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Capital Structure in a Perfect Market

Should a Company Issue Stocks or Bonds?

How should entrepreneurs and managers think of the multitudes of instruments with which they can finance the firm? To understand how a firm should choose its capital structure, we start with the world that is easiest to understand and that you already know: the "perfect market" (no opinion differences, no transaction costs, no taxes, and many buyers and sellers). This chapter shows (again) that the value of the firm's capital in a perfect market is determined by the present value of its projects, and not by whether the firm is financed with debt or equity. This is because in a perfect financial market, many investors would vie to step in immediately to correct any mistakes managers could commit. As a result, the value of the firm's capital cannot depend on the claims a firm might choose to issue.

This chapter also explains the simplest version of the weighted average cost of capital formula (WACC). The next few chapters will then explain how financing in the real world differs from financing in this perfect-market world.

17.1 Maximization of Equity Value or Firm Value?

Now that you understand the claims that firms *can* and *do* issue, let's focus on what kinds they *should* issue. The best way to conceptualize an optimal firm structure is as follows: You are the entrepreneur who owns all of the firm. You want to sell your firm for the highest possible price. Your stepstone goal is to design your firm—including your corporate charter and capital structure—in a way that maximizes its total market value *today*. This value is the price that new investors are willing to pay to buy the firm from you. If your firm's charter or its capital structure allows or even induces you or your managers to take negative-NPV projects or steal from investors in the future, then who would want to buy your firm today? Thus, the better you design your firm today, the higher the price that you can get from outside investors. (The design of the firm is also a central subject in the web chapter on corporate governance.)

You should think about an optimal capital structure from the perspective of an all-owning entrepreneur.

Let's first talk about what management's incentives are. Who does management represent (other than themselves)? Who *should* management represent? Does it make a difference whether management is representing just the shareholders or all the claimants on the firm? A popular misconception is that managers should only be concerned about **shareholder wealth maximization**. In the presence of other claims—such as financial debt, pension obligations, and accounts payable—this is neither simple nor even legal.

Should our entrepreneur incentivize management to maximize shareholder value?

In the United States, shareholders in publicly traded corporations must elect the corporate board of directors at least once a year. Legally, shareholders are *not* the principals of the firm.

In the US, shareholders elect the board.

Their elected corporate board is.

The board is supposed to represent shareholders in normal situations.

In turn, the board appoints management. Both the board and its appointed managers have a legal **fiduciary duty** to their board and shareholders. This is eminently sensible—management should negotiate with suppliers, creditors, and so on—not on the behalves of these other parties, but on behalf of its own residual equity owners. It should not willingly pay other parties more than the firm has to.

The duty may change and extend to creditors if the firm should go into distress.

However, the legal situation changes when insolvency becomes a possibility. In this case, management's legal fiduciary responsibility extends to other claimants, too. Again, this makes sense, because if the firm is underwater, it may already belong more to the creditors than the shareholders. However, these formal fiduciary responsibilities are not laws of nature. They are different in other countries. For example, in German joint stock companies, limited liability companies, and cooperatives with more than 500 employees, one-third of the **supervisory board** must be employees. (Perhaps not surprisingly, many corporate headquarters have taken advantage of the freedom to move out of Germany to other countries within the European Union.)

Not a dilemma—easy.

In practice, U.S. managers see themselves primarily as representatives of shareholders and not creditors. Yet, even if managers seek to maximize shareholder wealth, it is not necessarily so obvious as to how they should think and what they should do. Let me explain what I mean. When both bondholders and shareholders benefit from a manager's actions, there is no problem. But what if there are situations in which optimizing the value of the equity is the opposite of optimizing the overall firm's value?

A dilemma—when shareholders can expropriate creditors

➤ Bondholder expropriation, Sect. 19.4, Pg.539.

For example, assume it is possible for managers to increase the value of equity by \$1, but at a cost to the value of financial debt of \$3. (You will later learn how easy it is to do exactly this.) This "expropriative" transaction would destroy \$2 in the net value of the firm. Even in our perfect world, this is the type of situation that can create a dilemma for management: Should management maximize firm value or shareholder value? Recall that it is shareholders who ultimately vote managers into office and allow them to stay there. When the time comes, managers may find it in their interest to execute such a transaction because doing so raises the equity value—and with it their executive bonuses. Whether this transaction hurts creditors or destroys value may not even enter their minds.

