GLOBAL EDITION

Principles of Managerial Finance Brief

EIGHTH EDITION

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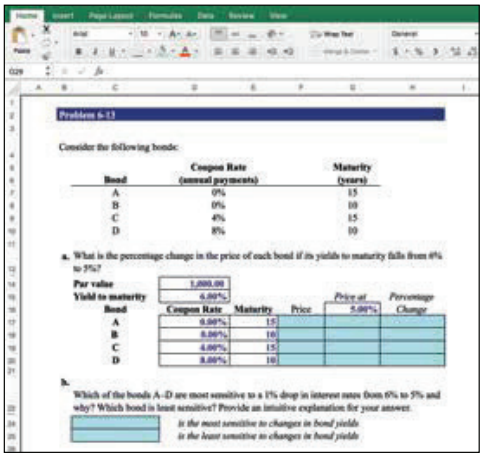

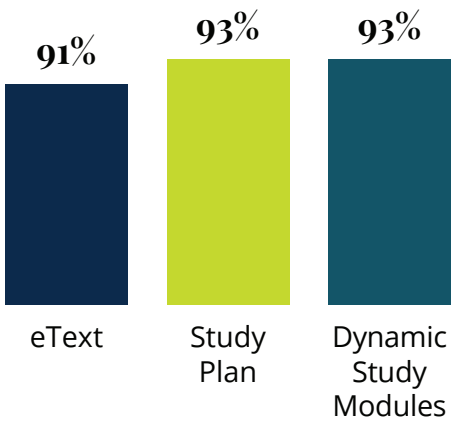

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that $5,000 cash inflow in 3 years. Like future value, present value depends on the interest rate and the timing of cash flows.

The Concept of Present Value

discounting cash flows
The process of finding present values; the inverse of compounding interest.

The process of finding present values is often referred to as **discounting cash flows.** Present value calculations answer the following question: If you can earn r percent on your money, what is the most you would be willing to pay now for an opportunity to receive FV_n dollars n periods from today?

This process is actually the inverse of compounding interest. Instead of finding the future value of present dollars invested at a given rate, discounting determines the present value of a future amount, assuming an opportunity to earn a certain return on the money. This annual rate of return is variously referred to as the *discount rate, required return, cost of capital,* and *opportunity cost*. We use these terms interchangeably in this text.

PERSONAL FINANCE EXAMPLE 5.4 Paul Shorter has an opportunity to receive $300 one year from now. What is the most that Paul should pay now for this opportunity? The answer depends in part on what Paul's current investment opportunities are (i.e., what his opportunity cost is). Suppose Paul can earn a return of 2% on money that he has on hand today. To determine how much he'd be willing to pay for the right to receive $300 one year from now, Paul can think about how much of his own money he'd have to set aside right now to earn $300 by next year. Letting PV_0 equal this unknown amount and using the same notation as in the future value discussion, we have

$$PV_0 \times (1 + 0.02) = \$300$$

Solving for PV_0 gives us

$$PV_0 = \frac{\$300}{(1 + 0.02)} = \$294.12$$

The value today ("present value") of $300 received 1 year from today, given an interest rate of 2%, is $294.12. That is, investing $294.12 today at 2% would result in $300 in 1 year. Given his opportunity cost (or his required return) of 2%, Paul should not pay more than $294.12 for this investment. Doing so would mean that he would earn a return of less than 2% on this investment. That's unwise if he has other similar investment opportunities that pay 2%. However, if Paul could buy this investment for less than $294.12, he would earn a return greater than his 2% opportunity cost.

The Equation for Present Value

We can find the present value of a future amount mathematically by solving Equation 5.1 for PV_0. In other words, the present value, PV_0, of some future amount, FV_n, to be received n periods from now, assuming an interest rate (or opportunity cost) of r, equals

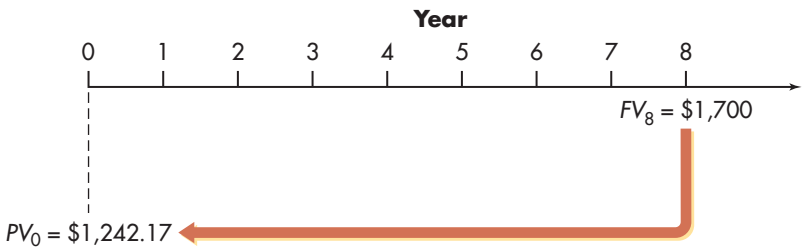
$$PV_0 = \frac{FV_n}{(1 + r)^n} \tag{5.2}$$

