jet fuel prices rose from an average of $2.07 per gallon to a price of $2.19 per gallon.[2] A $0.12-per-gallon increase in the price of jet fuel may not seem significant, but on an annualized basis, a price increase of this magnitude would increase the company’s jet fuel bill by approximately $500 million.

That added cost cuts into the profits of the company, leaving less money available to provide a return to the company’s investors. Rising costs could even cause the business to become unprofitable and close, causing many employees to lose their jobs. The financial managers of American Airlines are not able to control the price of jet fuel. However, they must be aware of the risk that price volatility poses to the company and consider prudent ways to manage this risk.

1 American Airlines. *American Airlines 2019 Environmental Data*. Accessed July 8, 2021. https://www.americanairlines.in/content/images/customer-service/about-us/corporate-governance/aag-2019-environmental-data.pdf
2 S&P Global. “Platts Jet Fuel.” *S&P Global Platts*. Accessed July 8, 2021. https://www.spglobal.com/platts/en/oil/refined-products/jetfuel#

20.1 The Importance of Risk Management

Learning Outcomes

By the end of this section, you will be able to:

- Describe risk in the context of financial management.
- Explain how risk can impact firm value.
- Distinguish between hedging and speculating.

What Is Risk?

The job of the financial manager is to maximize the value of the firm for the owners, or shareholders, of the company. The three major areas of focus for the financial manager are the size, the timing, and the riskiness of the cash flows of the company. Broadly, the financial manager should work to

- increase cash coming into the company and decrease cash going out of the company;
- speed up cash coming into the company and slow down cash going out of the company; and
- decrease the riskiness of both money coming in and money going out of the company.

The first item in this list is obvious. The more revenue a company has, the more profitable it will be. Businesspeople talk about “top line” growth when discussing this objective because revenue appears at the top of the company’s income statement. Also, the lower the company’s expenses, the more profitable the company will be. When businesspeople talk about the “bottom line,” they are focused on what will happen to a company’s net income. The net income appears at the bottom of the income statement and reflects the amount of revenue left over after all of the company’s expenses have been paid.

The second item in the list—the speed at which money enters and exits the company—has been addressed throughout this book. One of the basic principles of finance is the time value of money—the idea that a dollar received today is more valuable than a dollar received tomorrow. Many of the topics explored in this book revolve around the issue of the time value of money.

The focus of this chapter is on the third item in the list: risk. In finance, risk is defined as uncertainty. Risk occurs because you cannot predict the future. Compared to other business decisions, financial decisions are generally associated with contracts in which the parties of the contract fulfill their obligations at different points in time. If you choose to purchase a loaf of bread, you pay the baker for the bread as you receive the bread; no future obligation arises for either you or the baker because of this purchase. If you choose to buy a bond, you pay the issuer of the bond money today, and in return, the issuer promises to pay you money in the future. The value of this bond depends on the likelihood that the promise will be fulfilled.

Because financial agreements often represent promises of future payment, they entail risk. Even if the party that is promising to make a payment in the future is ethical and has every intention of honoring the promise, things can happen that can make it impossible for them to do so. Thus, much of financial management hinges on managing this risk.

Risk and Firm Value

You would expect the managers of Starbucks Corporation to know a lot about coffee. They must also know a lot about risk. It is not surprising that the term *coffee* appears in the text of the company’s 2020 annual report 179 times, given that the company’s core business is coffee. It might be surprising, however, that the term *risk* appears in the report 99 times.[3] Given that the text of the annual report is less than 100 pages long, the word *risk* appears, on average, more than once per page.

Starbucks faces a number of different types of risk. In 2020, corporations experienced an unprecedented risk because of COVID-19. Coffee shops were forced to remain closed as communities experienced government-

3 Starbucks. *Starbucks Fiscal 2020 Annual Report*. Seattle: Starbucks Corporation, 2020. https://s22.q4cdn.com/869488222/files/doc_financials/2020/ar/2020-Starbucks-Annual-Report.pdf

mandated lockdowns. Locations that were able to service customers through drive-up windows were not immune to declining revenue due to the pandemic. As fewer people gathered in the workplace, Starbucks experienced a declining number of to-go orders from meeting attendees. In addition, Starbucks locations faced the risk of illness spreading as baristas gathered in their buildings to fill to-go orders.

While COVID-19 brought discussions of risk to the forefront of everyday conversations, risk was an important focus of companies such as Starbucks before the pandemic began. (The term *risk* appeared in the company's 2019 annual report 82 times.[4]) Starbucks's business model revolves around turning coffee beans into a pleasurable drink. Anything that impacts the company's ability to procure coffee beans, produce a drink, and sell that drink to the customer will impact the company's profitability.

The investors in the company have allowed Starbucks to use its capital to lease storefronts, purchase espresso machines, and obtain all of the assets necessary for the company to operate. Debt holders expect interest to be paid and their principal to be returned. Stockholders expect a return on their investment. Because investors are risk averse, the riskier they perceive the cash flows they will receive from the business to be, the higher the expected return they will require to let the company use their money. This required return is a cost of doing business. Thus, the riskier the cash flows of a company, the higher the cost of obtaining capital. As any cost of operating a business increases, the value of the firm declines.

LINK TO LEARNING

Starbucks

The most recent annual report for Starbucks Corp., along with the reports from recent years, is available on the company's investor relations website under the Financial Data section (https://openstax.org/r/Financial_Data_section). Go to the most recent annual report for the company. Search for the word *risk* in the annual report, and read the discussions surrounding this topic. Note the major types of risk the company discusses. Pay attention to the types of risk that Starbucks categorizes as uncontrollable and which types of risk the company attempts to mitigate.

In the following sections, you will learn about some of the types of risk that firms commonly face. You will also learn about ways in which firms can reduce their exposure to these risks. When firms take actions to reduce their exposures to risk, they are said to be **hedging**. Firms hedge to try to protect themselves from losses. Thus, in finance, hedging is a risk management tool.

Certain strategies are commonly used by firms to hedge risk, which is part of corporate financial management. Many of these same strategies can be used by economic players who wish to speculate. **Speculating** occurs when someone bets on a future outcome. It involves trying to predict the future and profit off of that prediction, knowing that there is some risk that an incorrect prediction will lead to a loss. Speculators bet on the future direction of an asset price. Thus, speculation involves directional bets.

If you are concerned that the price of hand sanitizer is going to rise because people are concerned about a new virus and you purchase a few extra bottles to keep on your shelf "just in case," you are hedging. If you see this situation as a business opportunity and purchase bottles of hand sanitizer, hoping that you can sell them on eBay in a few weeks at twice what you paid for them, you are speculating.

In the popular press, you will often hear of some of the strategies in this chapter discussed in terms of people using them to speculate. In upper-level finance courses, these strategies are discussed in more depth, including how they might be used to speculate. In this chapter, however, the focus is on the perspective of a financial manager using these strategies to manage risk.

4 Starbucks. *Starbucks Fiscal 2019 Annual Report*. Seattle: Starbucks Corporation, 2019. https://s22.q4cdn.com/869488222/files/doc_financials/2019/2019-Annual-Report.pdf

20.2 Commodity Price Risk

Learning Outcomes

By the end of this section, you will be able to:

- Describe commodity price risk.
- Explain the use of long-term contracts as a hedge.
- Explain the use vertical integration as a hedge.
- Explain the use of futures contracts as a hedge.

One of the most significant risks that many companies face arises from normal business operations. Companies purchase raw materials to produce the products and provide the services they sell. A change in the market price of these raw materials can significantly impact the profitability of a company.

For example, Starbucks must purchase coffee beans in order to make its coffee drinks. The price of coffee beans is highly volatile. Sample prices of a pound of Arabica coffee beans over the past couple of decades are shown in Table 20.1. Over this period, the price of coffee beans ranged from a low of $0.52 per pound in the summer of 2002 to a high of over $3.00 per pound in the spring of 2011. The costs, and thus the profits, of Starbucks will vary greatly depending on if the company is paying less than $1.00 per pound for coffee or if it is paying three times that much.

Date	Price per Pound ($)
January 1, 2000	1.09
January 1, 2004	0.74
January 1, 2008	1.39
January 1, 2012	2.41
January 1, 2016	1.46
January 1, 2020	1.50

Table 20.1 Price of Coffee in Select Years, 2000-2020[5]

Long-Term Contracts

One method of hedging the risk of volatile input prices is for a firm to enter into long-term contracts with its suppliers. Starbucks, for example, could enter into an agreement with a coffee farmer to purchase a particular quantity of coffee beans at a predetermined price over the next several years.