Rational bond buyers understand future conflicts of interest and assume the worst.

However, there is one big wrinkle in this logic. Put yourself in the shoes of the original entrepreneur today. You are trying to set up a corporate charter and capital structure that maximizes the value of your firm—that is, the price you could get if you sold it today. You want to find the best capital structure *today*. How can you attract new investors and in particular creditors? How can you persuade them to part with their hard-earned cash? Clearly, any potential creditor contemplating purchasing your bonds will take into consideration what your managers may do to them in the future. If it looks as though managers will want to execute the aforementioned dubious transaction, your potential creditors would rationally demand much higher interest rates. If you do not commit the firm today *not* to undertake the \$3-for-\$1 transaction in the future, your prospective bond buyers will realize today (before the fact, or **ex ante**) that you or your management will have the incentive to execute it later (after the fact, or **ex post**), no matter how much you sweet-talk them today.

To secure financing at a low cost of capital, entrepreneurs want to commit not to expropriate bond buyers in the future.

If potential investors believe your firm will undertake this transaction in the future, what will your firm be worth today? The answer is "less than a firm that had been committed not to destroy \$2 of value in the future." Therefore, you have a choice:

- You can avoid debt altogether, but this may hamper you for other reasons explained later.
- You can find a way to commit yourself today not to exploit bondholders in the future.
- You can sell the firm today for a lower net present value. This takes into account your value destruction tomorrow—because everyone realizes that you will be irresistibly tempted to destroy \$2 of firm value.

It should be clear to you that if you want to attract creditors who are not stupid, you should want to do everything in your power to commit yourself visibly today not to exploit them in the future. Committing yourself can optimize the value of your overall firm in the future, which in turn can maximize the value of your firm today.

Internalization—the fact that it is the principal who reaps all benefits and suffers all costs *today* due to all actions in the future and even if they affect only other claimants—is one of the most important insights with respect to capital structure, and one worth repeating again and again and again.

The conceptual basis of capital structure theory: Future behavior and events impact corporate value and costs of capital today.

The cost of *ex-post* actions against smart claimants who can voluntarily walk away from the transaction today is then not really borne by these claimants tomorrow, but it is primarily internalized by the existing owners today. Thus, it is in owners' best interests today to commit themselves not to exploit future claimants tomorrow—especially if everyone knows that when the time comes, owners will want to change their minds. The advantage of a firm that is committed to maximizing firm value in the future is that it can obtain a better price for its claims (e.g., a lower interest rate for its bonds) today. Therefore, it is the firm itself that has the incentive to try to find ways to commit itself today (ex ante) to treating claimants well in the future (ex post).

The entrepreneur's goal is to design a capital structure that will maximize firm value today.

From a financial perspective, the ex-ante capital structure that results in the highest firm value today is the optimal capital structure. This entire argument is based on the implication that *caveat emptor* ("buyer beware") works: Bond and stock purchasers are forward-looking. Moreover, they can be hurt only to the extent that future opportunistic actions by management are unforeseen surprises.

Competition among management teams could pressure firms to improve capital structures.

In a perfect capital market, what will happen if your current management team cannot commit to avoid such bad future $3-for-$1 exchanges? In this case, another management team that has the ability to restrain itself would value the firm more highly than the current management team. It would buy the firm and make an immediate profit. The competition among many management teams with this capability would push the firm toward the best capital structure. At the risk of sounding repetitive, the most important point of this chapter is that firms that can commit to doing "the right thing" tomorrow (ex post) are worth more today (ex ante). *It is a direct consequence that entrepreneurs should maximize firm value and not just shareholder value.*

IMPORTANT

- In deciding on an appropriate price to pay, the buyers of financial claims should—and smart claimants usually do—take into account what the firm is likely to do in the future.
- The basis of **optimal capital structure** theory is the insight that entrepreneurs want to maximize the value of the firm in an upfront sale today, and not necessarily the value of equity today or in the future.
- When we discuss the optimal capital structure, we mean the one that maximizes overall value today.

The conflict between shareholders and bondholders increases in financial distress.

