CHAPTER

15

Capital Structure

Basic Concepts

In early 2006, conglomerate Tyco International, Ltd., was evaluating a plan to break up the company. The breakup would result in three separate companies: electronics, health care, and fire and security services. Under the plan Tyco's shareholders would end up with shares in the three new companies. But one looming question was how the company would split its existing debt load among the three new companies. With the current debt on its balance sheet and an additional $1 billion in costs associated with the breakup, Tyco would have about $12.5 billion in total debt to allocate. The company offered little guidance on the capital structures it planned for new companies, other than to say the debt for each company would have "solid investment grade" ratings. So how should a company choose a capital structure for itself or, in Tyco's case, for its offspring? We will explore this and other issues in this chapter.

15.1 The Capital Structure Question and the Pie Theory

How should a firm choose its debt–equity ratio? We call our approach to the capital structure question the **pie model**. If you are wondering why we chose this name, just take a look at Figure 15.1. The pie in question is the sum of the financial claims of the firm, debt and equity in this case. We *define* the value of the firm to be this sum. Hence the value of the firm, V, is:

$$V \equiv B + S \qquad \textbf{(15.1)}$$

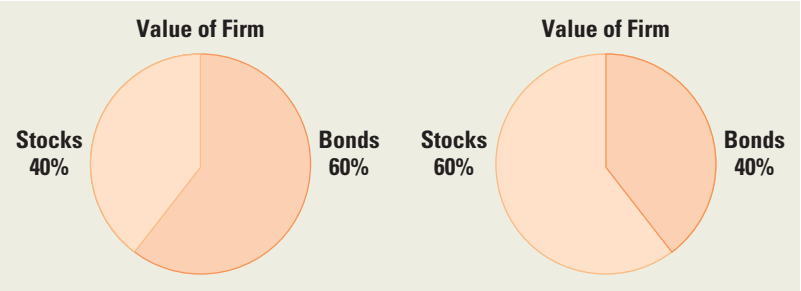
where B is the market value of the debt and S is the market value of the equity. Figure 15.1 presents two possible ways of slicing this pie between stock and debt: 40 percent–60 percent and 60 percent–40 percent. If the goal of the management of the firm is to make the firm as valuable as possible, then the firm should pick the debt–equity ratio that makes the pie—the total value—as big as possible.

This discussion begs two important questions:

1. Why should the stockholders in the firm care about maximizing the value of the entire firm? After all, the value of the firm is, by definition, the sum of both the debt and the equity. Instead, why should the stockholders not prefer the strategy that maximizes their interests only?
2. What ratio of debt to equity maximizes the shareholders' interests?

Let us examine each of the two questions in turn.

Figure 15.1
Two Pie Models of Capital Structure



15.2 Maximizing Firm Value versus Maximizing Stockholder Interests

The following example illustrates that the capital structure that maximizes the value of the firm is the one that financial managers should choose for the shareholders.

EXAMPLE 15.1

Debt and Firm Value Suppose the market value of the J. J. Sprint Company is $1,000. The company currently has no debt, and each of J. J. Sprint's 100 shares of stock sells for $10. A company such as J. J. Sprint with no debt is called an *unlevered* company. Further suppose that J. J. Sprint plans to borrow $500 and pay the $500 proceeds to shareholders as an extra cash dividend of $5 per share. After the issuance of debt, the firm becomes *levered*. The investments of the firm will not change as a result of this transaction. What will the value of the firm be after the proposed restructuring?

Management recognizes that, by definition, only one of three outcomes can occur from restructuring. Firm value after restructuring can be (I) greater than the original firm value of $1,000, (2) equal to $1,000, or (3) less than $1,000. After consulting with investment bankers, management believes that restructuring will not change firm value more than $250 in either direction. Thus it views firm values of $1,250, $1,000, and $750 as the relevant range. The original capital structure and these three possibilities under the new capital structure are presented next:

	No Debt (Original Capital Structure)	Value of Debt plus Equity after Payment of Dividend (Three Possibilities)		
		I	II	III
Debt	$ 0	$ 500	$ 500	$500
Equity	1,000	750	500	250
Firm value	$1,000	$1,250	$1,000	$750

Note that the value of equity is below $1,000 under any of the three possibilities. This can be explained in one of two ways. First, the table shows the value of the equity *after* the extra cash dividend is paid. Because cash is paid out, a dividend represents a partial liquidation of the firm. Consequently there is less value in the firm for the equityholders after the dividend payment. Second, in the event of a future liquidation, stockholders will be paid only after bondholders have been paid in full. Thus the debt is an encumbrance of the firm, reducing the value of the equity.

(*continued*)

Of course management recognizes that there are infinite possible outcomes. These three are to be viewed as *representative* outcomes only. We can now determine the payoff to stockholders under the three possibilities:

	Payoff to Shareholders after Restructuring		
	I	**II**	**III**
Capital gains	−$250	−$500	−$750
Dividends	500	500	500
Net gain or loss to stockholders	$250	$ 0	−$250

No one can be sure ahead of time which of the three outcomes will occur. However, imagine that managers believe that outcome I is most likely. They should definitely restructure the firm because the stockholders would gain $250. That is, although the price of the stock declines by $250 to $750, they receive $500 in dividends. Their net gain is $250 = −$250 + $500. Also, notice that the value of the firm would rise by $250 = $1,250 − $1,000.

Alternatively, imagine that managers believe that outcome III is most likely. In this case they should not restructure the firm because the stockholders would expect a $250 loss. That is, the stock falls by $750 to $250 and they receive $500 in dividends. Their net loss is −$250 = −$750 + $500. Also, notice that the value of the firm would change by −$250 = $750 − $1,000.

Finally, imagine that the managers believe that outcome II is most likely. Restructuring would not affect the stockholders' interest because the net gain to stockholders in this case is zero. Also notice that the value of the firm is unchanged if outcome II occurs.

This example explains why managers should attempt to maximize the value of the firm. In other words, it answers question (1) in Section 15.1. We find in this example the following wisdom:

Changes in capital structure benefit the stockholders *if and only if* the value of the firm increases.

Conversely, these changes hurt the stockholders if and only if the value of the firm decreases. This result holds true for capital structure changes of many different types.[1] As a corollary, we can say the following:

Managers should choose the capital structure that they believe will have the highest firm value because this capital structure will be most beneficial to the firm's stockholders.

Note however that this example does not tell us which of the three outcomes is most likely to occur. Thus it does not tell us whether debt should be added to J. J. Sprint's capital structure. In other words, it does not answer question (2) in Section 15.1. This second question is treated in the next section.

[1] This result may not hold exactly in a more complex case where debt has a significant possibility of default. Issues of default are treated in the next chapter.

Table 15.1
Financial Structure of Trans Am Corporation

	Current	Proposed
Assets	$8,000	$8,000
Debt	$ 0	$4,000
Equity (market and book)	$8,000	$4,000
Interest rate	10%	10%
Market value/share	$ 20	$ 20
Shares outstanding	400	200

The proposed capital structure has leverage, whereas the current structure is all equity.

Table 15.2
Trans Am's Current Capital Structure: No Debt

	Recession	Expected	Expansion
Return on assets (ROA)	5%	15%	25%
Earnings	$ 400	$1,200	$2,000
Return on equity (ROE) = Earnings/Equity	5%	15%	25%
Earnings per share (EPS)	$1.00	$ 3.00	$ 5.00

15.3 Financial Leverage and Firm Value: An Example

Leverage and Returns to Shareholders

The previous section shows that the capital structure producing the highest firm value is the one that maximizes shareholder wealth. In this section, we wish to determine that optimal capital structure. We begin by illustrating the effect of capital structure on returns to stockholders. We will use a detailed example that we encourage students to study carefully. Once we have this example under our belts, we will be ready to determine the optimal capital structure.

Trans Am Corporation currently has no debt in its capital structure. The firm is considering issuing debt to buy back some of its equity. Both its current and proposed capital structures are presented in Table 15.1. The firm's assets are $8,000. There are 400 shares of the all-equity firm, implying a market value per share of $20. The proposed debt issue is for $4,000, leaving $4,000 in equity. The interest rate is 10 percent.

The effect of economic conditions on earnings per share is shown in Table 15.2 for the current capital structure (all-equity). Consider first the middle column where earnings are expected to be $1,200. Because assets are $8,000, the return on assets (ROA) is 15 percent (= $1,200/$8,000). Assets equal equity for this all-equity firm, so return on equity (ROE) is also 15 percent. Earnings per share (EPS) is $3.00 (= $1,200/400). Similar calculations yield EPS of $1.00 and $5.00 in the cases of recession and expansion, respectively.

The case of leverage is presented in Table 15.3. ROA in the three economic states is identical in Tables 15.2 and 15.3 because this ratio is calculated before interest is considered. Debt is $4,000 here, so interest is $400 (= .10 × $4,000). Thus earnings after interest are $800 (= $1,200 − $400) in the middle (expected) case. Because equity is $4,000, ROE is 20 percent (= $800/$4,000). Earnings per share are $4.00 (= $800/200). Similar calculations yield earnings of $0 and $8.00 for recession and expansion, respectively.

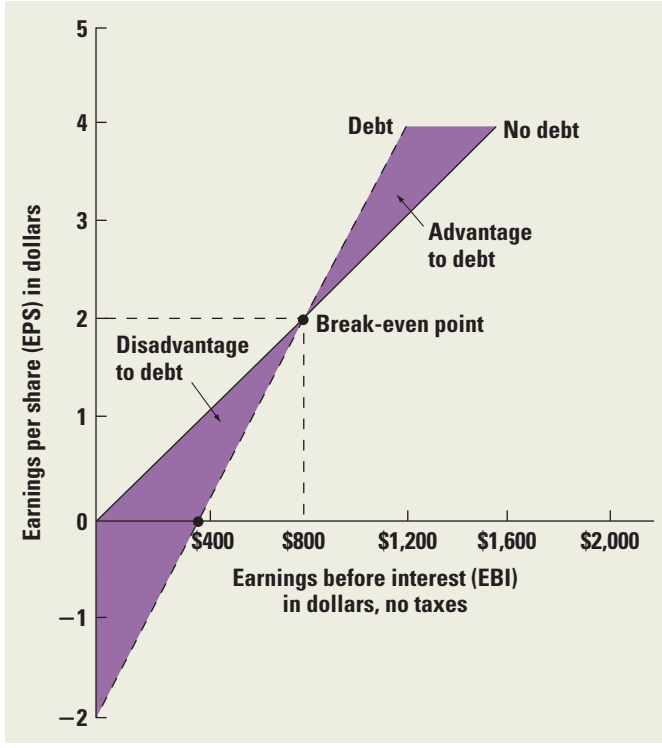
Table 15.3

Trans Am's Proposed Capital Structure: Debt = $4,000

	Recession	Expected	Expansion
Return on assets (ROA)	5%	15%	25%
Earnings before interest (EBI)	$400	$1,200	$2,000
Interest	−400	−400	−400
Earnings after interest	$ 0	$ 800	$1,600
Return on equity (ROE) = Earnings after interest/Equity	0	20%	40%
Earnings per share (EPS)	0	$4.00	$ 8.00

Figure 15.2

Financial Leverage: EPS and EBI for the Trans Am Corporation



Tables 15.2 and 15.3 show that the effect of financial leverage depends on the company's earnings before interest. If earnings before interest are equal to $1,200, the return on equity (ROE) is higher under the proposed structure. If earnings before interest are equal to $400, the ROE is higher under the current structure.