These long-term contracts can benefit both the buyer and the seller. The buyer is concerned that rising commodity prices will increase its cost of goods sold. The seller, however, is concerned that falling commodity prices will mean lower revenue. By entering into a long-term contract, the buyer is able to lock in a price for its raw materials and the seller is able to lock in its sales price. Thus, both parties are able to reduce uncertainty.

While long-term contracts reduce uncertainty about the commodity price, and thus reduce risk, there are several possible disadvantages to these types of contracts. First, both parties are exposed to the risk that the other party may default and fail to live up to the terms of the contract. Second, these contracts cannot be entered into anonymously; the parties to the contract know each other's identity. This lack of anonymity may have strategic disadvantages for some firms. Third, the value of this contract cannot be easily determined, making it difficult to track gains and losses. Fourth, canceling the contract may be difficult or even impossible.

5 Data from International Monetary Fund. "Global Price of Coffee, Other Mild Arabica (PCOFFOTMUSDM)." FRED. Federal Reserve Bank of St. Louis, accessed August 6, 2021. https://fred.stlouisfed.org/series/PCOFFOTMUSDM

Vertical Integration

A common method of handling the risk associated with volatile input prices is **vertical integration**, which involves the merger of a company and its supplier. For Starbucks, a vertical integration would involve Starbucks owning a coffee bean farm. If the price of coffee beans rises, the firm's costs increase and the supplier's revenues rise. The two companies can offset these risks by merging.

Although vertical integration can reduce commodity price risk, it is not a perfect hedge. Starbucks may decrease its commodity price risk by purchasing a coffee farm, but that action may expose it to other risks, such as land ownership and employment risk.

Futures Contracts

Another method of hedging commodity price risk is the use of a futures contract. A commodity futures contract is designed to avoid some of the disadvantages of entering into a long-term contract with a supplier. A **futures contract** is an agreement to trade an asset on some future date at a price locked in today. Futures exist for a range of commodities, including natural resources such as oil, natural gas, coal, silver, and gold and agricultural products such as soybeans, corn, wheat, rice, sugar, and cocoa.

Futures contracts are traded anonymously on an exchange; the market price is publicly observable, and the market is highly liquid. The company can get out of the contract at any time by selling it to a third party at the current market price.

A futures contract does not have the credit risk that a long-term contract has. Futures exchanges require traders to post **margin** when buying or selling commodities futures contracts. The margin, or collateral, serves as a guarantee that traders will honor their obligations. Additionally, through a procedure known as **marking to market**, cash flows are exchanged daily rather than only at the end of the contract. Because gains and losses are computed each day based on the change in the price of the futures contract, there is not the same risk as with a long-term contract that the counterparty to the contract will not be able to fulfill their obligation.

THINK IT THROUGH

The CME Group

In 2007, the Chicago Mercantile Exchange merged with the Chicago Board of Trade to form CME Group Inc. CME Group provides trading in futures as well as other types of contracts that companies can use to hedge risk.

You can watch the video Getting Started with Your Broker (https://openstax.org/r/Getting_Started_with_Your_Broker) to learn how futures contracts for agricultural products such as coffee beans, corn, wheat, and soybeans are traded. You will also see other types of futures contracts traded, including futures for silver, crude oil, natural gas, Japanese yen, and Russian rubles.

20.3 Exchange Rates and Risk

Learning Outcomes

By the end of this section, you will be able to:

- Describe exchange rate risk.
- Identify transaction, translation, and economic risks.
- Describe a natural hedge.
- Explain the use of forward contracts as a hedge.
- List the characteristics of an option contract.
- Describe the payoff to the holder and writer of a call option.
- Describe the payoff to the holder and writer of a put option.

The managers of companies that operate in the global marketplace face additional complications when managing the riskiness of their cash flows compared to domestic companies. Managers must be aware of differing business climates and customs and operate under multiple legal systems. Often, business must be conducted in multiple languages. Geopolitical events can impact business relationships. In addition, the company may receive cash flows and make payments in multiple currencies.

Exchange Rates

The costs to companies are impacted when the prices of the raw materials they use change. Very little coffee is grown in the United States. This means that all of those coffee beans that Starbucks uses in its espresso machines in Seattle, New York, Miami, and Houston were bought from suppliers outside of the United States. Brazil is the largest coffee-producing country, exporting about one-third of the world's coffee.[6] When a company purchases raw materials from a supplier in another country, the company needs not just money but the money that is used in that country to make the purchase. Thus, the company is concerned about the **exchange rate**, or the price of the foreign currency.

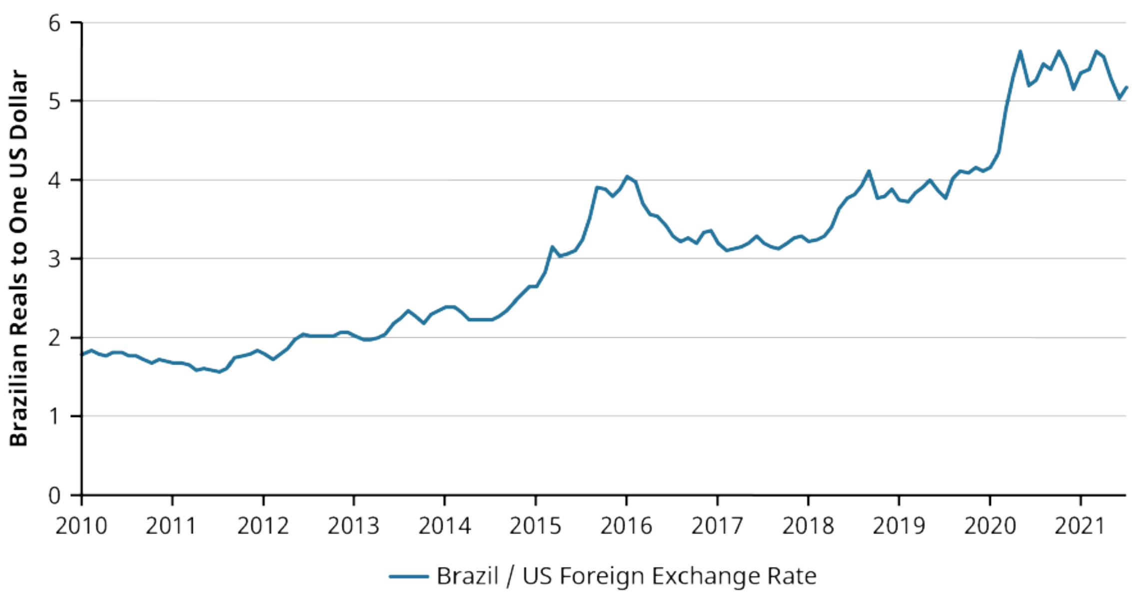

Figure 20.2 Brazilian Reals to One US Dollar[7]

The currency used in Brazil is called the Brazilian real. Figure 20.2 shows how many Brazilian reals could be purchased for $1.00 from 2010 through the first quarter of 2021. In March 2021, 5.4377 Brazilian reals could be purchased for $1.00. This will often be written in the form of

6 Global Agricultural Information Network. *Brazil: Coffee Annual 2019*. GAIN Report No. BR19006. Washington, DC: USDA Foreign Agricultural Service, May 2019. https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Coffee%20Annual_Sao%20Paulo%20ATO_Brazil_5-16-2019.pdf

$$\text{USD } 1 = \text{BRL } 5.4377$$

BRL is an abbreviation for Brazilian real, and USD is an abbreviation for the US dollar. This price is known as a currency exchange rate, or the rate at which you can exchange one currency for another currency.

If you know the price of $1.00 is 5.4377 Brazilian reals, you can easily find the price of Brazilian reals in US dollars. Simply divide both sides of the equation by 5.4377, or the price of the US dollar:

$$\begin{aligned} \text{USD } 1 &= \text{BRL } 5.4377 \\ \frac{\text{USD } 1}{5.4377} &= \frac{\text{BRL } 5.4377}{5.4377} \\ \text{USD } 0.1839 &= \text{BRL } 1 \end{aligned}$$

If you have US dollars and want to purchase Brazilian reals, it will cost you $0.1839 for each Brazilian real you want to buy.

The foreign exchange rate changes in response to demand for and supply of the currency. In early 2020, the exchange rate was $\text{USD } 1 = \text{BRL } 4$. In other words, $1 purchased fewer reals in early 2020 than in it did a year later. Because you receive more reals for each dollar in 2021 than you would have a year earlier, the dollar is said to have **appreciated** relative to the Brazilian real. Likewise, because it takes more Brazilian reals to purchase $1.00, the real is said to have **depreciated** relative to the US dollar.