In our theoretical perfect world, firms should commit themselves to maximizing overall firm value, not shareholder value. In real life, existing lenders such as commercial or investment banks are smart enough to write contracts that do not allow firms to walk away from their promises in normal situations. And, therefore, the popular mantra of "shareholder value maximization" is normally synonymous with "total value maximization." However, in existing companies, shareholder and firm objectives can diverge when firms get closer to financial distress. This will all be explained below.

Future capital needs do not necessarily restrain managers.

Note that the need to raise capital in the future may, on occasion, help restrain managerial or entrepreneurial opportunism, but this is not necessarily the case. Today's funders and firms alike realize that potential future funding providers will understand that the past is the past. Even if a firm has not expropriated its past capital providers earlier, it is no guarantee that it will not do so in the future. (And, even if it has expropriated them, it is not a guarantee that it will do so again.) The logic is not primarily about judgment and building reputations in order to satisfy future funding needs. They may matter, but the primary logic is about cold anticipation about what managers will find to be in their self-interest *after* they have received funding.

Agency conflicts with managers are more important in large US firms.

➤ Agency conflicts, Sect. 13.8, Pg.348.

In the United States, managers tend to be less conflicted with respect to favoring shareholders at the expense of bondholders than they are conflicted with respect to their own welfare. (These are the agency conflicts that we first discussed in Section 13.8 and that we will take up again in great length in a web chapter on corporate governance.) In some cases, managers' own self-interests may even lead them to take projects that favor creditors over shareholders—a force that mitigates their incentives to expropriate creditors on behalf of the shareholders.

Q 17.1. Explain the difference between ex ante and ex post, especially in the capital structure context. Give an example in which the two differ.

Q 17.2. Can an ex-post maximizing choice be bad from an ex-ante perspective? If you could, would you want to restrain yourself from acting in such a way later on?

Q 17.3. If a firm has just learned of a legal loophole that allows it to renege on its obligations to pay back its creditors, should it do so?

17.2 Modigliani and Miller

The Economics Nobel Prize from Merton Miller's Perspective

How difficult it is to summarize briefly the contribution of these 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&M theorems and we wonder if you could explain them briefly to our television viewers." "How briefly?" I asked. "Oh, take 10 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 30 printed pages and each with 60 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. Some corporate treasurers might well think that they could enhance total value by increasing the proportion of debt instruments because yields on debt instruments, given their lower risk, are, by and large, substantially below those on equity capital. But, under the ideal conditions assumed, the added risk to the shareholders from issuing more debt will raise required yields on the equity by just enough to offset the seeming gain from use of low-cost debt.

Such a summary would not only have been too long, but it relied on shorthand terms and concepts, like perfect capital markets, that are rich in connotations to economists, but hardly so to the general public.

The Economics Nobel Prize from Merton Miller's Perspective

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. (Selling cream is the analog 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. Skim milk corresponds to the levered equity. The M&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 for a while. They informed me that it was still too long, too complicated and too academic. "Don't you have anything simpler?" they asked. I thought of another way that the M&M proposition is presented 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&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 release that there were two M&M propositions. Maybe we should try the other one."

He was referring, of course, to the dividend invariance proposition and I know from long experience that attempts at brief statements of that one always cause problems. The term "dividend" has acquired too great a halo of pleasant connotations for people to accept the notion that the more dividends the better might not always be true. Dividends, however, as we pointed out in our article, do not fall like manna from heaven. The funds to pay them have to come from somewhere—either from cutting back on real investments or from further sales (or reduced purchases) of financial instruments. The M&M dividend proposition offered no advice as to which source or how much to tap. It claimed, rather, that once the firm had made its real operating and investment decisions, its dividend policy would have no effect on shareholder value. Any seeming gain in wealth from raising the dividend and giving the shareholders more cash would be offset by the subtraction of that part of their interest in the firm sold off to provide the necessary funds. To convey that notion within my allotted 10 seconds I said: "The M&M dividend proposition amounts to saying that if you take money from your left-hand pocket and put it in your right-hand pocket, you are no better off."

Once again whispered conversation. This time, they shut the lights off. They folded up their equipment. They thanked me for my cooperation. They said they would 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 10-second sound bites. Some have the talent for it; and some just don't.

These simple, commonsense analogies certainly do less than full justice to the M&M propositions; crude caricatures or cartoons they may be but they do have some resemblance. So much, in fact, that looking back now after more than 25 years it is hard to understand why they were so strongly resisted at first. One writer—David Durand, the same critic who had so strongly attacked the Markowitz model—even checked out the prices for whole milk, skim milk and cream in his neighborhood supermarket. He found, of course, that the M&M propositions didn't hold exactly; but, of course, empirical relations never do.