This idea is represented in Figure 15.2. The solid line represents the case of no leverage. The line begins at the origin, indicating that earnings per share (EPS) would be zero if earnings before interest (EBI) were zero. The EPS rise in tandem with a rise in EBI.

The dotted line represents the case of $4,000 of debt. Here EPS are negative if EBI are zero. This follows because $400 of interest must be paid regardless of the firm's profits.

Now consider the slopes of the two lines. The slope of the dotted line (the line with debt) is higher than the slope of the solid line. This occurs because the levered firm has *fewer* shares of stock outstanding than the unlevered firm. Therefore, any increase in EBI leads to a greater rise in EPS for the levered firm because the earnings increase is distributed over fewer shares of stock.

Because the dotted line has a lower intercept but a higher slope, the two lines must intersect. The *break-even* point occurs at $800 of EBI. Were earnings before interest to be $800, both firms would produce $2 of earnings per share (EPS). Because $800 is breakeven, earnings above $800 lead to greater EPS for the levered firm. Earnings below $800 lead to greater EPS for the unlevered firm.

The Choice between Debt and Equity

Tables 15.2 and 15.3 and Figure 15.2 are important because they show the effect of leverage on earnings per share. Students should study the tables and figure until they feel comfortable with the calculation of each number in them. However, we have not yet presented the punch line. That is, we have not yet stated which capital structure is better for Trans Am.

At this point many students believe that leverage is beneficial because EPS are expected to be $4.00 with leverage and only $3.00 without leverage. However, leverage also creates *risk*. Note that in a recession, EPS are higher ($1.00 versus $0) for the unlevered firm. Thus a risk-averse investor might prefer the all-equity firm, whereas a risk-neutral (or less risk-averse) investor might prefer leverage. Given this ambiguity, which capital structure *is* better?

Modigliani and Miller (MM or M & M) have a convincing argument that a firm cannot change the total value of its outstanding securities by changing the proportions of its capital structure. In other words, the value of the firm is always the same under different capital structures. In still other words, no capital structure is any better or worse than any other capital structure for the firm's stockholders. This rather pessimistic result is the famous **MM Proposition I**.[2]

Their argument compares a simple strategy, which we call strategy *A*, with a two-part strategy, which we call strategy *B*. Both of these strategies for shareholders of Trans Am are illuminated in Table 15.4. Let us now examine the first strategy.

Strategy A: Buy 100 shares of the levered equity:

The first line in the top panel of Table 15.4 shows EPS for the proposed levered equity in the three economic states. The second line shows the earnings in the three states for an individual buying 100 shares. The next line shows that the cost of these 100 shares is $2,000.

Let us now consider the second strategy, which has two parts to it.

Strategy B: Homemade Leverage

1. Borrow $2,000 from either a bank or, more likely, a brokerage house. (If the brokerage house is the lender, we say that this activity is *going on margin*.)
2. Use the borrowed proceeds plus your own investment of $2,000 (a total of $4,000) to buy 200 shares of the current unlevered equity at $20 per share.

The bottom panel of Table 15.4 shows payoffs under strategy *B*, which we call the *homemade leverage* strategy. First observe the middle column, which indicates that 200 shares of the unlevered equity are expected to generate $600 of earnings. Assuming that the $2,000 is borrowed at a 10 percent interest rate, the interest expense is $200 ($= .10 \times \$2{,}000$). Thus the net earnings are expected to be $400. A similar calculation generates net earnings of either $0 or $800 in recession or expansion, respectively.

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[2]The original paper is F. Modigliani and M. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review* (June 1958).

Table 15.4 **Payoff and Cost to Shareholders of Trans Am Corporation under the Proposed Structure and under the Current Structure with Homemade Leverage**

	Recession	Expected	Expansion
Strategy *A*: Buy 100 Shares of Levered Equity			
EPS of *levered* equity (taken from last line of Table 15.3)	$0	$ 4	$ 8
Earnings per 100 shares	0	400	800
Initial cost = 100 shares @ $20/share = $2,000			
Strategy *B*: Homemade Leverage			
Earnings per 200 shares in current *unlevered* Trans Am	$1 × 200 = 200	$3 × 200 = 600	$5 × 200 = 1,000
Interest at 10% on $2,000	−200	−200	−200
Net earnings	$ 0	$ 400	$ 800
Initial cost = 200 shares @ $20/share − $2,000 = $2,000 (Cost of stock; Amount borrowed)			

Investor receives the same payoff whether she (1) buys shares in a levered corporation or (2) buys shares in an unlevered firm and borrows on personal account. Her initial investment is the same in either case. Thus the firm neither helps nor hurts her by adding debt to capital structure.

Now let us compare these two strategies, both in terms of earnings per year and in terms of initial cost. The top panel of the table shows that strategy *A* generates earnings of $0, $400, and $800 in the three states. The bottom panel of the table shows that strategy *B* generates the *same* net earnings in the three states.

The top panel of the table shows that strategy *A* involves an initial cost of $2,000. Similarly, the bottom panel shows an *identical* net cost of $2,000 for strategy *B*.

This shows a very important result. Both the cost and the payoff from the two strategies are the same. Thus we must conclude that Trans Am is neither helping nor hurting its stockholders by restructuring. In other words, an investor is not receiving anything from corporate leverage that she could not receive on her own.

Note that, as shown in Table 15.1, the equity of the unlevered firm is valued at $8,000. Because the equity of the levered firm is $4,000 and its debt is $4,000, the value of the levered firm is also $8,000. Now suppose that, for whatever reason, the value of the levered firm were actually greater than the value of the unlevered firm. Here strategy *A* would cost more than strategy *B*. In this case an investor would prefer to borrow on his own account and invest in the stock of the unlevered firm. He would get the same net earnings each year as if he had invested in the stock of the levered firm. However, his cost would be less. The strategy would not be unique to our investor. Given the higher value of the levered firm, no rational investor would invest in the stock of the levered firm. Anyone desiring shares in the levered firm would get the same dollar return more cheaply by borrowing to finance a purchase of the unlevered firm's shares. The equilibrium result would be, of course, that the value of the levered firm would fall and the value of the unlevered firm would rise until they became equal. At this point individuals would be indifferent between strategy *A* and strategy *B*.

This example illustrates the basic result of Modigliani—Miller (MM) and is, as we have noted, commonly called their Proposition I. We restate this proposition as follows:

MM Proposition I (no taxes): The value of the levered firm is the same as the value of the unlevered firm.

This is perhaps the most important result in all of corporate finance. In fact, it is generally considered the beginning point of modern managerial finance. Before MM, the effect

of leverage on the value of the firm was considered complex and convoluted. Modigliani and Miller showed a blindingly simple result: If levered firms are priced too high, rational investors will simply borrow on their personal accounts to buy shares in unlevered firms. This substitution is oftentimes called *homemade leverage*. As long as individuals borrow (and lend) on the same terms as the firms, they can duplicate the effects of corporate leverage on their own.

The example of Trans Am Corporation shows that leverage does not affect the value of the firm. Because we showed earlier that stockholders' welfare is directly related to the firm's value, the example indicates that changes in capital structure cannot affect the stockholders' welfare.

A Key Assumption

The MM result hinges on the assumption that individuals can borrow as cheaply as corporations. If, alternatively, individuals can borrow only at a higher rate, we can easily show that corporations can increase firm value by borrowing.

Is this assumption of equal borrowing costs a good one? Individuals who want to buy stock and borrow can do so by establishing a margin account with a broker. Under this arrangement the broker lends the individual a portion of the purchase price. For example, the individual might buy $10,000 of stock by investing $6,000 of her own funds and borrowing $4,000 from the broker. Should the stock be worth $9,000 on the next day, the individual's net worth or equity in the account would be $5,000 = $9,000 − $4,000.[3]

The broker fears that a sudden price drop will cause the equity in the individual's account to be negative, implying that the broker may not get her loan repaid in full. To guard against this possibility, stock exchange rules require that the individual make additional cash contributions (replenish her margin account) as the stock price falls. Because (1) the procedures for replenishing the account have developed over many years and (2) the broker holds the stock as collateral, there is little default risk to the broker.[4] In particular, if margin contributions are not made on time, the broker can sell the stock to satisfy her loan. Therefore, brokers generally charge low interest, with many rates being only slightly above the risk-free rate.

By contrast, corporations frequently borrow using illiquid assets (e.g., plant and equipment) as collateral. The costs to the lender of initial negotiation and ongoing supervision, as well as of working out arrangements in the event of financial distress, can be quite substantial. Thus it is difficult to argue that individuals must borrow at higher rates than corporations.

15.4 Modigliani and Miller: Proposition II (No Taxes)

Risk to Equityholders Rises with Leverage

At a Trans Am corporate meeting, a corporate officer said, "Well, maybe it does not matter whether the corporation or the individual levers—as long as some leverage takes place. Leverage benefits investors. After all, an investor's expected return rises with the amount of the leverage present." He then pointed out that, as shown in Tables 15.2 and 15.3, the expected return on unlevered equity is 15 percent whereas the expected return on levered equity is 20 percent.

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[3] We are ignoring the one-day interest charge on the loan.

[4] Had this text been published before October 19, 1987, when stock prices declined by more than 20 percent in a single day, we might have used the phrase "virtually no" risk instead of "little" risk.

However, another officer replied, "Not necessarily. Though the expected return rises with leverage, the *risk* rises as well." This point can be seen from an examination of Tables 15.2 and 15.3. With earnings before interest (EBI) varying between $400 and $2,000, earnings per share (EPS) for the stockholders of the unlevered firm vary between $1.00 and $5.00. EPS for the stockholders of the levered firm vary between $0 and $8.00. This greater range for the EPS of the levered firm implies greater risk for the levered firm's stockholders. In other words, levered stockholders have better returns in good times than do unlevered stockholders but have worse returns in bad times. The two tables also show greater range for the ROE of the levered firm's stockholders. The earlier interpretation concerning risk applies here as well.