Exchange Rate Risks

Starbucks, like other firms that are engaged in international business, faces currency exchange rate risk. Changes in exchange rates can impact a business in several ways. These risks are often classified as transaction, translation, or economic risk.

Transaction Risk

Transaction risk is the risk that the value of a business's expected receipts or expenses will change as a result of a change in currency exchange rates. If Starbucks agrees to pay a Brazilian coffee grower seven million Brazilian reals for an order of one million pounds of coffee beans, Starbucks will need to purchase Brazilian reals to pay the bill. How much it will cost Starbucks to purchase these Brazilian reals depends on the exchange rate at the time Starbucks makes the purchase.

In March 2021, with an exchange rate of $\text{USD } 0.1839 = \text{BRL } 1$, it would have cost Starbucks $\$0.1839 \times 7{,}000{,}000 = \$1{,}287{,}300$ to purchase the reals needed to receive the one million pounds of coffee beans. If, however, Starbucks agreed in March to purchase the coffee beans several months later, in July, Starbucks would not have known then what the exchange rate would be when it came time to complete the transaction. Although Starbucks would have locked in a price of BRL 7,000,000 for one million pounds of coffee beans, it would not have known what the coffee beans would cost the company in terms of US dollars.

If the US dollar appreciated so that it cost less to purchase each Brazilian real in July, Starbucks would find that it was paying less than $1,287,300 for the coffee beans. For example, suppose the dollar appreciated so that the exchange rate was $\text{USD } 0.1800 = \text{BRL } 1$ in July 2021. Then the coffee beans would only cost Starbucks $\$0.1800 \times 7{,}000{,}000 = \$1{,}260{,}000$.

On the other hand, if the US dollar depreciated and it cost more to purchase each Brazilian real, then Starbucks would find that its dollar cost for the coffee beans was higher than it expected. If the US dollar depreciated (and the Brazilian real appreciated) so that the exchange rate was $\text{USD } 0.2000 = \text{BRL } 1$ in July 2021, then the coffee beans would cost Starbucks $\$0.2000 \times 7{,}000{,}000 = \$1{,}000{,}400$. This uncertainty regarding the dollar cost of the coffee beans Starbucks would purchase to make its lattes is an example of transaction risk.

7 Data from Board of Governors of the Federal Reserve System (US). "Brazil / US Foreign Exchange Rate (DEXBZUS)." FRED. Federal Reserve Bank of St. Louis, accessed August 6, 2021. https://fred.stlouisfed.org/series/DEXBZUS

A global company such as Starbucks has transaction risk not only because it is purchasing raw materials in foreign countries but also because it is selling its product—and thus collecting revenue—in foreign countries. Customers in Japan, for example, spend Japanese yen when they purchase a Starbucks cappuccino, coffee mug, or bag of coffee beans. Starbucks must then convert these Japanese yen to US dollars to pay the expenses that it incurs in the United States to produce and distribute these products.

The Japanese yen–US dollar foreign exchange rates from 2011 through the first quarter of 2021 are shown in Figure 20.3. In 2012, $1.00 could be purchased with fewer than 80 Japanese yen. In 2015, it took over 120 yen to purchase $1.00.

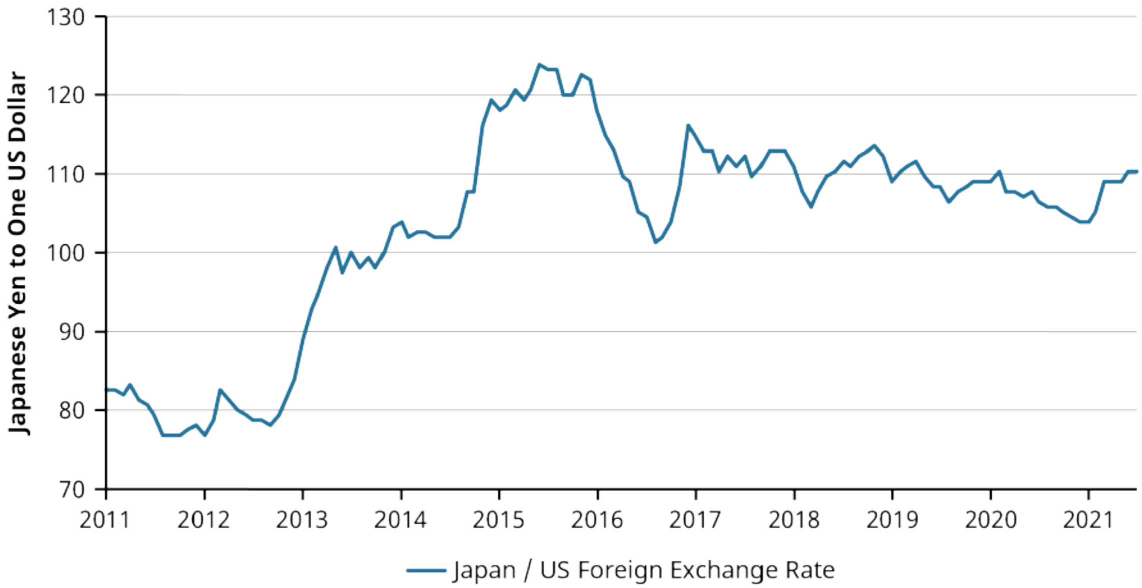

Figure 20.3 Japanese Yen to One US Dollar[8]

If a company is receiving yen from customers and paying expenses in dollars, the company is harmed when the yen depreciates relative to the dollar, meaning that the yen the company receives from its customers can be exchanged for fewer dollars. Conversely, when the yen appreciates, it takes fewer yen to purchase each dollar; this appreciation of the yen benefits companies with revenues in yen and expenses in dollars.

THINK IT THROUGH

Projecting Sales in US Dollars

The managers of a firm think that the exchange rate of Japanese yen to US dollars will be $\text{JPY}\ \ 100 = \text{USD}\ \ 1$ next year. If the company thinks that it will have sales of 50 million yen next year, how much will it project these sales will be worth in dollars? What happens if the actual exchange rate over the next year is $\text{JPY}\ \ 120 = \text{USD}\ \ 1$?

Solution:

An exchange rate of $\text{JPY}\ \ 100 = \text{USD}\ \ 1$ implies that $\text{JPY}\ \ 1 = \text{USD}\ \ 0.0100$. If the company expects to have sales of JPY 50,000,000, it is expecting sales to be worth USD 500,000. If the exchange rate is really $\text{JPY}\ \ 120 = \text{USD}\ \ 1$, this is the same as $\text{JPY}\ \ 1 = \text{USD}\ \ 0.0083$. With this exchange rate, JPY 50,000,000 in sales would be equivalent to USD 415,000. The company would receive $85,000 less from these sales in Japan than it was expecting, even if it met its goals as far as the number of units of items sold.

8 Data from Board of Governors of the Federal Reserve System (US). “Japan / US Foreign Exchange Rate (DEXJPUS).” FRED. Federal Reserve Bank of St. Louis, accessed August 6, 2021. https://fred.stlouisfed.org/series/DEXJPUS

Translation Risk

In addition to the transaction risk, if Starbucks holds assets in a foreign country, it faces **translation risk**. Translation risk is an accounting risk. Starbucks might purchase a coffee plantation in Costa Rica for 120 million Costa Rican colones. This land is an asset for Starbucks, and as such, the value of it should appear on the company's balance sheet.

The balance sheet for Starbucks is created using US dollar values. Thus, the value of the coffee plantation has to be translated to dollars. Because exchange rates are volatile, the dollar value of the asset will vary depending on the day on which the translation takes place. If the exchange rate is 500 colones to the dollar, then this coffee plantation is an asset with a value of $240,000. If the Costa Rican colón depreciates to 600 colones to the dollar, then the asset has a value of only $200,000 when translated using this exchange rate.

Although it is the same piece of land with the same productive capacity, the value of the asset, as reported on the balance sheet, falls as the Costa Rican colón depreciates. This decrease in the value of the company's assets must be offset by a decrease in the stockholders' equity for the balance sheet to balance. The loss is due simply to changes in exchange rates and not the underlying profitability of the company.

Economic Risk

Economic risk is the risk that a change in exchange rates will impact a business's number of customers or its sales. Even a company that is not involved in international transactions can face this type of risk. Consider a company located in Mississippi that makes shirts using 100% US-grown cotton. All of the shirts are made in the United States and sold to retail outlets in the United States. Thus, all of the company's expenses and revenues are in US dollars, and the company holds no assets outside of the United States.