IRF PERSONAL FINANCE EXAMPLE 5.5 Pam Valenti has been offered an investment opportunity that will pay her $1,700 eight years from now. Pam has other investment opportunities available to her that pay 4%, so she will require a 4% return on this opportunity. How much should Pam pay for this opportunity? In other words, what is the present value of $1,700 that comes in 8 years if the opportunity cost is 4%? Substituting $FV_8 = \$1{,}700$, $n = 8$, and $r = 0.04$ into Equation 5.2 yields

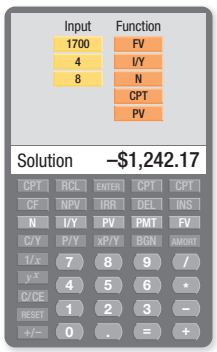
$$PV_0 = \frac{\$1{,}700}{(1 + 0.04)^8} = \frac{\$1{,}700}{1.36857} = \$1{,}242.17$$

The following timeline shows this analysis.

Timeline for present value of a single amount ($1,700 future amount, discounted at 4%, for 8 years)



MyLab Finance Financial Calculator



Calculator use Using the calculator's financial functions and the inputs shown at the left, you should find the present value to be $1,242.17. Notice that the calculator result is represented as a negative value to indicate that the present value is a cash outflow (i.e., the investment's cost).

Spreadsheet use The format of Excel's present value function is very similar to the future value function covered earlier. The appropriate syntax is PV(rate,nper,pmt,fv,type). The input list inside the parentheses is the same as in Excel's future value function with one exception. The present value function contains the term *fv*, which represents the future lump sum payment (or receipt) whose present value you are trying to calculate. The following Excel spreadsheet illustrates how to use this function to calculate the present value.

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	A	B
1	PRESENT VALUE OF A SINGLE AMOUNT	
2	Future value	$1,700
3	Annual rate of interest	4%
4	Number of years	8
5	Present value	–$1,242.17

Entry in Cell B5 is =PV(B3,B4,0,B2,0).
The minus sign appears before the $1,242.17 in B5 because the cost of the investment is treated as a cash outflow.

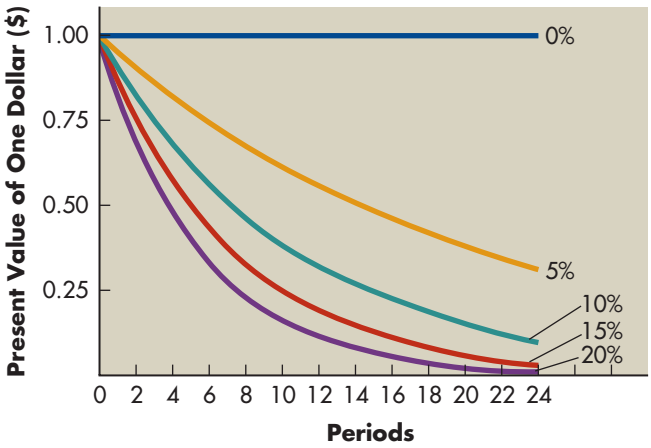
A Graphical View of Present Value

Figure 5.5 illustrates how the present value of $1 depends on the interest rate (or discount rate) and the number of periods an investor must wait to receive $1. The figure shows that, everything else being equal, (1) the higher the discount

FIGURE 5.5

Present Value Relationship
Discount rates, time periods, and present value of one dollar

MyLab Finance Animation



rate, the lower the present value; and (2) the longer the waiting period, the lower the present value. Also note that if the discount rate is 0%, the present value of $1 always equals $1 no matter when that dollar arrives. But for any discount rate greater than zero, the present value is less than $1.

→ REVIEW QUESTIONS MyLab Finance Solutions

5–3 How is the compounding process related to the payment of interest on savings? What is the general equation for future value?

5–4 What effect would a decrease in the interest rate have on the future value of a deposit? What effect would an increase in the holding period have on future value?

5–5 What is meant by "the present value of a future amount"? What is the general equation for present value?