The same insight can be taken from Figure 15.2. The slope of the line for the levered firm is greater than the slope of the line for the unlevered firm. This means that the levered stockholders have better returns in good times than do unlevered stockholders but have worse returns in bad times, implying greater risk with leverage. In other words, the slope of the line measures the risk to stockholders because the slope indicates the responsiveness of ROE to changes in firm performance (earnings before interest).

Proposition II: Required Return to Equityholders Rises with Leverage

Because levered equity has greater risk, it should have a greater expected return as compensation. In our example, the market *requires* only a 15 percent expected return for the unlevered equity, but it requires a 20 percent expected return for the levered equity.

This type of reasoning allows us to develop **MM Proposition II**. Here MM argue that the expected return on equity is positively related to leverage because the risk to equityholders increases with leverage.

To develop this position recall that the firm's weighted average cost of capital, R_{WACC}, can be written as[5]

$$R_{\text{WACC}} = \frac{S}{B+S} \times R_S + \frac{B}{B+S} \times R_B \qquad \textbf{(15.2)}$$

where

R_B	is the cost of debt.
R_S	is the expected return on equity or stock, also called the *cost of equity* or the *required return on equity*.
R_{WACC}	is the firm's weighted average cost of capital.
B	is the value of the firm's debt or bonds.
S	is the value of the firm's stock or equity.

Equation 15.2 is quite intuitive. It simply says that a firm's weighted average cost of capital is a weighted average of its cost of debt and its cost of equity. The weight applied to debt is the proportion of debt in the capital structure, and the weight applied to equity is the proportion of equity in the capital structure. Calculations of R_{WACC} from Equation 15.2 for both the unlevered and the levered firm are presented in Table 15.5.

An implication of MM Proposition I is that R_{WACC} is a constant for a given firm, regardless of the capital structure.[6] For example, Table 15.5 shows that R_{WACC} for Trans Am is 15 percent, with or without leverage.

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[5] Because we do not have taxes here, the cost of debt is R_B, not $R_B(1 - t_C)$ as it was in Chapter 12.

[6] This statement holds in a world of no taxes. It does not hold in a world with taxes, a point to be brought out later in this chapter (see Figure 15.6).

Table 15.5
Cost of Capital Calculations for Trans Am

$$R_{WACC} = \frac{B}{B+S} \times R_B + \frac{S}{B+S} \times R_S$$

$$\text{Unlevered firm:} \quad 15\% = \frac{0}{\$8{,}000} \times 10\%^* + \frac{\$8{,}000}{\$8{,}000} \times 15\%^\dagger$$

$$\text{Levered firm:} \quad 15\% = \frac{\$4{,}000}{\$8{,}000} \times 10\%^* + \frac{\$4{,}000}{\$8{,}000} \times 20\%^\ddagger$$

*10% is the cost of debt.

†From the "Expected" column in Table 15.2, we learn that expected earnings after interest for the unlevered firm are $1,200. From Table 15.1 we learn that equity for the unlevered firm is $8,000. Thus R_S for the unlevered firm is

$$\frac{\text{Expected earnings after interest}}{\text{Equity}} = \frac{\$1{,}200}{\$8{,}000} = 15\%$$

‡From the "Expected" column in Table 15.3, we learn that expected earnings after interest for the levered firm are $800. From Table 15.1 we learn that equity for the levered firm is $4,000. Thus R_S for the levered firm is

$$\frac{\text{Expected earnings after interest}}{\text{Equity}} = \frac{\$800}{\$4{,}000} = 20\%$$

Let us now define R_0 to be the *cost of capital for an all-equity firm*. For the Trans Am Corp., R_0 is calculated as

$$R_0 = \frac{\text{Expected earnings to unlevered firm}}{\text{Unlevered equity}} = \frac{\$1{,}200}{\$8{,}000} = 15\%$$

As can be seen from Table 15.5, R_{WACC} is equal to R_0 for Trans Am. In fact, R_{WACC} must *always* equal R_0 in a world without corporate taxes.[7]

Proposition II states the expected return of equity, R_S, in terms of leverage. The exact relationship, derived by setting $R_{WACC} = R_0$ and then rearranging Equation 15.2, is[8]

MM Proposition II (No Taxes)

$$R_S = R_0 + \frac{B}{S}(R_0 - R_B) \tag{15.3}$$

Equation 15.3 implies that the required return on equity is a linear function of the firm's debt–equity ratio. Examining Equation 15.3, we see that if R_0 exceeds the cost of debt, R_B,

[7]This statement holds in a world of no taxes. It does not hold in a world with taxes, a point to be brought out later in this chapter (see Figure 15.6).

[8]This can be derived from Equation 15.2 by setting $R_{WACC} = R_0$, yielding

$$\frac{B}{B+S} R_B + \frac{S}{B+S} R_S = R_0$$

Multiplying both sides by $(B + S)/S$ yields

$$\frac{B}{S} R_B + R_S = \frac{B+S}{S} R_0$$

We can rewrite the right side as

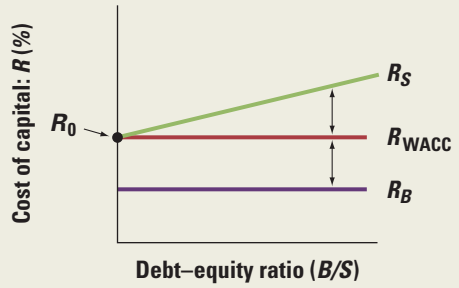
$$\frac{B}{S} R_B + R_S = \frac{B}{S} R_0 + R_0$$

Moving $(B/S)R_B$ to the right side and rearranging yields

$$R_S = R_0 + \frac{B}{S}(R_0 - R_B)$$

Figure 15.3

The Cost of Equity, the Cost of Debt, and the Weighted Average Cost of Capital: MM Proposition II with No Corporate Taxes



$R_S = R_0 + (R_0 - R_B)B/S$

R_S is the cost of equity.

R_B is the cost of debt.

R_0 is the cost of capital for an all-equity firm.

R_{WACC} is a firm's weighted average cost of capital. In a world with no taxes, R_{WACC} for a levered firm is equal to R_0.

R_0 is a single point whereas R_S, R_B, and R_{WACC} are all entire lines.

The cost of equity capital, R_S, is positively related to the firm's debt–equity ratio. The firm's weighted average cost of capital, R_{WACC}, is invariant to the firm's debt–equity ratio.

then the cost of equity rises with increases in the debt–equity ratio, B/S. Normally R_0 should exceed R_B. That is, because even unlevered equity is risky, it should have an expected return greater than that of riskless debt. Note that Equation 15.3 holds for Trans Am in its levered state:

$$.20 = .15 + \frac{\$4{,}000}{\$4{,}000}(.15 - .10)$$

Figure 15.3 graphs Equation 15.3. As you can see, we have plotted the relation between the cost of equity, R_S, and the debt–equity ratio, B/S, as a straight line. What we witness in Equation 15.3 and illustrate in Figure 15.3 is the effect of leverage on the cost of equity. As the firm raises the debt–equity ratio, each dollar of equity is levered with additional debt. This raises the risk of equity and therefore the required return, R_S, on the equity.

Figure 15.3 also shows that R_{WACC} is unaffected by leverage, a point we have already made. (It is important for students to realize that R_0, the cost of capital for an all-equity firm, is represented by a single dot on the graph. By contrast, R_{WACC} is an entire line.)

EXAMPLE 15.2

MM Propositions I and II Luteran Motors, an all-equity firm, has expected earnings of $10 million per year in perpetuity. The firm pays all of its earnings out as dividends, so the $10 million may also be viewed as the stockholders' expected cash flow. There are 10 million shares outstanding, implying expected annual cash flow of $1 per share. The cost of capital for this unlevered firm is 10 percent. In addition, the firm will soon build a new plant for $4 million. The plant is expected to generate additional cash flow of $1 million per year. These figures can be described as follows:

Current Company	New Plant
Cash flow: $10 million	Initial outlay: $4 million
Number of outstanding shares: 10 million	Additional annual cash flow: $1 million

(*continued*)

The project's net present value is

$$-\$4 \text{ million} + \frac{\$1 \text{ million}}{.1} = \$6 \text{ million}$$

assuming that the project is discounted at the same rate as the firm as a whole. Before the market knows of the project, the *market value* balance sheet of the firm is this:

LUTERAN MOTORS
Balance Sheet (All Equity)

Old assets:	$\frac{\$10 \text{ million}}{.1} = \$100 \text{ million}$	Equity:	\$100 million (10 million shares of stock)

The value of the firm is \$100 million because the cash flow of \$10 million per year is capitalized (discounted) at 10 percent. A share of stock sells for \$10 (= \$100 million/10 million) because there are 10 million shares outstanding.

The market value balance sheet is a useful tool for financial analysis. Because students are often thrown off guard by it initially, we recommend extra study here. The key is that the market value balance sheet has the same form as the balance sheet that accountants use. That is, assets are placed on the left side whereas liabilities and owners' equity are placed on the right side. In addition, the left and right sides must be equal. The difference between a market value balance sheet and the accountant's balance sheet is in the numbers. Accountants value items in terms of historical cost (original purchase price less depreciation), whereas financial analysts value items in terms of market value.

The firm will issue \$4 million of either equity or debt. Let us consider the effect of equity and debt financing in turn.

Stock Financing Imagine that the firm announces that in the near future it will raise \$4 million in equity to build a new plant. The stock price, and therefore the value of the firm, will rise to reflect the positive net present value of the plant. According to efficient markets, the increase occurs immediately. That is, the rise occurs on the day of the announcement, not on the date of either the onset of construction of the plant or the forthcoming stock offering. The market value balance sheet becomes this:

LUTERAN MOTORS
Balance Sheet
(Upon Announcement of Equity Issue to Construct Plant)

Old assets	\$100 million	Equity	\$106 million (10 million shares of stock)
NPV of plant: $-4 \text{ million} + \frac{\$1 \text{ million}}{.1} =$	6 million		
Total assets	\$106 million		

Note that the NPV of the plant is included in the market value balance sheet. Because the new shares have not yet been issued, the number of outstanding shares remains 10 million. The price per share has now risen to \$10.60 (= \$106 million/10 million) to reflect news concerning the plant.