Although this firm has no financial transactions involving international currency, it can be impacted by changes in exchange rates. Suppose the US dollar strengthens relative to the Vietnamese dong. This will allow US retail outlets to purchase more Vietnamese dong, and thus more shirts from Vietnamese suppliers, for the same amount of US dollars. Because of this, the retail outlets experience a drop in the cost of procuring the Vietnamese shirts relative to the shirts produced by the firm in Mississippi. The Mississippi company will lose some of its customers to these Vietnamese producers simply because of a change in the exchange rate.

Hedging

Just as companies may practice hedging techniques to reduce their commodity risk exposure, they may choose to hedge to reduce their currency risk exposure. The types of futures contracts that we discussed earlier in this chapter exist for currencies as well as for commodities. A company that knows that it will need Korean won later this year to purchase raw materials from a South Korean supplier, for example, can purchase a futures contract for Korean won.

While futures contracts allow companies to lock in prices today for a future commitment, these contracts are not flexible enough to meet the risk management needs of all companies. Futures contracts are standardized contracts. This means that the contracts have set sizes and maturity dates. Futures contracts for Korean won, for example, have a contract size of 125 million won. A company that needs 200 million won later this year would need to either purchase one futures contract, hedging only a portion of its needs, or purchase two futures contracts, hedging more than it needs. Either way, the company has remaining currency risk.

In this next section, we will explore some additional hedging techniques.

Forward Contracts

Suppose a company needs access to 200 million Korean won on March 1. In addition to a specified contract size, currency futures contracts have specified days on which the contracts are settled. For most currency futures contracts, this occurs on the third Wednesday of the month. If the company needed 125 million Korean won (the basic contract size) on the third Wednesday of March (the standard settlement date), the futures contract could be useful. Because the company needs a different number of Korean won on a different date from those specified in the standard contract, the futures contract is not going to meet the specific risk management needs of the company.

Another type of contract, the **forward contract**, can be used by this company to meet its specific needs. A forward contract is simply a contractual agreement between two parties to exchange a specified amount of currencies at a future date. A company can approach its bank, for example, saying that it will need to purchase 200 million Korean won on March 1. The bank will quote a forward rate, which is a rate specified today for the sale of currency on a future date, and the company and the bank can enter into a forward contract to exchange dollars for 200 million Korean won at the quoted rate on March 1.

Because a forward contract is a contract between two parties, those two parties can specify the amount that will be traded and the date the trade will occur. This contract is similar to your agreeing with a hotel that you will arrive on March 1 and rent a room for three nights at $200 per night. You are agreeing today to show up at the hotel on a future (specified) date and pay the quoted price when you arrive. The hotel agrees to provide you the room on March 1 and cannot change the price of the room when you arrive. With a forward contract, you are also agreeing that you will indeed make the purchase and you cannot change your mind; so, using the hotel room analogy, this would mean that the hotel will definitely charge your credit card for the agreed-upon $200 per night on March 1.

The forward contract is an individualized contract between the buyer and the seller; they are both under a contractual obligation to honor the contract. Because this contract is not standardized like the futures contract (so that it can be traded on an exchange), it can be tailored to the needs of the two parties. While the forward contract has the advantage of being fine-tuned to meet the company's needs, it has a risk, known as *counterparty risk*, that the futures contract does not have. The forward contract is only as good as the promise of the counterparty. If the company enters into a forward contract to purchase 200 million Korean won on March 1 from its bank and the bank goes out of business before March 1, the company will not be able to make the exchange with a nonexistent bank. The exchanges on which futures contracts are traded guard the purchaser of a futures contract from this type of risk by guaranteeing the contract.

Natural Hedges

A hedge simply refers to a reduction in the risk or exposure that a company has to volatility and uncertainty. We have been focusing on how a company might use financial market instruments to hedge, but sometimes a company can use a **natural hedge** to mitigate risk. A natural hedge occurs when a business can offset its risk simply through its own operations. With a natural hedge, when a risk occurs that would decrease the value of a company, an offsetting event occurs within the firm that increases the value of the company.

As an example, consider a British-based travel agency. One of the major tours the company offers is a tour of Italy. The company arranges for transportation, lodging, meals, and sightseeing for Brits to visit the highlights of Rome, Florence, and Venice. Because the company charges customers in British pounds but must pay the bus companies, hotels, and other service providers in Italy in euros, the travel agency faces significant transaction exposure. If the value of the British pound depreciates after the company sets the price it will charge for the tour but before it pays the Italian suppliers, the company will be harmed. In fact, if the British pound depreciates by a great deal, the company could end up in a situation in which the British pounds it collects are not enough to purchase the euros it needs to pay its suppliers.

The company could create a natural hedge by offering tours of London to individuals living in the European Union. The travel agency could charge people who live in Germany, Italy, Spain, or any other country that has the euro as its currency for a travel package to London. Then the agency would pay British restaurants, tour guides, hotels, and bus companies in British pounds. This segment of the business also has currency risk. If the British pound depreciates, the company gains because the euros it collects from its EU customers will purchase more British pounds than before.

Thus, the company has created a situation in which if the British pound depreciates, the decrease in value of its tours of Italy is exactly offset by the increase in value of its tours of London. If the British pound appreciates, the opposite occurs: the company experiences a gain in its division that charges British pounds for tourists traveling to Italy and an offsetting loss in its division that charges euros for tourists traveling to London.

Options

A financial **option** gives the owner the right, but not the obligation, to purchase or sell an asset for a specified price at some future date. Options are considered **derivative** securities because the value of a derivative is derived from, or comes from, the value of another asset.

Options Terminology

Specific terminology is used in the finance industry to describe the details of an options contract. If the owner of an option decides to purchase or sell the asset according to the terms of the options contract, the owner is said to be **exercising** the option. The price the option holder pays if purchasing the asset or receives if selling the asset is known as the *strike price* or *exercise price*. The price the owner of the option paid for the option is known as the *premium*.

An option contract will have an **expiration date**. The most common kinds of options are **American options**, which allow the holder to exercise the option at any time up to and including the expiration date. Holders of **European options** may exercise their options only on the expiration date. The labels *American option* and *European option* can be confusing as they have nothing to do with the location where the options are traded. Both American and European options are traded worldwide.

Option contracts are written for a variety of assets. The most common option contracts are options on shares of stock. Options are traded for US Treasury securities, currencies, gold, and oil. There are also options on agricultural products such as wheat, soybeans, cotton, and orange juice. Thus, options can be used by financial managers to hedge many types of risk, including currency risk, interest rate risk, and the risk that arises from fluctuations in the prices of raw materials.

Options are divided into two main categories, call options and put options. A **call option** gives the owner of the option the right, but not the obligation, to buy the underlying asset. A **put option** gives the owner the right, but not the obligation, to sell the underlying asset.

Call Options

If a Korean company knows that it will need pay a $100,000 bill to a US supplier in six months, it knows how many US dollars it will need to pay the bill. As a Korean company, however, its bank account is denominated in Korean won. In six months, it will need to use its Korean won to purchase 100,000 US dollars.

The company can determine how many Korean won it would take to purchase $100,000 today. If the current exchange rate is $\text{KWN } 1{,}100 = \text{USD } 1$, then it will need KWN 110,000,000 to pay the bill. The current exchange rate is known as the **spot rate**.

The company, however, does not need the US dollars for another six months. The company can purchase a call option, which is a contract that will allow it to purchase the needed US dollars in six months at a price stated in the contract. This allows the company to guarantee a price for dollars in six months, but it does not obligate the company to purchase the dollars at that price if it can find a better price when it needs the dollars in six months.

The price that is in the contract is called the **strike price (exercise price)**. Suppose the company purchases a call contract for US dollars with a strike price of KWN 1,200/USD. While this contract would be for a set size, or a certain number of US dollars, we will talk about this transaction as if it were per one US dollar to highlight how options contracts work.

The company must pay a price, known as the **premium**, to purchase this call option contract. For our example, let’s assume the premium for the call option contract is KWN 50. In other words, the company has paid KWN 50 for the right to buy US dollars in six months for a price of KWN 1,200/USD.

In six months, the company makes a choice to either (1) pay the strike price of KWN 1,200/USD or (2) let the option expire. If the company chooses to pay the strike price and purchase the US dollars, it is exercising the option. How does the company choose which to do? It simply compares the strike price of KWN 1,200/USD to the market, or spot, exchange rate at the time the option is expiring.