5–6 What effect does increasing the required return have on the present value of a future amount? Why?

5–7 How are present value and future value calculations related?

→ EXCEL REVIEW QUESTIONS MyLab Finance Solutions

5–8 It is tax time and you would like to make a tax-deductible contribution to an individual retirement account (IRA). Using the information provided at MyLab Finance, find the future value of an IRA contribution that grows until you retire.

5–9 It is never too soon to begin investing for a child's college education. Using the information provided at MyLab Finance, determine the present value you would need to invest today to ensure that your child receives the college education she deserves.

LG3

5.3 Annuities

annuity
A stream of equal periodic cash flows over a specified time period. These cash flows can be inflows or outflows of funds.

ordinary annuity
An annuity for which the cash flow occurs at the end of each period.

annuity due
An annuity for which the cash flow occurs at the beginning of each period.

How much would you pay today for an investment that pays $3,000 at the end of each of the next 20 years, given that you can earn 7% on other investments? How much will you have after 5 years if your employer withholds and invests $1,000 of your bonus at the end of each of the next 5 years, guaranteeing you a 9% annual rate of return? To answer these questions, you need to understand the application of time value of money to *annuities*.

An **annuity** is a stream of equal periodic cash flows over a specified time. These cash flows may arrive at annual intervals, but they can also occur at other intervals, such as monthly rent or car payments. The cash flows in an annuity can be inflows (the $3,000 received at the end of each of the next 20 years) or outflows (the $1,000 invested at the end of each of the next 5 years).

TYPES OF ANNUITIES

Annuities are of two general types. For an **ordinary annuity**, the cash flow occurs at the *end* of each period. For an **annuity due**, the cash flow occurs at the *beginning* of each period.

PERSONAL FINANCE EXAMPLE 5.6 Fran Abrams is evaluating two annuities. Both annuities pay $1,000 per year, but annuity A is an ordinary annuity, while annuity B is an annuity due. To better understand the difference between these annuities, she has listed their cash flows in Table 5.2. The two annuities differ only in the timing of their cash flows: The cash flows occur sooner with the annuity due than with the ordinary annuity.

Although the cash flows of both annuities in Table 5.2 total $5,000, the annuity due would have a higher future value than the ordinary annuity because each of its five annual cash flows can earn interest for 1 year more than each of the ordinary annuity's cash flows. In general, as we will demonstrate later in this chapter, *the value (present or future) of an annuity due is always greater than the value of an otherwise identical ordinary annuity.*

TABLE 5.2 Comparison of Ordinary Annuity and Annuity Due Cash Flows ($1,000, 5 Years)

	Annual cash flows	
Year	Annuity A (*ordinary*)	Annuity B (*annuity due*)
0	$ 0	$1,000
1	1,000	1,000
2	1,000	1,000
3	1,000	1,000
4	1,000	1,000
5	1,000	0
Totals	$5,000	$5,000

FINDING THE FUTURE VALUE OF AN ORDINARY ANNUITY

One way to find the future value of an ordinary annuity is to calculate the future value of each cash flow and then add up those figures. Fortunately, several shortcuts lead to the answer. You can calculate the future value after n years of an ordinary annuity that makes n annual cash payments equal to CF_1 by using Equation 5.3:

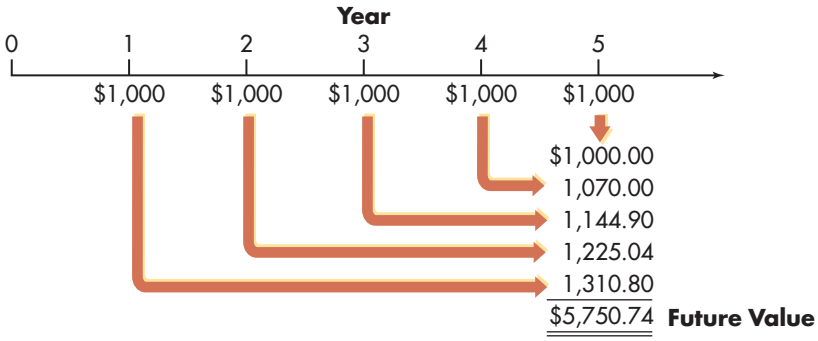
$$FV_n = CF_1 \times \left\{ \frac{[(1 + r)^n - 1]}{r} \right\} \quad (5.3)$$

As before, in this equation r represents the interest rate, and n represents the number of payments in the annuity (or, equivalently, the number of years over which the annuity is spread). The subscript 1 on the term CF_1 highlights that with an ordinary annuity, the first payment comes after 1 year (or, more generally, after 1 *period*). The calculations required to find the future value of an ordinary annuity are illustrated in the following example.