(*continued*)

Shortly thereafter, $4 million of stock is issued or *floated*. Because the stock is selling at $10.60 per share, 377,358 (= $4 million/$10.60) shares of stock are issued. Imagine that funds are put in the bank *temporarily* before being used to build the plant. The market value balance sheet becomes this:

LUTERAN MOTORS
Balance Sheet
(Upon Issuance of Stock but Before Construction Begins on Plant)

Old assets	$100 million	Equity	$110 million (10,377,358 shares of stock)
NPV of plant	6 million		
Proceeds from new issue of stock (currently placed in bank)	4 million		
Total assets	$110 million		

The number of shares outstanding is now 10,377,358 because 377,358 new shares were issued. The price per share is $10.60 (= $110,000,000/10,377,358). Note that the price has not changed. This is consistent with efficient capital markets because the stock price should move due only to new information.

Of course the funds are placed in the bank only temporarily. Shortly after the new issue, the $4 million is given to a contractor who builds the plant. To avoid problems in discounting, we assume that the plant is built immediately. The balance sheet then looks like this:

LUTERAN MOTORS
Balance Sheet
(Upon Completion of the Plant)

Old assets	$100 million	Equity	$110 million (10,377,358 shares of stock)
PV of plant: $\frac{\$1 \text{ million}}{.1}$ =	10 million		
Total assets	$110 million		

Though total assets do not change, the composition of the assets does change. The bank account has been emptied to pay the contractor. The present value of cash flows of $1 million a year from the plant is reflected as an asset worth $10 million. Because the building expenditures of $4 million have already been paid, they no longer represent a future cost. Hence they no longer reduce the value of the plant. According to efficient capital markets, the price per share of stock remains $10.60.

Expected yearly cash flow from the firm is $11 million, $10 million of which comes from the old assets and $1 million from the new. The expected return to equityholders is

$$R_S = \frac{\$11 \text{ million}}{\$110 \text{ million}} = .10$$

Because the firm is all equity, $R_S = R_0 = .10$.

Debt Financing Alternatively, imagine the firm announces that in the near future it will borrow $4 million at 6 percent to build a new plant. This implies yearly interest payments of $240,000

(*continued*)

(= $4,000,000 × 6%). Again the stock price rises immediately to reflect the positive net present value of the plant. Thus we have the following:

LUTERAN MOTORS
Balance Sheet
(Upon Announcement of Debt Issue to Construct Plant)

Old assets	$100 million	Equity	$106 million (10 million shares of stock)
NPV of plant: $-\$4 \text{ million} + \frac{\$1 \text{ million}}{.1} =$	6 million		
Total assets	$106 million		

The value of the firm is the same as in the equity financing case because (1) the same plant is to be built and (2) MM proved that debt financing is neither better nor worse than equity financing.

At some point $4 million of debt is issued. As before, the funds are placed in the bank temporarily. The market value balance sheet becomes this:

LUTERAN MOTORS
Balance Sheet
(Upon Debt Issuance but Before Construction Begins on Plant)

Old assets	$100 million	Debt	$ 4 million
NPV of plant	6 million	Equity	106 million (10 million shares of stock)
Proceeds from debt issue (currently invested in bank)	4 million		
Total assets	$110 million	Debt plus equity	$110 million

Note that debt appears on the right side of the balance sheet. The stock price is still $10.60 in accordance with our discussion of efficient capital markets.

Finally the contractor receives $4 million and builds the plant. The market value balance sheet turns into this:

LUTERAN MOTORS
Balance Sheet
(Upon Completion of the Plant)

Old assets	$100 million	Debt	$ 4 million
PV of plant	10 million	Equity	106 million (10 million shares of stock)
Total assets	$110 million	Debt plus equity	$110 million

The only change here is that the bank account has been depleted to pay the contractor. The equityholders expect yearly cash flow after interest of

$10,000,000	+	$1,000,000	−	$240,000	=	$10,760,000
Cash flow on old assets		Cash flow on new assets		Interest: $4 million × 6%		

(*continued*)

The equityholders expect to earn a return of

$$\frac{\$10{,}760{,}000}{\$106{,}000{,}000} = 10.15\%$$

This return of 10.15 percent for levered equityholders is higher than the 10 percent return for the unlevered equityholders. This result is sensible because, as we argued earlier, levered equity is riskier. In fact, the return of 10.15 percent should be exactly what MM Proposition II predicts. This prediction can be verified by plugging values into

$$R_S = R_0 + \frac{B}{S} \times (R_0 - R_B) \qquad \textbf{(15.3)}$$

We obtain

$$10.15\% = 10\% + \frac{\$4{,}000{,}000}{\$106{,}000{,}000} \times (10\% - 6\%)$$

This example was useful for two reasons. First, we wanted to introduce the concept of market value balance sheets, a tool that will prove useful elsewhere in the text. Among other things, this technique allows us to calculate the price per share of a new issue of stock. Second, the example illustrates three aspects of Modigliani and Miller:

1. The example is consistent with MM Proposition I because the value of the firm is $110 million after either equity or debt financing.
2. Students are often more interested in stock price than in firm value. We show that the stock price is always $10.60, regardless of whether debt or equity financing is used.
3. The example is consistent with MM Proposition II. The expected return to equityholders rises from 10 to 10.15 percent, just as Equation 15.3 states. This rise occurs because the equityholders of a levered firm face more risk than do the equityholders of an unlevered firm.

MM: An Interpretation

The Modigliani–Miller results indicate that managers cannot change the value of a firm by repackaging the firm's securities. Though this idea was considered revolutionary when it was originally proposed in the late 1950s, the MM approach and proof have since met with wide acclaim.[9]

MM argue that the firm's overall cost of capital cannot be reduced as debt is substituted for equity, even though debt appears to be cheaper than equity. The reason for this is that as the firm adds debt, the remaining equity becomes more risky. As this risk rises, the cost of equity capital rises as a result. The increase in the cost of the remaining equity capital offsets the higher proportion of the firm financed by low-cost debt. In fact, MM prove that the two effects exactly offset each other, so that both the value of the firm and the firm's overall cost of capital are invariant to leverage.

MM use an interesting analogy to food. They consider a dairy farmer with two choices. On the one hand, he can sell whole milk. On the other hand, by skimming he can sell a combination of cream and lowfat milk. Though the farmer can get a high price for the cream, he gets a low price for the lowfat milk, implying no net gain. In fact, imagine that the proceeds from the whole-milk strategy were less than those from the cream–lowfat milk strategy. Arbitrageurs would buy the whole milk, perform the skimming operation themselves, and resell the cream and lowfat milk separately. Competition between arbitrageurs would tend to boost the price of whole milk until proceeds from the two strategies became equal. Thus the value of the farmer's milk is invariant to the way in which the milk is packaged.

[9] Both Merton Miller and Franco Modigliani were awarded separate Nobel Prizes, in part for their work on capital structure.

In Their Own Words

IN PROFESSOR MILLER'S WORDS . . .

The Modigliani–Miller results are not easy to understand fully. This point is related in a story told by Merton Miller.*

"How difficult it is to summarize briefly the contribution of the [Modigliani–Miller] papers was brought home to me very clearly last October after Franco Modigliani was awarded the Nobel Prize in Economics in part—but, of course, only in part—for the work in finance. The television camera crews from our local stations in Chicago immediately descended upon me. 'We understand,' they said, 'that you worked with Modigliani some years back in developing these M and M theorems and we wonder if you could explain them briefly to our television viewers.'

"'How briefly?' I asked.

"'Oh, take ten seconds,' was the reply.

"Ten seconds to explain the work of a lifetime! Ten seconds to describe two carefully reasoned articles, each running to more than thirty printed pages and each with sixty or so long footnotes! When they saw the look of dismay on my face, they said, 'You don't have to go into details. Just give us the main points in simple, commonsense terms.'

"The main point of the first or cost-of-capital article was, in principle at least, simple enough to make. It said that in an economist's ideal world of complete and perfect capital markets and with full and symmetric information among all market participants, the total market value of all the securities issued by a firm was governed by the earning power and risk of its underlying real assets and was independent of how the mix of securities issued to finance it was divided between debt instruments and equity capital. . . .

"Such a summary, however, uses too many shorthanded terms and concepts, like perfect capital markets, that are rich in connotations to economists but hardly so to the general public. So I thought, instead, of an analogy that we ourselves had invoked in the original paper. . . .

"'Think of the firm,' I said, 'as a gigantic tub of whole milk. The farmer can sell the whole milk as is. Or he can separate out the cream and sell it at a considerably higher price than the whole milk would bring. (That's the analogy of a firm selling low-yield and hence high-priced debt securities.) But, of course, what the farmer would have left would be skim milk with low butterfat content and that would sell for much less than whole milk. That corresponds to the levered equity. The M and M proposition says that if there were no costs of separation (and, of course, no government dairy support programs), the cream plus the skim milk would bring the same price as the whole milk.'

"The television people conferred among themselves and came back to inform me that it was too long, too complicated, and too academic.

"'Don't you have anything simpler?' they asked. I though of another way that the M and M proposition is presented these days, which emphasizes the notion of market completeness and stresses the role of securities as devices for 'partitioning' a firm's payoffs in each possible state of the world among the group of its capital suppliers.

"'Think of the firm,' I said, 'as a gigantic pizza, divided into quarters. If now you cut each quarter in half into eighths, the M and M proposition says that you will have more pieces but not more pizza.'

"Again there was a whispered conference among the camera crew, and the director came back and said:

"'Professor, we understand from the press releases that there were two M and M propositions. Can we try the other one?'"

[Professor Miller tried valiantly to explain the second proposition, though this was apparently even more difficult to get across. After his attempt:]

"Once again there was a whispered conversation. They shut the lights off. They folded up their equipment. They thanked me for giving them the time. They said that they'd get back to me. But I knew that I had somehow lost my chance to start a new career as a packager of economic wisdom for TV viewers in convenient ten-second bites. Some have the talent for it . . . and some just don't."

*Taken from *GSB Chicago*, University of Chicago (Autumn 1986).

Food found its way into this chapter earlier when we viewed the firm as a pie. MM argue that the size of the pie does not change no matter how stockholders and bondholders divide it. MM say that a firm's capital structure is irrelevant; it is what it is by some historical accident. The theory implies that firms' debt–equity ratios could be anything. They are what they are because of whimsical and random managerial decisions about how much to borrow and how much stock to issue.

Summary of Modigliani–Miller Propositions without Taxes

Assumptions

- No taxes.
- No transaction costs.
- Individuals and corporations borrow at same rate.

Results

Proposition I: $V_L = V_U$ (Value of levered firm equals value of unlevered firm)

Proposition II: $R_S = R_0 + \frac{B}{S}(R_0 - R_B)$

Intuition

Proposition I: Through homemade leverage individuals can either duplicate or undo the effects of corporate leverage.

Proposition II: The cost of equity rises with leverage because the risk to equity rises with leverage.