If, six months from now, the spot exchange rate is $\text{KWN } 1{,}150 = \text{USD } 1$, it will be cheaper for the company to buy the US dollars it needs at the spot price than it would be to buy the dollars with the option. In fact, if the spot rate is anything below $\text{KWN } 1{,}200 = \text{USD } 1$, the company will not choose to exercise the option. If, however, the spot exchange rate in six months is $\text{KWN } 1{,}300 = \text{USD } 1$, the company will exercise the option and purchase each US dollar for only KWN 1,200.

The profitability, or the payoff, to the owner of a call option is represented by the chart in Figure 20.4 below. Possible spot prices are measured from left to right, and the financial gain or loss to the company of the option contract is measured vertically. If the spot price is anything less than KWN 1,200/USD, the option expires without being exercised. The company paid KWN 50 for something that ended up being worthless.

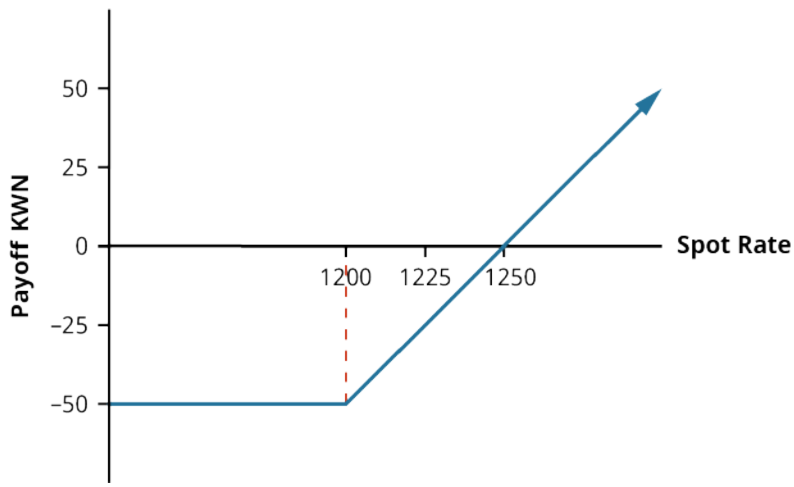

Figure 20.4 The Payoff to the Holder of a Call Option

If, in six months, the spot exchange rate is $\text{KWN } 1{,}225 = \text{USD } 1$, then the company will choose to exercise the option. The company will be saving KWN 25 for each dollar purchased, but the company originally paid 50 KWN for the contract. So, the company will be 25 KWN worse off than if it had never purchased the call option.

If the spot exchange rate is $\text{KWN } 1{,}250 = \text{USD } 1$, the company will be in exactly the same position having purchased and exercised the call option as it would have been if it had not purchased the option. At any spot price higher than KWN 1,250/USD, the firm will be in a better financial position, or will have a positive payoff, because it purchased the call option. The more the Korean won depreciates over the next six months, the higher the payoff to the firm of owning the call contract. Purchasing the call contract is a way that the company can protect itself from the currency exposure it faces.

For any transaction, there must be two parties—a buyer and a seller. For the company to have purchased the call option, another party must have sold the call option. The seller of a call option is called the **option writer**. Let’s consider the potential benefits and risks to the writer of the call option.

When the company purchases the call option, it pays the premium to the writer. The writer of the option does not have a choice regarding whether the option will be exercised. The purchaser of the option has the right to make the choice; in essence, the writer of the option sold the right to make that decision to the purchasers of the call option.

Figure 20.5 shows the payoff to the writer of the call option. Recall that the buyer of the call option will let the option expire if the spot rate is less than $\text{KWN } 1{,}200 = \text{USD } 1$ when the call option matures in six months. If this occurs, the writer of the option collected the KWN 50 option premium when the contract was sold and then never hears from the purchaser again. This is what the writer of the option is hoping for; the writer of the call option profits when the options contract is not exercised

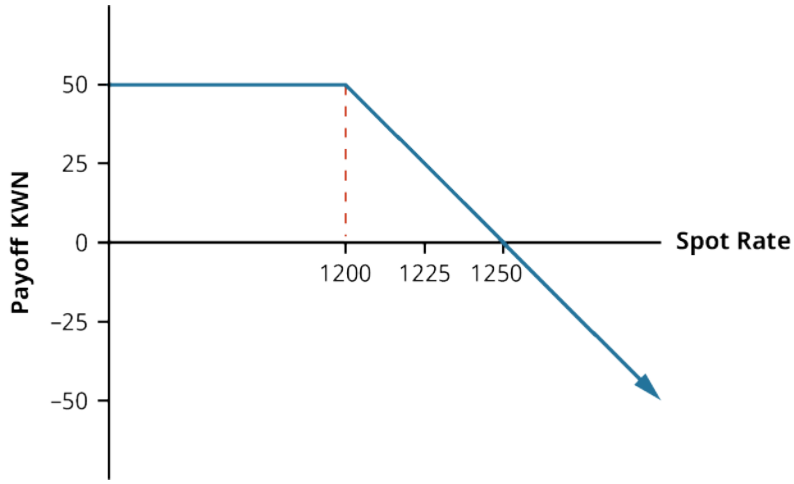

Figure 20.5 The Payoff to the Writer of a Call Option

If the spot rate is above $\text{KWN } 1{,}200 = \text{USD } 1$, then the holder of the option will choose to exercise the right to purchase the won at the option strike price. Then the writer of the option will be obligated to sell the Korean won at a price of KWN 1,200/USD. If the spot rate is $\text{KWN } 1{,}250 = \text{USD } 1$, the option writer will be obligated to sell the dollars for KWN 50 less than what they are worth; because the option writer was initially paid a KWN 50 premium for taking on that obligation, the option writer will just break even. For any exchange rate higher than $\text{KWN } 1{,}250 = \text{USD } 1$, the writer of the call option will have a loss.

The option contract is a zero-sum game. Any payoff the owner of the option receives is exactly equal to the loss the writer of the option has. Any loss the owner of the option has is exactly equal to the payoff the writer of the option receives.

Put Options

While the call option you just considered gives the owner the right to buy an underlying asset, the put option gives the owner to right to sell an underlying asset. Take, for example, an Indian company that has a contract to provide graphic artwork for a US company. The US company will pay the Indian company 200,000 US dollars in three months.

While the Indian company receives US dollars, it must pay its workers in Indian rupees. Because the company does not know what the spot exchange rate will be in three months, it faces transaction risk and may be interested in hedging this exposure using a put option.

The company knows that the current spot rate is $\text{INR } 75 = \text{USD } 1$, meaning that the company would be able to use $200,000 to purchase $\text{USD } 200{,}000 \times \frac{\text{INR } 75}{\text{USD}} = \text{INR } 15{,}000{,}000$ if it possessed the $200,000 today. If the Indian rupee appreciates relative to the US dollar over the next three months, however, the company will receive fewer rupees when it makes the exchange; perhaps the company will not be able to purchase enough rupees to cover the wages of its employees.

Assume the company can purchase a put option that gives it the right to sell US dollars in three months at a strike price of INR 75/USD; the premium for this put option is INR 5. By purchasing this put option, the company is spending INR 5 to guarantee that it can sell its US dollars for rupees in three months at a price of INR 75/USD.

If, in three months, when the company receives payment in US dollars, the spot exchange rate is higher than $\text{INR } 75 = \text{USD } 1$, the company will simply exchange the US dollars for rupees at that exchange rate, allowing the put option to expire without exercising it. The payoff to the company for the option is INR -5, the premium that was paid for the option that was never used (see Figure 20.6).

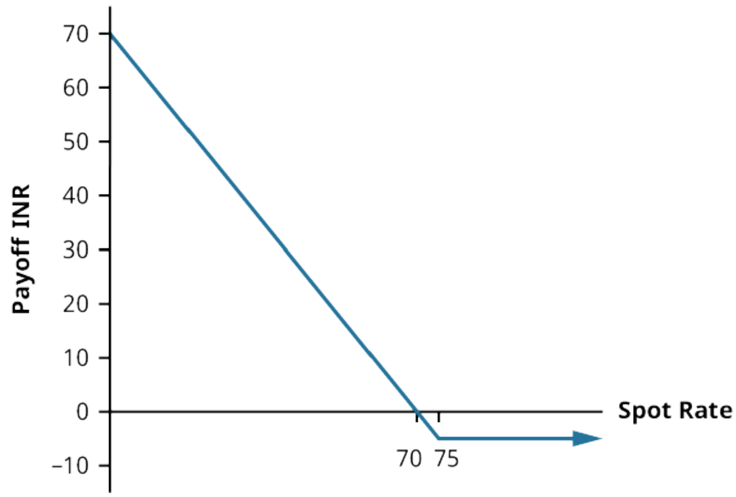

Figure 20.6 The Payoff to the Holder of a Put Option

If, however, in three months, the spot exchange rate is anything less than $\text{INR } 75 = \text{USD } 1$, then the company will choose to exercise the option. If the spot rate is between $\text{INR } 70 = \text{USD } 1$ and $\text{INR } 75 = \text{USD } 1$, the payoff for the option is negative. For example, if the spot exchange rate is $\text{INR } 72 = \text{USD } 1$, the company will exercise the option and receive three more Indian rupees per dollar than it would in the spot market. However, the company had to spend INR 5 for the option, so the payoff is INR -2. At a spot exchange rate of $\text{INR } 70 = \text{USD } 1$, the company has a zero payoff; the benefit of exercising the option, INR 5, is exactly equal to the price of purchasing the option, the premium of INR 5.