IRF PERSONAL FINANCE EXAMPLE 5.7

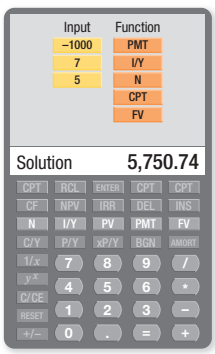
MyLab Finance Animation

Fran Abrams wishes to determine how much money she will have after 5 years if she chooses annuity A, the ordinary annuity. She will deposit the $1,000 annual payments that the annuity provides at the end of each of the next 5 years into a savings account paying 7% annual interest. This situation is depicted on the following timeline.



Timeline for future value of an ordinary annuity ($1,000 end-of-year deposit, earning 7%, after 5 years)

MyLab Finance Financial Calculator



As the figure shows, after 5 years, Fran will have $5,750.74 in her account. Note that because she makes deposits at the end of the year, the first deposit will earn interest for 4 years, the second for 3 years, and so on. Plugging the relevant values into Equation 5.3, we have

$$FV_5 = \$1{,}000 \times \left\{ \frac{[(1 + 0.07)^5 - 1]}{0.07} \right\} = \$5{,}750.74$$

Calculator use Using the calculator inputs shown at the left, you can confirm that the future value of the ordinary annuity equals $5,750.74. In this example, we enter the $1,000 annuity payment as a negative value, which in turn causes the calculator to report the resulting future value as a positive value. You can think of each $1,000 deposit that Fran makes into her investment account as

a payment into the account or a cash outflow, and after 5 years the future value is the balance in the account, or the cash inflow that Fran receives as a reward for investing.

Spreadsheet use To calculate the future value of an annuity in Excel, we will use the same future value function that we used to calculate the future value of a lump sum, but we will add two new input values. Recall that the future value function's syntax is FV(rate,nper,pmt,pv,type). We have already explained the terms *rate, nper,* and *pv* in this function. The term *pmt* refers to the annual payment the annuity offers. The term *type* is an input that lets Excel know whether the annuity being valued is an ordinary annuity (in which case the input value for *type* is 0 or omitted) or an annuity due (in which case the correct input value for *type* is 1). In this particular problem, the input value for *pv* is 0 because there is no up-front money received that is separate from the annuity. The only cash flows are those that are part of the annuity stream. The following Excel spreadsheet demonstrates how to calculate the future value of the ordinary annuity.

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	A	B
1	FUTURE VALUE OF AN ORDINARY ANNUITY	
2	Annual annuity payment	–$1,000
3	Annual rate of interest	7%
4	Number of years	5
5	Future value	$5,750.74

Entry in Cell B5 is =FV(B3,B4,B2,0,0). The minus sign appears before the $1,000 in B2 because the annuity's payments are cash outflows.

FINDING THE PRESENT VALUE OF AN ORDINARY ANNUITY

Quite often in finance, we need to find the present value of a stream of cash flows spread over several future periods. An annuity is, of course, a stream of equal periodic cash flows. The method for finding the present value of an ordinary annuity is similar to the method just discussed. One approach is to calculate the present value of each cash flow in the annuity and then add up those present values. Alternatively, the algebraic shortcut for finding the present value of an ordinary annuity that makes an annual payment of CF_1 for n years looks like

$$PV_0 = \left(\frac{CF_1}{r}\right) \times \left[1 - \frac{1}{(1 + r)^n}\right] \tag{5.4}$$

Of course, the simplest approach is to solve problems like this one with a financial calculator or spreadsheet program.

IRF EXAMPLE 5.8

MyLab Finance Solution Video

MyLab Finance Animation

Braden Company, a small producer of plastic toys, wants to determine the most it should pay for a particular ordinary annuity. The annuity consists of cash inflows of $700 at the end of each year for 5 years. The firm requires the annuity to provide a minimum return of 4%. The following timeline depicts this situation.