Although scholars are always fascinated with far-reaching theories, students are perhaps more concerned with real-world applications. Do real-world managers follow MM by treating capital structure decisions with indifference? Unfortunately for the theory, virtually all companies in certain industries, such as banking, choose high debt–equity ratios. Conversely, companies in other industries, such as pharmaceuticals, choose low debt–equity ratios. In fact, almost any industry has a debt–equity ratio to which companies in that industry tend to adhere. Thus companies do not appear to be selecting their degree of leverage in a frivolous or random manner. Because of this, financial economists (including MM themselves) have argued that real-world factors may have been left out of the theory.

Though many of our students have argued that individuals can borrow only at rates above the corporate borrowing rate, we disagreed with this argument earlier in the chapter. But when we look elsewhere for unrealistic assumptions in the theory, we find two:[10]

1. Taxes were ignored.
2. Bankruptcy costs and other agency costs were not considered.

We turn to taxes in the next section. Bankruptcy costs and other agency costs will be treated in the next chapter. A summary of the main Modigliani–Miller results without taxes is presented in the nearby boxed section.

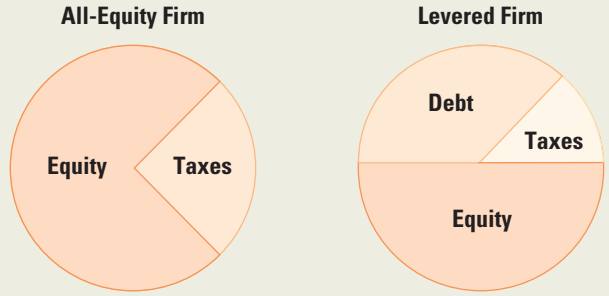
15.5 Taxes

The Basic Insight

The previous part of this chapter showed that firm value is unrelated to debt in a world without taxes. We now show that in the presence of corporate taxes, the firm's value is positively related to its debt. The basic intuition can be seen from a pie chart, such as the

[10] MM were aware of both of these issues, as can be seen in their original paper.

Figure 15.4
Two Pie Models of Capital Structure under Corporate Taxes



The levered firm pays less in taxes than does the all-equity firm. Thus the sum of the debt plus the equity of the levered firm is greater than the equity of the unlevered firm.

one in Figure 15.4. Consider the all-equity firm on the left. Here both equityholders and the IRS have claims on the firm. The value of the all-equity firm is, of course, that part of the pie owned by the equityholders. The proportion going to taxes is simply a cost.

The pie on the right for the levered firm shows three claims: equityholders, debtholders, and taxes. The value of the levered firm is the sum of the value of the debt and the value of the equity. In selecting between the two capital structures in the picture, a financial manager should select the one with the higher value. Assuming that the total area is the same for both pies[11] value is maximized for the capital structure paying the least in taxes. In other words, the manager should choose the capital structure that the IRS hates the most.

We will show that due to a quirk in U.S. tax law, the proportion of the pie allocated to taxes is less for the levered firm than it is for the unlevered firm. Thus, managers should select high leverage.

EXAMPLE 15.3

Taxes and Cash Flow The Water Products Company has a corporate tax rate, t_C, of 35 percent and expected earnings before interest and taxes (EBIT) of $1 million each year. Its entire earnings after taxes are paid out as dividends.

The firm is considering two alternative capital structures. Under Plan I, Water Products would have no debt in its capital structure. Under Plan II, the company would have $4,000,000 of debt, B. The cost of debt, R_B, is 10 percent.

The chief financial officer for Water Products makes the following calculations:

	Plan I	Plan II
Earnings before interest and corporate taxes (EBIT)	$1,000,000	$1,000,000
Interest (R_BB)	0	400,000
Earnings before taxes (EBT) = (EBIT − R_BB)	1,000,000	600,000
Taxes (t_C = .35)	350,000	210,000
Earnings after corporate taxes (EAT) = [(EBIT − R_BB) × (1 − t_C)]	650,000	390,000
Total cash flow to both stockholders and bondholders [EBIT × (1 − t_C) + t_CR_BB]	$ 650,000	$ 790,000

(continued)

[11] Under the MM propositions developed earlier, the two pies should be of the same size.

The most relevant numbers for our purposes are the two on the bottom line. Dividends, which are equal to earnings after taxes in this example, are the cash flow to stockholders, and interest is the cash flow to bondholders. Here we see that more cash flow reaches the owners of the firm (both stockholders and bondholders) under Plan II. The difference is \$140,000 = \$790,000 − \$650,000. It does not take us long to realize the source of this difference. The IRS receives less tax under Plan II (\$210,000) than it does under Plan I (\$350,000). The difference here is \$140,000 = \$350,000 − \$210,000.

This difference occurs because the way the IRS treats interest is different from the way it treats earnings going to stockholders.[12] Interest totally escapes corporate taxation, whereas earnings after interest but before corporate taxes (EBT) are taxed at the 35 percent rate.

Present Value of the Tax Shield

The previous discussion shows a tax advantage to debt or, equivalently, a tax disadvantage to equity. We now want to value this advantage. The dollar interest is

$$\text{Interest} = \underbrace{R_B}_{\text{Interest rate}} \times \underbrace{B}_{\text{Amount borrowed}}$$

This interest is \$400,000 (= 10 percent × \$4,000,000) for Water Products. All this interest is tax deductible. That is, whatever the taxable income of Water Products would have been without the debt, the taxable income is now \$400,000 *less* with the debt.

Because the corporate tax rate is .35 in our example, the reduction in corporate taxes is \$140,000 (= .35 × \$400,000). This number is identical to the reduction in corporate taxes calculated previously.

Algebraically, the reduction in corporate taxes is

$$\underbrace{t_C}_{\text{Corporate tax rate}} \times \underbrace{R_B \times B}_{\text{Dollar amount of interest}} \tag{15.4}$$

That is, whatever the taxes that a firm would pay each year without debt, the firm will pay $t_C R_B B$ less with the debt of B. Expression 15.4 is often called the *tax shield from debt*. Note that it is an *annual* amount.

As long as the firm expects to be in a positive tax bracket, we can assume that the cash flow in Expression 15.4 has the same risk as the interest on the debt. Thus its value can be determined by discounting at the cost of debt, R_B. Assuming that the cash flows are perpetual, the present value of the tax shield is

$$\frac{t_C R_B B}{R_B} = t_C B$$

Value of the Levered Firm

We have just calculated the present value of the tax shield from debt. Our next step is to calculate the value of the levered firm. The annual aftertax cash flow of an unlevered firm is

$$\text{EBIT} \times (1 - t_C)$$

[12] Note that stockholders actually receive more under Plan I (\$650,000) than under Plan II (\$390,000). Students are often bothered by this because it seems to imply that stockholders are better off without leverage. However, remember that there are more shares outstanding in Plan I than in Plan II. A full-blown model would show that earnings *per share* are higher with leverage.

where EBIT is earnings before interest and taxes. The value of an unlevered firm (that is, a firm with no debt) is the present value of EBIT $\times (1 - t_C)$:

$$V_U = \frac{\text{EBIT} \times (1 - t_C)}{R_0}$$

Here

V_U = Present value of an unlevered firm.
EBIT $\times (1 - t_C)$ = Firm cash flows after corporate taxes.
t_C = Corporate tax rate.
R_0 = The cost of capital to an all-equity firm. As can be seen from the formula, R_0 now discounts *aftertax* cash flows.

As shown previously, leverage increases the value of the firm by the tax shield, which is $t_C B$ for perpetual debt. Thus we merely add this tax shield to the value of the unlevered firm to get the value of the levered firm.

We can write this algebraically as follows:[13]

MM Proposition I (Corporate Taxes)

$$V_L = \frac{\text{EBIT} \times (1 - t_C)}{R_0} + \frac{t_C R_B B}{R_B} = V_U + t_C B \qquad \textbf{(15.5)}$$

Equation 15.5 is MM Proposition I under corporate taxes. The first term in Equation 15.5 is the value of the cash flows of the firm with no debt tax shield. In other words, this term is equal to V_U, the value of the all-equity firm. The value of the levered firm is the value of an all-equity firm plus $t_C B$, the tax rate times the value of the debt. $t_C B$ is the present value of the tax shield in the case of perpetual cash flows.[14] Because the tax shield

[13] This relationship holds when the debt level is assumed to be constant through time. A different formula would apply if the debt–equity ratio was assumed to be a nonconstant over time. For a deeper treatment of this point, see J. A. Miles and J. R. Ezzel, "The Weighted Average Cost of Capital, Perfect Capital Markets and Project Life," *Journal of Financial and Quantitative Analysis* (September 1980).

[14] The following example calculates the present value if we assume the debt has a finite life. Suppose the Maxwell Company has $1 million in debt with an 8 percent coupon rate. If the debt matures in two years and the cost of debt capital, R_B, is 10 percent, what is the present value of the tax shields if the corporate tax rate is 35 percent? The debt is amortized in equal installments over two years.

Year	Loan Balance	Interest	Tax Shield	Present Value of Tax Shield
0	$1,000,000			
1	500,000	$80,000	0.35 × $80,000	$25,454.54
2	0	40,000	0.35 × $40,000	11,570.25
				$37,024.79

The present value of the tax saving is

$$\text{PV} = \frac{0.35 \times \$80{,}000}{1.10} + \frac{0.35 \times \$40{,}000}{(1.10)^2} = \$37{,}024.79$$

The Maxwell Company's value is higher than that of a comparable unlevered firm by $37,024.79.

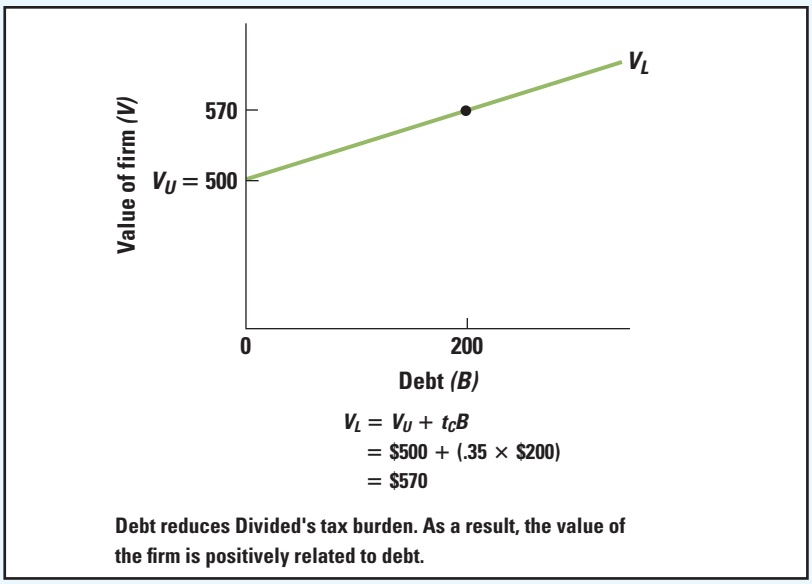
increases with the amount of debt, the firm can raise its total cash flow and its value by substituting debt for equity.