If, in three months, the spot exchange rate is anything below $\text{INR } 70 = \text{USD } 1$, the payoff of the put option is positive. At the theoretical extreme, if the USD became worthless and would purchase no rupees in the spot market when the company received the dollars, the company could exercise its option and receive INR 75/USD, and its payoff would be INR 70.

Now that we have considered the payoff to a purchaser of a put contract, let’s consider the opposite side of the contract: the seller, or writer, of the put option. The writer of a put option is selling the right to sell dollars to the purchaser of the put option. The writer of the put option collects a premium for this. The writer of the put has no choice as to whether the put option will be exercised; the writer only has an obligation to honor the contract if the owner of the put option chooses to exercise it.

The owner of the option will choose to let the option expire if the spot exchange rate is anything above $\text{INR } 75 = \text{USD } 1$. If that is the case, the writer of the put option collects the INR 5 premium for writing the put, as shown by the horizontal line in Figure 20.7. This is what the writer of the put is hoping will occur.

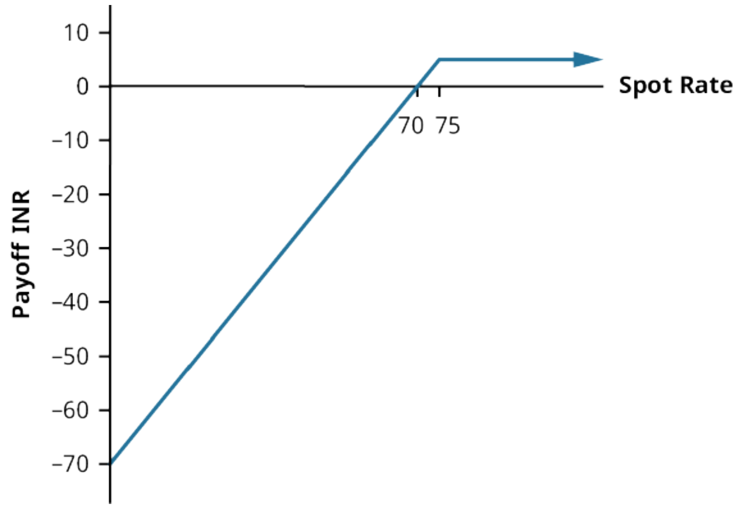

Figure 20.7 The Payoff to the Writer of a Put Option

The owner of the option will choose to exercise the option if the exchange rate is less than $\text{INR}\ 75 = \text{USD}\ 1$. If the spot exchange rate is between $\text{INR}\ 70 = \text{USD}\ 1$ and $\text{INR}\ 75 = \text{USD}\ 1$, the writer of the put option has a positive payoff. Although the writer must now purchase US dollars for a price higher than what the dollars are worth, the INR 5 premium that the writer received when entering into the position is more than enough to offset that loss.

If the spot exchange rate drops below $\text{INR}\ 70 = \text{USD}\ 1$, however, the writer of the put option is losing more than INR 5 when the option is exercised, leaving the writer with a negative payoff. In the extreme, the writer of the put will have to purchase worthless US dollars for INR 75/USD, resulting in a loss of INR 70.

Notice that the payoff to the writer of the put is the negative of the payoff to the holder of the put at every spot price. The highest payoff occurs to the writer of the put when the option is never exercised. In that instance, the payoff to the writer is the premium that the holder of the put paid when purchasing the option (see Figure 20.7).

Table 20.2 provides a summary of the positions that the parties who enter into options contract are in. Remember that the buyer of an option is always the one purchasing the right to do something. The seller or writer of an option is selling the right to make a decision; the seller has the obligation to fulfill the contract should the buyer of the option choose to exercise the option. The most the seller of an option can ever profit is by the premium that was paid for the option; this occurs when the option is not exercised.

			Benefits		Harm	
Party to an Option Contract	**Right of the Party**	**Obligation of the Party**	**When**	**Maximum Profit**	**When**	**Maximum Loss**
Buyer of a call	To buy		Price of underlying rises	Unlimited	Price of underlying falls	Premium paid
Seller of a call		To sell	Price of underlying falls	Premium received	Price of underlying rises	Unlimited
Buyer of a put	To sell		Price of underlying falls	Strike price minus premium	Price of underlying rises	Premium paid

Table 20.2 Summary of Option Contracts

			Benefits		Harm	
Party to an Option Contract	Right of the Party	Obligation of the Party	When	Maximum Profit	When	Maximum Loss
Seller of a put		To buy	Price of underlying rises	Premium received	Price of underlying falls	Strike price minus premium

Table 20.2 Summary of Option Contracts

20.4 Interest Rate Risk

Learning Outcomes

By the end of this section, you will be able to:

- Describe interest rate risk.
- Explain how a change in interest rates changes the value of cash flows.
- Describe the use of an interest rate swap.

An interest rate is simply the price of borrowing money. Just as other prices are volatile, interest rates are also volatile. Just as volatility in other prices leads to uncertain cash flows for a company, volatility in interest rates can also lead to uncertain cash flows.

Measuring Interest Rate Risk

Suppose that a company is supposed to pay a bill of $1,000 in 10 years. The present value of this bill depends on the level of interest rates. If the interest rate is 5%, the present value of the bill is $\frac{\$1{,}000}{(1 + 0.05)^{10}} = \$613.91$. If the interest rate rises to 6%, the present value of the bill is $\frac{\$1{,}000}{(1 + 0.06)^{10}} = \$558.39$. The increase in the interest rate by 1% causes the present value of the expected cash flow to fall by $\frac{613.91 - 558.39}{613.91} = 0.0904 = 9.04\%$.

Interest rate risk can be highlighted by looking at bonds. Consider two $1,000 face value bonds with a 5% coupon rate, paid semiannually. One of the bonds matures in five years, and the other bond matures in 30 years. If the market interest rate is 5%, each of these bonds will sell for face value, or $1,000. If, instead, the market interest rate is 6%, the five-year bond will sell for $957.35 and the 30-year bond will sell for $861.62.

Notice that as the interest rate rises, the price of both of these bonds will fall. However, the price of the longer-term bond will fall by more than the price of the shorter-term bond. The longer-term bond price will fall by 1.38%; the shorter-term bond price will fall by only 0.43%.

Consider two additional $1,000 face value bonds. The difference is that these bonds have a 6% coupon rate, paid semiannually. If a bond has a 6% coupon rate and matures in five years, it will sell for $1,043.76 when the market interest rate is 5%. A 30-year bond that matures in 30 years and has a 6% coupon rate will sell for $1,154.54 when the market interest rate is 5%. However, if the interest rate in the economy is 6%, both of these bonds will sell for a price of $1,000. The price of the five-year bond will drop by 4.19%; the price of the 30-year bond will drop by 13.39%.

THINK IT THROUGH

Calculating Bond Prices as the Interest Rates Changes

You are considering purchasing a $10,000 face value bond with a 4% coupon rate, paid semiannually, that matures in 20 years. If you require a 5% return to purchase this bond, what is the maximum price you would be willing to pay for the bond? If, instead, you require an 8% return to purchase this bond, what is the maximum price you would be willing to pay for the bond?

Solution:

If the bond pays coupon interest semiannually, you will receive one-half of the face value of the bond multiplied by the coupon rate every six months. So, you will receive 40 coupon payments of $\$10{,}000 \times 0.02 = \$200$. At maturity, you will receive one lump sum of the face value of the bond. Follow the steps in Table 20.3 to calculate the price of the bond if you require a 5% return, using a financial calculator.