EXAMPLE 15.4

MM with Corporate Taxes Divided Airlines is currently an unlevered firm. The company expects to generate $153.85 in earnings before interest and taxes (EBIT) in perpetuity. The corporate tax rate is 35 percent, implying aftertax earnings of $100. All earnings after tax are paid out as dividends.

The firm is considering a capital restructuring to allow $200 of debt. Its cost of debt capital is 10 percent. Unlevered firms in the same industry have a cost of equity capital of 20 percent. What will the new value of Divided Airlines be?

Figure 15.5 **The Effect of Financial Leverage on Firm Value: MM with Corporate Taxes in the Case of Divided Airlines**



Debt reduces Divided's tax burden. As a result, the value of the firm is positively related to debt.

The value of Divided Airlines will be equal to

$$V_L = \frac{\text{EBIT} \times (1 - t_C)}{R_0} + t_C B$$
$$= \frac{\$100}{.20} + (.35 \times \$200)$$
$$= \$500 + \$70 = \$570$$

The value of the levered firm is $570, which is greater than the unlevered value of $500. Because $V_L = B + S$, the value of levered equity, S, is equal to $570 − $200 = $370. The value of Divided Airlines as a function of leverage is illustrated in Figure 15.5.

Expected Return and Leverage under Corporate Taxes

MM Proposition II under no taxes posits a positive relationship between the expected return on equity and leverage. This result occurs because the risk of equity increases with

leverage. The same intuition also holds in a world of corporate taxes. The exact formula in a world of corporate taxes is this:[15]

MM Proposition II (Corporate Taxes)

$$R_S = R_0 + \frac{B}{S} \times (1 - t_C) \times (R_0 - R_B) \quad \textbf{(15.6)}$$

Applying the formula to Divided Airlines, we get

$$R_S = .2351 = .20 + \frac{200}{370} \times (1 - .35) \times (.20 - .10)$$

This calculation is illustrated in Figure 15.6.

Whenever $R_0 > R_B$, R_S increases with leverage, a result that we also found in the no-tax case. As stated earlier in this chapter, R_0 should exceed R_B. That is, because equity (even unlevered equity) is risky, it should have an expected return greater than that on the less risky debt.

Let's check our calculations by determining the value of the levered equity in another way. The algebraic formula for the value of levered equity is

$$S = \frac{(\text{EBIT} - R_B B) \times (1 - t_C)}{R_S}$$

---

[15] This relationship can be shown as follows: Given MM Proposition I under taxes, a levered firm's market value balance sheet can be written as:

V_U = Value of unlevered firm	B = Debt
$t_C B$ = Tax shield	S = Equity

The value of the unlevered firm is simply the value of the assets without benefit of leverage. The balance sheet indicates that the firm's value increases by $t_C B$ when debt of B is added. The expected cash flow *from* the left side of the balance sheet can be written as

$$V_U R_0 + t_C B R_B \quad \textbf{(a)}$$

Because assets are risky, their expected rate of return is R_0. The tax shield has the same risk as the debt, so its expected rate of return is R_B.

The expected cash *to* bondholders and stockholders together is

$$S R_S + B R_B \quad \textbf{(b)}$$

Expression (b) reflects the fact that stock earns an expected return of R_S and debt earns the interest rate R_B.

Because all cash flows are paid out as dividends in our no-growth perpetuity model, the cash flows going into the firm equal those going to stockholders. Hence (a) and (b) are equal:

$$S R_S + B R_B = V_U R_0 + t_C B R_B \quad \textbf{(c)}$$

Dividing both sides of (c) by S, subtracting $B R_B$ from both sides, and rearranging yields

$$R_S = \frac{V_U}{S} \times R_0 - (1 - t_C) \times \frac{B}{S} R_B \quad \textbf{(d)}$$

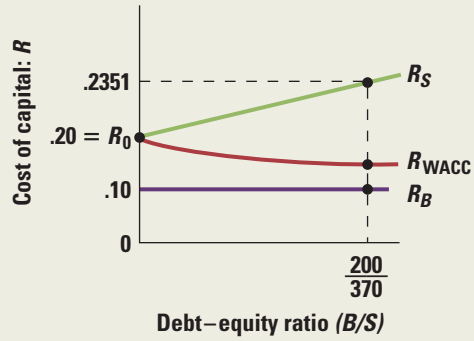
Because the value of the levered firm, V_L, equals $V_U + t_C B = B + S$, it follows that $V_U = S + (1 - t_C) \times B$. Thus (d) can be rewritten as

$$R_S = \frac{S + (1 - t_C) \times B}{S} \times R_0 - (1 - t_C) \times \frac{B}{S} R_B \quad \textbf{(e)}$$

Bringing the terms involving $(1 - t_C) \times (B/S)$ together produces Equation 15.6.

Figure 15.6

The Effect of Financial Leverage on the Cost of Debt and Equity Capital



$$R_S = R_0 + (1 - t_C)(R_0 - R_B)B/S = .20 + \left(.65 \times .10 \times \frac{200}{370}\right) = .2351$$

Financial leverage adds risk to the firm's equity. As compensation, the cost of equity rises with the firm's risk. Note that R_0 is a single point whereas R_S, R_B, and R_{WACC} are all entire lines.

The numerator is the expected cash flow to levered equity after interest and taxes. The denominator is the rate at which the cash flow to equity is discounted.

For Divided Airlines we get

$$\frac{(\$153.85 - .10 \times \$200)(1 - .35)}{.2351} = \$370$$

the same result we obtained earlier (ignoring a small rounding error).

The Weighted Average Cost of Capital, R_{WACC}, and Corporate Taxes

In Chapter 12, we defined the weighted average cost of capital (with corporate taxes) as follows (note that $V_L = S + B$):

$$R_{WACC} = \frac{S}{V_L} R_S + \frac{B}{V_L} R_B(1 - t_C)$$

Note that the cost of debt capital, R_B, is multiplied by $(1 - t_C)$ because interest is tax deductible at the corporate level. However, the cost of equity, R_S, is not multiplied by this factor because dividends are not deductible. In the no-tax case, R_{WACC} is not affected by leverage. This result is reflected in Figure 15.3, which we discussed earlier. However, because debt is tax advantaged relative to equity, it can be shown that R_{WACC} declines with leverage in a world with corporate taxes. This result can be seen in Figure 15.6.

For Divided Airlines, R_{WACC} is equal to

$$R_{WACC} = \left(\frac{370}{570} \times .2351\right) + \left(\frac{200}{570} \times .10 \times .65\right) = .1754$$

Divided Airlines has reduced its R_{WACC} from .20 (with no debt) to .1754 with reliance on debt. This result is intuitively pleasing because it suggests that when a firm lowers its R_{WACC}, the firm's value will increase. Using the R_{WACC} approach, we can confirm that the value of Divided Airlines is \$570:

$$V_L = \frac{\text{EBIT} \times (1 - t_C)}{R_{WACC}} = \frac{\$100}{.1754} = \$570$$

Stock Price and Leverage under Corporate Taxes

At this point students often believe the numbers—or at least are too intimidated to dispute them. However, they sometimes think we have asked the wrong question. "Why are we choosing to maximize the value of the firm?" they will say. "If managers are looking out for the stockholders' interest, why aren't they trying to maximize stock price?" If this question occurred to you, you have come to the right section.

Our response is twofold: First, we showed in the first section of this chapter that the capital structure that maximizes firm value is also the one that most benefits the interests of the stockholders.

However, that general explanation is not always convincing to students. As a second procedure, we calculate the stock price of Divided Airlines both before and after the exchange of debt for stock. We do this by presenting a set of market value balance sheets. The market value balance sheet for the company in its all-equity form can be represented as follows:

DIVIDED AIRLINES
Balance Sheet
(All-Equity Firm)

Physical assets		Equity	$500
$\frac{\$153.85}{.20} \times (1 - .35) = \$500$			(100 shares)

Assuming that there are 100 shares outstanding, each share is worth \$5 = \$500/100.

Next imagine the company announces that in the near future it will issue \$200 of debt to buy back \$200 of stock. We know from our previous discussion that the value of the firm will rise to reflect the tax shield of debt. If we assume that capital markets efficiently price securities, the increase occurs immediately. That is, the rise occurs on the day of the announcement, not on the date of the debt-for-equity exchange. The market value balance sheet now becomes this:

DIVIDED AIRLINES
Balance Sheet
(Upon Announcement of Debt Issue)

Physical assets	$500	Equity	$570
			(100 shares)
Present value of tax shield:			
$t_C B = 35\% \times \$200 =$	70		
Total assets	$570		

Note that the debt has not yet been issued. Therefore, only equity appears on the right side of the balance sheet. Each share is now worth \$570/100 = \$5.70, implying that the stockholders have benefited by \$70. The equityholders gain because they are the owners of a firm that has improved its financial policy.

The introduction of the tax shield to the balance sheet is perplexing to many students. Although physical assets are tangible, the ethereal nature of the tax shield bothers these students. However, remember that an asset is any item with value. The tax shield has value

because it reduces the stream of future taxes. The fact that one cannot touch the shield in the way that one can touch a physical asset is a philosophical, not financial, consideration.

At some point the exchange of debt for equity occurs. Debt of $200 is issued, and the proceeds are used to buy back shares. How many shares of stock are repurchased? Because shares are now selling at $5.70 each, the number of shares that the firm acquires is $200/$5.70 = 35.09. This leaves 64.91 (= 100 − 35.09) shares of stock outstanding. The market value balance sheet is now this:

DIVIDED AIRLINES
Balance Sheet
(After Exchange Has Taken Place)

Physical assets	$500	Equity (100 − 35.09 = 64.91 shares)	$370
Present value of tax shield	70	Debt	200
Total assets	$570	Debt plus equity	$570

Each share of stock is worth $370/64.91 = $5.70 after the exchange. Notice that the stock price does not change on the exchange date. As we mentioned, the stock price moves on the date of the announcement only. Because the shareholders participating in the exchange receive a price equal to the market price per share after the exchange, they do not care whether they exchange their stock.

This example was provided for two reasons. First, it shows that an increase in the value of the firm from debt financing leads to an increase in the price of the stock. In fact, the stockholders capture the entire $70 tax shield. Second, we wanted to provide more work with market value balance sheets.

A summary of the main results of Modigliani–Miller with corporate taxes is presented in the following boxed section:

Summary of Modigliani–Miller Propositions with Corporate Taxes

Assumptions

- Corporations are taxed at the rate t_C, on earnings after interest.
- No transaction costs.
- Individuals and corporations borrow at same rate.

Results

Proposition I: $V_L = V_U + t_C B$ (for a firm with perpetual debt)

Proposition II: $R_S = R_0 + \frac{B}{S}(1 - t_C)(R_0 - R_B)$

Intuition

Proposition I: Because corporations can deduct interest payments but not dividend payments, corporate leverage lowers tax payments.

Proposition II: The cost of equity rises with leverage because the risk to equity rises with leverage.

Summary and Conclusions

1. We began our discussion of the capital structure decision by arguing that the particular capital structure that maximizes the value of the firm is also the one that provides the most benefit to the stockholders.
2. In a world of no taxes, the famous Proposition I of Modigliani and Miller proves that the value of the firm is unaffected by the debt–equity ratio. In other words, a firm's capital structure is a matter of indifference in that world. The authors obtain their results by showing that either a high or a low corporate ratio of debt to equity can be offset by homemade leverage. The result hinges on the assumption that individuals can borrow at the same rate as corporations, an assumption we believe to be quite plausible.
3. MM's Proposition II in a world without taxes states that

$$R_S = R_0 + \frac{B}{S}(R_0 - R_B)$$

   This implies that the expected rate of return on equity (also called the *cost of equity* or the *required return on equity*) is positively related to the firm's leverage. This makes intuitive sense because the risk of equity rises with leverage, a point illustrated by Figure 15.2.
4. Although the above work of MM is quite elegant, it does not explain the empirical findings on capital structure very well. MM imply that the capital structure decision is a matter of indifference, whereas the decision appears to be a weighty one in the real world. To achieve real-world applicability, we next considered corporate taxes.
5. In a world with corporate taxes but no bankruptcy costs, firm value is an increasing function of leverage. The formula for the value of the firm is

$$V_L = V_U + t_C B$$

   Expected return on levered equity can be expressed as

$$R_S = R_0 + (1 - t_C) \times (R_0 - R_B) \times \frac{B}{S}$$

   Here, value is positively related to leverage. This result implies that firms should have a capital structure almost entirely composed of debt. Because real-world firms select more moderate levels of debt, the next chapter considers modifications to the results of this chapter.

Concept Questions

1. **MM Assumptions** List the three assumptions that lie behind the Modigliani–Miller theory in a world without taxes. Are these assumptions reasonable in the real world? Explain.
2. **MM Propositions** In a world with no taxes, no transaction costs, and no costs of financial distress, is the following statement true, false, or uncertain? If a firm issues equity to repurchase some of its debt, the price per share of the firm's stock will rise because the shares are less risky. Explain.
3. **MM Propositions** In a world with no taxes, no transaction costs, and no costs of financial distress, is the following statement true, false, or uncertain? Moderate borrowing will not increase the required return on a firm's equity. Explain.
4. **MM Propositions** What is the quirk in the tax code that makes a levered firm more valuable than an otherwise identical unlevered firm?
5. **Business Risk versus Financial Risk** Explain what is meant by business and financial risk. Suppose firm *A* has greater business risk than firm *B*. Is it true that firm *A* also has a higher cost of equity capital? Explain.

6. **MM Propositions** How would you answer in the following debate?
   Q: Isn't it true that the riskiness of a firm's equity will rise if the firm increases its use of debt financing?
   A: Yes, that's the essence of MM Proposition II.
   Q: And isn't it true that, as a firm increases its use of borrowing, the likelihood of default increases, thereby increasing the risk of the firm's debt?
   A: Yes.
   Q: In other words, increased borrowing increases the risk of the equity *and* the debt?
   A: That's right.
   Q: Well, given that the firm uses only debt and equity financing, and given that the risks of both are increased by increased borrowing, does it not follow that increasing debt increases the overall risk of the firm and therefore decreases the value of the firm?
   A: ??
7. **Optimal Capital Structure** Is there an easily identifiable debt–equity ratio that will maximize the value of a firm? Why or why not?
8. **Financial Leverage** Why is the use of debt financing referred to as financial "leverage"?
9. **Homemade Leverage** What is homemade leverage?
10. **Capital Structure Goal** What is the basic goal of financial management with regard to capital structure?

Questions and Problems

BASIC
(Questions 1–16)

1. **EBIT and Leverage** Money, Inc., has no debt outstanding and a total market value of $150,000. Earnings before interest and taxes, EBIT, are projected to be $14,000 if economic conditions are normal. If there is strong expansion in the economy, then EBIT will be 30 percent higher. If there is a recession, then EBIT will be 60 percent lower. Money is considering a $60,000 debt issue with a 5 percent interest rate. The proceeds will be used to repurchase shares of stock. There are currently 2,500 shares outstanding. Ignore taxes for this problem.
   a. Calculate earnings per share, EPS, under each of the three economic scenarios before any debt is issued. Also calculate the percentage changes in EPS when the economy expands or enters a recession.
   b. Repeat part (a) assuming that Money goes through with recapitalization. What do you observe?

2. **EBIT, Taxes, and Leverage** Repeat parts (a) and (b) in Problem 1 assuming Money has a tax rate of 35 percent.
3. **ROE and Leverage** Suppose the company in Problem 1 has a market-to-book ratio of 1.0.
   a. Calculate return on equity, ROE, under each of the three economic scenarios before any debt is issued. Also calculate the percentage changes in ROE for economic expansion and recession, assuming no taxes.
   b. Repeat part (a) assuming the firm goes through with the proposed recapitalization.
   c. Repeat parts (a) and (b) of this problem assuming the firm has a tax rate of 35 percent.
4. **Break-Even EBIT** Rolston Corporation is comparing two different capital structures, an all-equity plan (Plan I) and a levered plan (Plan II). Under Plan I, Rolston would have 150,000 shares of stock outstanding. Under Plan II, there would be 60,000 shares of stock outstanding and $1.5 million in debt outstanding. The interest rate on the debt is 10 percent and there are no taxes.
   a. If EBIT is $200,000, which plan will result in the higher EPS?
   b. If EBIT is $700,000, which plan will result in the higher EPS?
   c. What are the break-even EBIT?
5. **MM and Stock Value** In Problem 4, use MM Proposition I to find the price per share of equity under each of the two proposed plans. What is the value of the firm?

6. **Break-Even EBIT and Leverage** Kolby Corp. is comparing two different capital structures. Plan I would result in 1,100 shares of stock and $16,500 in debt. Plan II would result in 900 shares of stock and $27,500 in debt. The interest rate on the debt is 10 percent.
   a. Ignoring taxes, compare both of these plans to an all-equity plan assuming that EBIT will be $10,000. The all-equity plan would result in 1,400 shares of stock outstanding. Which of the three plans has the highest EPS? The lowest?
   b. In part (a) what are the break-even levels of EBIT for each plan as compared to that for an all-equity plan? Is one higher than the other? Why?
   c. Ignoring taxes, when will EPS be identical for Plans I and II?
   d. Repeat parts (a), (b), and (c) assuming that the corporate tax rate is 40 percent. Are the break-even levels of EBIT different from before? Why or why not?

7. **Leverage and Stock Value** Ignoring taxes in Problem 6, what is the price per share of equity under Plan I? Plan II? What principle is illustrated by your answers?

8. **Homemade Leverage** Star, Inc., a prominent consumer products firm, is debating whether or not to convert its all-equity capital structure to one that is 40 percent debt. Currently there are 2,000 shares outstanding and the price per share is $70. EBIT is expected to remain at $16,000 per year forever. The interest rate on new debt is 8 percent, and there are no taxes.
   a. Ms. Brown, a shareholder of the firm, owns 100 shares of stock. What is her cash flow under the current capital structure, assuming the firm has a dividend payout rate of 100 percent?
   b. What will Ms. Brown's cash flow be under the proposed capital structure of the firm? Assume that she keeps all 100 of her shares.
   c. Suppose Star does convert, but Ms. Brown prefers the current all-equity capital structure. Show how she could unlever her shares of stock to recreate the original capital structure.
   d. Using your answer to part (c), explain why Star's choice of capital structure is irrelevant.

9. **Homemade Leverage and WACC** ABC Co. and XYZ Co. are identical firms in all respects except for their capital structure. ABC is all equity financed with $600,000 in stock. XYZ uses both stock and perpetual debt; its stock is worth $300,000 and the interest rate on its debt is 10 percent. Both firms expect EBIT to be $73,000. Ignore taxes.
   a. Richard owns $30,000 worth of XYZ's stock. What rate of return is he expecting?
   b. Show how Richard could generate exactly the same cash flows and rate of return by investing in ABC and using homemade leverage.
   c. What is the cost of equity for ABC? What is it for XYZ?
   d. What is the WACC for ABC? For XYZ? What principle have you illustrated?

10. **MM** Nina Corp. uses no debt. The weighted average cost of capital is 13 percent. If the current market value of the equity is $35 million and there are no taxes, what is EBIT?

11. **MM and Taxes** In the previous question, suppose the corporate tax rate is 35 percent. What is EBIT in this case? What is the WACC? Explain.

12. **Calculating WACC** Weston Industries has a debt–equity ratio of 1.5. Its WACC is 12 percent, and its cost of debt is 12 percent. The corporate tax rate is 35 percent.
   a. What is Weston's cost of equity capital?
   b. What is Weston's unlevered cost of equity capital?
   c. What would the cost of equity be if the debt–equity ratio were 2? What if it were 1.0? What if it were zero?

13. **Calculating WACC** Shadow Corp. has no debt but can borrow at 8 percent. The firm's WACC is currently 12 percent, and the tax rate is 35 percent.
   a. What is Shadow's cost of equity?
   b. If the firm converts to 25 percent debt, what will its cost of equity be?
   c. If the firm converts to 50 percent debt, what will its cost of equity be?
   d. What is Shadow's WACC in part (b)? In part (c)?

14. **MM and Taxes** Bruce & Co. expects its EBIT to be $95,000 every year forever. The firm can borrow at 11 percent. Bruce currently has no debt, and its cost of equity is 22 percent. If the

tax rate is 35 percent, what is the value of the firm? What will the value be if Bruce borrows $60,000 and uses the proceeds to repurchase shares?

15. **MM and Taxes** In Problem 14, what is the cost of equity after recapitalization? What is the WACC? What are the implications for the firm's capital structure decision?

16. **MM Proposition I** Levered, Inc., and Unlevered, Inc., are identical in every way except their capital structures. Each company expects to earn $96 million before interest per year in perpetuity, with each company distributing all its earnings as dividends. Levered's perpetual debt has a market value of $275 million and costs 8 percent per year. Levered has 4.5 million shares outstanding, currently worth $100 per share. Unlevered has no debt and 10 million shares outstanding, currently worth $80 per share. Neither firm pays taxes. Is Levered's stock a better buy than Unlevered's stock?