Step	Description	Enter	Display	
1	Enter the number of coupon payments you will receive	40 `N`	N =	40
2	Enter your semiannual required return	2.5 `I/Y`	I/Y =	2.5
3	Enter the semiannual coupon payment	200 `PMT`	PMT =	200
4	Enter the face value of the bond	10000 `FV`	FV =	10,000
5	Calculate the present value	`CPT` `PV`	PV =	-8,744.86

Table 20.3 Calculator Step to Price a Bond Requiring a 5% Return[9]

When your required yield is 5%, the most you would be willing to pay for this bond is $8,744.86.

To calculate the price of the bond if your required return is 8%, use the same process, replacing the I/YR in step 2 with 4 (see Table 20.4). All other variables remain the same because the characteristics of the bond have not changed.

Step	Description	Enter	Display	
1	Enter the number of coupon payments you will receive	40 `N`	N =	40
2	Enter your semiannual required return	4 `I/Y`	I/Y =	4
3	Enter the semiannual coupon payment	200 `PMT`	PMT =	200
4	Enter the face value of the bond	10000 `FV`	FV =	10,000
5	Calculate the present value	`CPT` `PV`	PV =	-6,041.45

Table 20.4 Calculator Steps to Price a Bond Requiring an 8% Return

If your required return is 8% to invest in this bond, you will be willing to pay only $6,041.45 to purchase the bond.

Thus, if interest rates rise because of changing market conditions, the price of bonds will fall.

The sensitivity of bond prices to changes in the interest rate is known as interest rate risk. **Duration** is an important measure of interest rate risk that incorporates the maturity and coupon rate of a bond as well as the level of current market interest rates. Calculating duration is a complex topic that is beyond the scope of this introductory textbook, but it is useful to note that

- the higher the duration of a bond, the more sensitive the price of the bond will be to interest rate

9 The specific financial calculator in these examples is the Texas Instruments BA II Plus™ Professional model, but you can use other financial calculators for these types of calculations.

changes;
- the duration of a bond will be higher when market yields are lower, all else being equal;
- the duration of a bond will be higher the longer the maturity of the bond, all else being equal; and
- the duration of a bond will be higher the lower the coupon rate on the bond, all else being equal.

Swap-Based Hedging

As the name suggests, a **swap** involves two parties agreeing to swap, or exchange, something. Generally, the two parties, known as counterparties, are swapping obligations to make specified payment streams.

To illustrate the basics of how an interest rate swap works, let's consider two hypothetical companies, Alpha and Beta. Alpha is a strong, well-established company with a AAA (triple-A) bond rating. This means that Alpha has the highest rating a company can have. With this high rating, Alpha can borrow at relatively low interest rates. Often, companies in this situation will borrow at a floating rate. This means that their interest rate goes up and down as interest rates in the overall economy vary. The floating rate will be tied to a benchmark rate that is widely quoted in the financial press. Historically, companies have often used the London Interbank Offered Rate (LIBOR) as the benchmark rate. Because published quotes for LIBOR will be phased out by 2023, firms are beginning to use alternative rates. As of yet, no single alternative has emerged as the most commonly used rate; therefore, LIBOR will be used in our example. Suppose that Alpha finds that it can borrow money at rate equal to $\text{LIBOR} + 0.25\%$; thus, if LIBOR is 2.75%, the company will pay 3.0% to borrow. If the company wants to borrow at a long-term fixed rate, its cost of borrowing will be 5.0%.

LINK TO LEARNING

LIBOR Transition

Although the basic principles of financial transactions remain the same over time, the particular financial instruments used change from time to time. Innovation, regulation, and technological advances lead to these changes in financial instruments. The use of LIBOR as a benchmark rate is winding down in the early 2020s. To find out more about this transition and how it impacts companies, visit the About LIBOR Transition (https://openstax.org/r/About_LIBOR_Transition) website.

Beta has a BBB bond rating. Although this is considered a good, investment-grade rating, it is lower than the rating of Alpha. Because Beta is less creditworthy and a bit riskier than Alpha, it will have to pay a higher interest rate to borrow money. If Beta wants to borrow money at a floating rate, it will need to pay $\text{LIBOR} + 0.75\%$. If LIBOR is 2.75%, Beta must pay 3.5% on its floating rate debt. In order for Beta to borrow at a long-term fixed rate, its cost of borrowing will be 6.75%.

Let's consider how these two companies can enter into a swap in which both parties benefit. Table 20.5 summarizes the situation and the rates at which Alpha and Beta can borrow. It also illustrates a way in which an interest rate swap can benefit both Alpha and Beta.

	Alpha	Beta
Bond rating	AAA	BBB
Floating rate	$\text{LIBOR} + 0.25$	$\text{LIBOR} + 0.75$
Fixed rate	5	6.75
Rate company chooses	Fixed at 5.0	Floating at $\text{LIBOR} + 0.75$
Swap	N/A	N/A
Beta pays Alpha fixed rate	5.5	-5.5

Table 20.5 Example of a Swap Agreement

	Alpha	Beta
Alpha pays Beta floating rate	-LIBOR	+LIBOR
Payments and receipts	$-5.0\ +\ 5.5 -\ \text{LIBOR}$	$-(\text{LIBOR}\ +\ 0.75) -\ 5.5\ +\ \text{LIBOR}$
Net amount	$0.5 -\ \text{LIBOR}$	-6.25
Benefit	0.75	0.5

Table 20.5 Example of a Swap Agreement

Alpha borrows in the capital markets at a fixed rate of 5%. Beta chooses to borrow at a floating rate that equals $\text{LIBOR}\ +\ 0.75\%.$ Beta also agrees to pay Alpha a fixed rate of 5.5%. In essence, Beta is paying 5.5% to Alpha, 0.75% to its lender, and LIBOR to its lender.

In return, Alpha promises to pay Beta LIBOR. The exact amount that Alpha will pay to Beta fluctuates as LIBOR fluctuates. However, from Beta's perspective, the payment of LIBOR it receives from Alpha exactly offsets the payment of LIBOR it makes to its lender. When LIBOR increases, the rate of $\text{LIBOR} + 0.75\%$ that Beta is paying to its lender increases, but the LIBOR rate it receives from Alpha also increases. When LIBOR decreases, Beta receives less from Alpha, but it also pays less to its lender. Because the LIBOR it receives from Alpha is exactly equal to the LIBOR it pays to its lender, Beta's net amount of interest paid is 6.25%—the 5.5% it pays to Alpha plus the 0.75% it pays to its lender.

Alpha is in the position of paying 5.0% to its lender and LIBOR to Beta while receiving 5.5% from Beta. This means that Alpha's net interest paid is $\text{LIBOR}\ -\ 0.5\%$. Alpha is said to have swapped its fixed interest rate for a floating rate. Because it is paying $\text{LIBOR}\ -\ 0.5\%$, it will experience fluctuating interest rates; however, as a company with a AAA bond rating, it is a strong, creditworthy company that can withstand that interest rate exposure. It would have cost Alpha $\text{LIBOR}\ +\ 0.25\%$ to borrow the money from its lenders at a variable rate. By participating in this swap arrangement, Alpha has been able to lower its interest rate by 0.75%.

Through this swap arrangement, Beta has been able to fix its interest rate at 6.25% rather than having a variable rate. This predictability is a benefit for a company, especially one that is in a bit more precarious position as far as its creditworthiness and stability. The 6.25% Beta pays as a result of this arrangement is 0.5% below the 6.75% it would have paid if it simply borrowed from its lenders at a fixed rate.

Summary

20.1 The Importance of Risk Management

Risk arises due to uncertainty. The future is unpredictable. One job of the financial manager is to manage the risks of both cash inflows and cash outflows. Investors are risk-averse. The riskier a firm’s cash flows are, the higher the rate of return investors require to provide capital to the company.

20.2 Commodity Price Risk

Companies do not know how much they will have to pay for raw materials in future months. The price of raw materials will change as economic conditions change, impacting a company’s cost of goods sold and profits. Some ways that a company can hedge this risk are through vertical integration, long-term contracts, and futures contracts.

20.3 Exchange Rates and Risk

Exchange rates are unpredictable. This leads to transaction risk, translation risk, and economic risk as currency values change. A forward contract is an agreement between two parties to make an exchange at a particular rate on a given date in the future. Companies can use options to mitigate the risks. A call option gives the holder the right, but not the obligation, to purchase an underlying asset. A put option give the holder the right, but not the obligation, to sell an underlying asset.

20.4 Interest Rate Risk

When interest rates increase, the present value of future cash flows decreases. Duration is a measure of interest rate risk. A swap involves two parties agreeing to exchange something, often specified payment streams.