INTERMEDIATE (Questions 17–25)

17. **MM** Tool Manufacturing has an expected EBIT of $35,000 in perpetuity and a tax rate of 35 percent. The firm has $70,000 in outstanding debt at an interest rate of 9 percent, and its unlevered cost of capital is 14 percent. What is the value of the firm according to MM Proposition I with taxes? Should Tool change its debt–equity ratio if the goal is to maximize the value of the firm? Explain.

18. **Firm Value** Old School Corporation expects an EBIT of $9,000 every year forever. Old School currently has no debt, and its cost of equity is 17 percent. The firm can borrow at 10 percent. If the corporate tax rate is 35 percent, what is the value of the firm? What will the value be if Old School converts to 50 percent debt? To 100 percent debt?

19. **MM Proposition I with Taxes** The Maxwell Company is financed entirely with equity. The company is considering a loan of $1 million. The loan will be repaid in equal installments over the next two years, and it has an 8 percent interest rate. The company's tax rate is 35 percent. According to MM Proposition I with taxes, what would be the increase in the value of the company after the loan?

20. **MM Proposition I without Taxes** Alpha Corporation and Beta Corporation are identical in every way except their capital structures. Alpha Corporation, an all-equity firm, has 5,000 shares of stock outstanding, currently worth $20 per share. Beta Corporation uses leverage in its capital structure. The market value of Beta's debt is $25,000, and its cost of debt is 12 percent. Each firm is expected to have earnings before interest of $35,000 in perpetuity. Neither firm pays taxes. Assume that every investor can borrow at 12 percent per year.
    a. What is the value of Alpha Corporation?
    b. What is the value of Beta Corporation?
    c. What is the market value of Beta Corporation's equity?
    d. How much will it cost to purchase 20 percent of each firm's equity?
    e. Assuming each firm meets its earnings estimates, what will be the dollar return to each position in part (d) over the next year?
    f. Construct an investment strategy in which an investor purchases 20 percent of Alpha's equity and replicates both the cost and dollar return of purchasing 20 percent of Beta's equity.
    g. Is Alpha's equity more or less risky than Beta's equity? Explain.

21. **Cost of Capital** Acetate, Inc., has equity with a market value of $20 million and debt with a market value of $10 million. Treasury bills that mature in one year yield 8 percent per year, and the expected return on the market portfolio over the next year is 18 percent. The beta of Acetate's equity is .90. The firm pays no taxes.
    a. What is Acetate's debt–equity ratio?
    b. What is the firm's weighted average cost of capital?
    c. What is the cost of capital for an otherwise identical all-equity firm?

22. **Homemade Leverage** The Veblen Company and the Knight Company are identical in every respect except that Veblen is not levered. The market value of Knight Company's 6 percent bonds is $1 million. Financial information for the two firms appears here. All earnings streams are perpetuities. Neither firm pays taxes. Both firms distribute all earnings available to common stockholders immediately.

	Veblen	Knight
Projected operating income	$ 300,000	$ 300,000
Year-end interest on debt	—	$ 60,000
Market value of stock	$2,400,000	$1,714,000
Market value of debt	—	$1,000,000

a. An investor who can borrow at 6 percent per year wishes to purchase 5 percent of Knight's equity. Can he increase his dollar return by purchasing 5 percent of Veblen's equity if he borrows so that the initial net costs of the two strategies are the same?
b. Given the two investment strategies in (a), which will investors choose? When will this process cease?

23. MM Propositions Locomotive Corporation is planning to repurchase part of its common stock by issuing corporate debt. As a result, the firm's debt–equity ratio is expected to rise from 40 percent to 50 percent. The firm currently has $7.5 million worth of debt outstanding. The cost of this debt is 10 percent per year. Locomotive expects to have an EBIT of $3.75 million per year in perpetuity. Locomotive pays no taxes.
a. What is the market value of Locomotive Corporation before and after the repurchase announcement?
b. What is the expected return on the firm's equity before the announcement of the stock repurchase plan?
c. What is the expected return on the equity of an otherwise identical all-equity firm?
d. What is the expected return on the firm's equity after the announcement of the stock repurchase plan?

24. Stock Value and Leverage Green Manufacturing, Inc., plans to announce that it will issue $2 million of perpetual debt and use the proceeds to repurchase common stock. The bonds will sell at par with a 6 percent annual coupon rate. Green is currently an all-equity firm worth $10 million with 500,000 shares of common stock outstanding. After the sale of the bonds, Green will maintain the new capital structure indefinitely. Green currently generates annual pretax earnings of $1.5 million. This level of earnings is expected to remain constant in perpetuity. Green is subject to a corporate tax rate of 40 percent.
a. What is the expected return on Green's equity before the announcement of the debt issue?
b. Construct Green's market value balance sheet before the announcement of the debt issue. What is the price per share of the firm's equity?
c. Construct Green's market value balance sheet immediately after the announcement of the debt issue.
d. What is Green's stock price per share immediately after the repurchase announcement?
e. How many shares will Green repurchase as a result of the debt issue? How many shares of common stock will remain after the repurchase?
f. Construct the market value balance sheet after the restructuring.
g. What is the required return on Green's equity after the restructuring?

25. MM with Taxes Williamson, Inc., has a debt–equity ratio of 2.5. The firm's weighted average cost of capital is 15 percent, and its pretax cost of debt is 10 percent. Williamson is subject to a corporate tax rate of 35 percent.
a. What is Williamson's cost of equity capital?
b. What is Williamson's unlevered cost of equity capital?
c. What would Williamson's weighted average cost of capital be if the firm's debt–equity ratio were .75? What if it were 1.5?

CHALLENGE (Questions 26–30)

26. Weighted Average Cost of Capital In a world of corporate taxes only, show that the R_{WACC} can be written as $R_{WACC} = R_0 \times [1 - t_C(B/V)]$.

27. Cost of Equity and Leverage Assuming a world of corporate taxes only, show that the cost of equity, R_S, is as given in the chapter by MM Proposition II with corporate taxes.

28. Business and Financial Risk Assume a firm's debt is risk-free, so that the cost of debt equals the risk-free rate, R_f. Define β_A as the firm's *asset* beta—that is, the systematic risk of the firm's assets. Define β_S to be the beta of the firm's equity. Use the capital asset pricing model, CAPM, along with MM Proposition II to show that $\beta_S = \beta_A \times (1 + B/S)$, where B/S is the debt–equity ratio. Assume the tax rate is zero.

29. Stockholder Risk Suppose a firm's business operations mirror movements in the economy as a whole very closely—that is, the firm's asset beta is 1.0. Use the result of previous problem to find the equity beta for this firm for debt–equity ratios of 0, 1, 5, and 20. What does this tell you about the relationship between capital structure and shareholder risk? How is the shareholders' required return on equity affected? Explain.

30. Unlevered Cost of Equity Beginning with the cost of capital equation—that is:

$$R_{WACC} = \frac{S}{B+S}R_S + \frac{B}{B+S}R_B$$

show that the cost of equity capital for a levered firm can be written as follows:

$$R_S = R_0 + \frac{B}{S}(R_0 - R_B)$$

S&P Problems

www.mhhe.com/edumarketinsight

1. Locate the annual balance sheets for General Motors (GM), Merck (MRK), and Kellogg (K). For each company calculate the long-term debt–equity ratio for the prior two years. Why would these companies use such different capital structures?

2. Look up Georgia Pacific (GP) and download the annual income statements. For the most recent year, calculate the average tax rate and EBIT, and find the total interest expense. From the annual balance sheets calculate the total long-term debt (including the portion due within one year). Using the interest expense and total long-term debt, calculate the average cost of debt. Next, find the estimated beta for Georgia Pacific on the S&P Stock Report. Use this reported beta, a current T-bill rate, and the historical average market risk premium found in a previous chapter to calculate the levered cost of equity. Now calculate the unlevered cost of equity, then the unlevered EBIT. What is the unlevered value of Georgia Pacific? What is the value of the interest tax shield and the value of the levered Georgia Pacific?

Mini Case

Stephenson Real Estate Recapitalization

Stephenson Real Estate Company was founded 25 years ago by the current CEO, Robert Stephenson. The company purchases real estate, including land and buildings, and rents the property to tenants. The company has shown a profit every year for the past 18 years, and the shareholders are satisfied with the company's management. Prior to founding Stephenson Real Estate, Robert was the founder and CEO of a failed alpaca farming operation. The resulting bankruptcy made him extremely averse to debt financing. As a result, the company is entirely equity financed, with 15 million shares of common stock outstanding. The stock currently trades at $32.50 per share.

Stephenson is evaluating a plan to purchase a huge tract of land in the southeastern United States for $100 million. The land will subsequently be leased to tenant farmers. This purchase is expected to increase Stephenson's annual pretax earnings by $25 million in perpetuity. Kim Weyand, the company's new CFO, has been put in charge of the project. Kim has determined that the company's current cost of capital is 12.5 percent. She feels that the company would be more valuable if it included debt in its capital structure, so she is evaluating whether the company should issue debt to entirely finance the project. Based on some conversations with investment banks, she thinks that the company can issue bonds at par value with an 8 percent coupon rate. Based on her analysis, she also believes that a capital structure in the range of 70 percent

equity/30 percent debt would be optimal. If the company goes beyond 30 percent debt, its bonds would carry a lower rating and a much higher coupon because the possibility of financial distress and the associated costs would rise sharply. Stephenson has a 40 percent corporate tax rate (state and federal).

1. If Stephenson wishes to maximize its total market value, would you recommend that it issue debt or equity to finance the land purchase? Explain.
2. Construct Stephenson's market value balance sheet before it announces the purchase.
3. Suppose Stephenson decides to issue equity to finance the purchase.
   a. What is the net present value of the project?
   b. Construct Stephenson's market value balance sheet after it announces that the firm will finance the purchase using equity. What would be the new price per share of the firm's stock? How many shares will Stephenson need to issue to finance the purchase?
   c. Construct Stephenson's market value balance sheet after the equity issue but before the purchase has been made. How many shares of common stock does Stephenson have outstanding? What is the price per share of the firm's stock?
   d. Construct Stephenson's market value balance sheet after the purchase has been made.
4. Suppose Stephenson decides to issue debt to finance the purchase.
   a. What will the market value of the Stephenson company be if the purchase is financed with debt?
   b. Construct Stephenson's market value balance sheet after both the debt issue and the land purchase. What is the price per share of the firm's stock?
5. Which method of financing maximizes the per-share stock price of Stephenson's equity?