Key Terms

American option an option that the holder can exercise at any time up to and including the exercise date
appreciate when one unit of a currency will purchase more of a foreign currency than it did previously
call option an option that gives the owner the right, but not the obligation, to buy the underlying asset at a specified price on some future date
depreciate when one unit of a currency will purchase less of a foreign currency than it did previously
derivative a security that derives its value from another asset
duration a measure of interest rate risk
economic risk the risk that a change in exchange rates will impact the number of customers a business has or its sales
European option an option that the holder can exercise only on the expiration date
exchange rate the price of one currency in terms of another currency
exercise price (strike price) the price the option holder pays for the underlying asset when exercising an option
exercising choosing to purchase or sell the asset underlying a held option according to the terms of the option contract
expiration date the date an option contract expires
forward contract a contractual agreement between two parties to exchange a specified amount of assets on a specified future date
futures contract a standardized contract to trade an asset on some future date at a price locked in today
hedging taking an action to reduce exposure to a risk
margin the collateral that must be posted to guarantee that a trader will honor a futures contract
marking to market a procedure by which cash flows are exchanged daily for a futures contract, rather than at the end of the contract

natural hedge when a company offsets the risk that something will decrease in value by having a company activity that would increase in value at the same time

option an agreement that gives the owner the right, but not the obligation, to purchase or sell an asset at a specified price on some future date

option writer seller of a call or put option

premium the price a buyer of an option pays for the option contract

put option an option that gives the owner the right, but not the obligation, to sell the underlying asset at a specified price on some future date

speculating attempting to profit by betting on the uncertain future, knowing that a risk of loss is involved

spot rate the current market exchange rate

strike price (exercise price) the price an option holder pays for the underlying asset when exercising the option

swap an agreement between two parties to exchange something, such as their obligations to make specified payment streams

transaction risk the risk that a change in exchange rates will impact the value of a business's expected receipts or expenses

translation risk the risk that a change in exchange rates will impact the value of items on a company's financial statements

vertical integration the merger of a company with its supplier

CFA Institute

This chapter supports some of the Learning Outcome Statements (LOS) in this [CFA® Level I Study Session (https://openstax.org/r/cfa-institute-Level-I-Study-Session)](https://openstax.org/r/cfa-institute-Level-I-Study-Session). Reference with permission of CFA Institute.

Multiple Choice

1. Which of the following does a financial manager want to do to maximize the value of the firm?
   a. Decrease the speed of money coming into the firm
   b. Speed up cash going out and slow down cash coming in
   c. Decrease the riskiness of cash inflows and cash outflows
   d. Increase the volatility and speed of cash going out of the firm

2. In finance, risk is _______.
   a. the same thing as profit
   b. ignored because it is inevitable
   c. thought of as uncertainty or unpredictability
   d. something that financial managers should strive to increase and maximize

3. American Jeans Corp. purchases a cotton farm. The cotton grown on the farm will be used to make denim cloth for the company's jeans. This is an example of _______.
   a. striking a price
   b. vertical integration
   c. a forward contract
   d. an American option

4. The price that a holder of an option pays to buy the underlying asset when exercising a call option is known as _______.
   a. the strike price
   b. the maturity price

c. the exchange price
d. the underlying premium

5. Which of the following gives the holder the right, but not the obligation, to purchase an underlying asset?
a. A call option
b. A forward contract
c. A European put option
d. An American put option

6. An American option allows the holder to _______.
a. exercise the option only on the expiration date
b. exercise the option at any time up to and including the expiration date
c. sell stocks, and a European option allows the holder to purchase stocks
d. purchase stocks, and a European option allows the holder to purchase bonds

7. The holder of a(n) _______ has the right to buy and the holder of a(n) _______ has the right to sell an underlying asset.
a. call option; put option
b. put option; call option
c. American option; European option
d. European option; American option

8. The three main categories of foreign exchange risk a company faces are _______.
a. economic risk, business risk, and exposure risk
b. exposure risk, fluctuation risk, and forward risk
c. transaction risk, translation risk, and economic risk
d. appreciation risk, depreciation risk, and duplication risk

9. In January, the exchange rate between the South Korean won and the US dollar was $\text{KWN } 1,100 = \text{USD } 1$. Three months later, the exchange rate was $\text{KWN } 1,200 = \text{USD } 1$. This means that _______.
a. the Korean won appreciated relative to the US dollar
b. the Korean won depreciated relative to the US dollar
c. the US dollar depreciated relative to the Korean won
d. both the Korean won and the US dollar appreciated

10. In January, the exchange rate between the South Korean won and the US dollar was $\text{KWN } 1,100 = \text{USD } 1$. Three months later, the exchange rate was $\text{KWN } 1,200 = \text{USD } 1$. This means that _______.
a. it will cost US companies more to purchase raw materials from South Korea
b. it will cost Korean companies more to purchase raw materials from the United States
c. US companies that sell their products in South Korea will find their revenue has increased
d. Korean companies that sell their products in the United States will find that their revenue has decreased

11. A foreign exchange forward contract _______.
a. is a standardized contract that is inflexible
b. occurs when a company swaps its translation exposure for transaction exposure
c. is a contractual agreement between two parties to exchange a specified amount of currencies on a future date

d. states the date on which a trade will take place, but the price for the trade will be determined at the time the trade occurs

12. Which of the following is a measure of interest rate risk?
a. LIBOR
b. Duration
c. Translation exposure
d. Contract inflexibility

13. A swap occurs when _______.
a. a company exchanges obligations with another company to make specified payment streams
b. a company purchases commodities from a company in another country, exposing it to both commodity and currency risk
c. a company chooses a local supplier over an international supplier to avoid currency exposure
d. a company chooses a foreign supplier so that its commodity risk will be offset by its currency risk

Review Questions

1. What is the difference between someone using a derivative security to hedge risk and someone using a derivative security to speculate?

2. Explain how vertical integration may be used as a method of hedging against commodity price risk.

3. What is the difference between a forward contract and a futures contract?

4. You are considering purchasing a call option to purchase Mexican pesos in three months with a strike price of MXN 20/USD. The premium for this call option is MXN 2. Show the payoff you will receive at various prices in a diagram.

5. You are considering writing a call option to purchase Mexican pesos in three months with a strike price of MXN 20/USD. The premium for this call option is MXN 2. Show the payoff you will receive at various prices in a diagram.

6. Why are options considered to be a "zero-sum game"?

Problems

1. The Olive Orchard is a US retail outlet for high-quality olive oils. One of the major suppliers of olive oil for the company is a farm in Greece. The Olive Orchard must pay the Greek farm 5.00 euros per liter of olive oil it purchases. The Olive Orchard would like to purchase 7,000 liters of the Greek farm's olive oil next year. Currently, it costs 0.900 euros to purchase 1 US dollar. If the exchange rate remains constant, how much will it cost the Olive Orchard (in US dollars) to purchase the 7,000 liters? If the exchange rate changes so that it costs 0.8599 euros to purchase 1 US dollar, how much will it cost to purchase the 7,000 liters of olive oil?

2. International Automobile Parts (IAP) holds a call option to purchase US dollars. The strike price on the call option is JPY 115/USD. IAP paid JPY 10 for the option. The spot price is JPY 120/USD, and the option expires today. Should IAP exercise the option? What is IAP's payoff?

3. Global Producers (GP) holds a put option to sell US dollars. The strike price on the put option is JPY 114/USD. GP paid JPY 10 for the option. The spot price is JPY 120/USD, and the option expires today. Should GP exercise the option? What is GP's payoff?

Video Activity

Hedging at Southwest Airlines

Click to view content (https://openstax.org/r/Single_Biggest_Risk)
Jet fuel costs represent a major expense for airlines. Southwest Airlines has been known as the most aggressive airline when it comes to hedging the risk of jet fuel cost volatility. In this interview, the CEO of Southwest Airlines, Gary Kelly, discusses crude oil prices in the spring of 2012 and the impact on Southwest Airlines.

1. How volatile are oil prices, and how large of an impact does that volatility have on the cost structure of an airline?
2. Gary Kelly states that he sees fuel prices as the largest single business risk Southwest Airlines faces and that hedging that risk has become more expensive. Why do you think it became more expensive for Southwest Airlines to hedge this risk in 2012?

BMW in the United States

Click to view content (https://openstax.org/r/BMW_US_Natural_Hedging)
While the name BMW may sound German, a significant amount of BMW's production occurs outside of Germany. Watch this video to learn about this international activity of BMW.

3. In the video, the potential car buyer is concerned about the impact of the value of the euro on the price of the BMW. Why, if he is paying for the car in US dollars, do you think that he is impacted by the currency exchange rate?
4. How do you think opening plants in the United States, and in other parts of the world, provides a currency hedge for BMW?

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