Merton Miller, Louvain, Belgium, 1986.

In a perfect financial market, no financial security adds or subtracts value.

The famous **Modigliani-Miller** (**M&M**) propositions (honored with two Nobel Prizes) are a good start to understanding firms' capital structure decisions. Although the M&M theory can be expressed with complex algebra, it is really based on very simple ideas, described in the anecdote on Page 458. The essential point that Modigliani and Miller argued is that in our familiar perfect market (no transaction costs, perfect competition, no taxes, no disagreement), the total value of all financial securities is the same, regardless of whether the firm is financed by equity or debt, or anything in between.

IMPORTANT

The Modigliani-Miller propositions state that in a perfect world, the value of a firm is independent of how it is financed. Instead, it is the underlying projects that determine the value of the firm.

M&M must hold due to (lack of) arbitrage.

➤ Imperfect capital markets, Sect. 11.1, Pg.247.

There would be arbitrage opportunities if the value of the firm depended on how it is financed. Because there should be no arbitrage, it follows that firms should be able to choose any mix of securities without impact on their values. You already know that these assumptions are the basis of all modern finance, even though they do not hold *perfectly*. However, you can only begin to understand how capital structure works in the real world if you understand perfectly how it works when these assumptions hold. Indeed, the next few chapters will be all about what happens if the world is *not* perfect.

M&M view #1: This is simple if we assume a fixed investment policy for the moment.

How does the M&M proof work? For simplicity, take it as given that the firm has already decided on what projects to take. (M&M stated this as one of their necessary assumptions, but it turns out not to matter in a fully perfect market.) The firm now considers how to finance its projects. Because we all agree on all current and future projects' expected cash flows and proper discount rates, we agree on the present value of these projects today. Call the value of the projects under a hypothetical best capital structure "PV." (This is almost by definition the present value that the firm's projects can fetch in our perfect capital market, of course.) The M&M proposition says that the present value of the firm's projects must equal the present value of the firm's issued claims today. In other words, if the firm has no debt and issues 100% equity, the equity must sell for the PV of the projects. If the firm instead finances itself by 50% debt and 50% equity, the two together must sell for the same PV. If the firm issues x% debt and (1 – x%) equity, the two together must sell for PV. The capital structure cannot change the project PV.

M&M is old news to you.

Of course, this should not come as a surprise to you. In Section 6.4, without calling it M&M, you already used it in the context of financing a building. You learned that neither the building value nor the weighted cost of capital were influenced by your debt versus equity mix: The building was worth what it was worth. This is M&M precisely. It is the very same argument.

➤ Splitting payoffs into debt and equity, Sect. 6.4, Pg.123.

M&M view #2: Additivity of projects and financing. Perfect-market financing is zero NPV.

M&M then allows you to think of financing as a decision that can be made independent of the underlying projects. Recall that net present values are additive, so

$$\text{Firm Value} = \text{Project Value} + \text{Financing Value} \qquad (17.1)$$

The M&M proposition states that any method of financing in a perfect market has an NPV of $0. Neither debt nor equity, nor any combination of debt and equity, can change the present value contribution of financing. Any type of financing is obtained from perfectly competitive investors. For the M&M proposition to break down, it would have to be the case that some kind of financing scheme could add or subtract net present value.

An Algebra Version

M&M proof: The argument with a little formality.

M&M is so important that it is worthwhile to put this general but verbal-only proof into a more concrete scenario analysis. To accomplish this as simply as possible, let's work with a firm worth $100. Assume that all claims have to offer the same expected rate of return of 10%, which also means that investors are risk-neutral. (You will work an example in a risk-averse world in Section 17.3. Risk neutrality is just for convenience, not because it makes any difference.) There are two ways to prove that it makes no difference how the firm is financed:

1. The full restructuring (takeover) argument

Absence-of-arbitrage: You could get rich if there was a capital structure worth $1 more or $1 less than what the firm is worth under the current structure.

Assume that the managers could find—and actually did choose—a capital structure that makes the firm worth $1 less than its PV. For example, assume that the firm is worth PV = $100 under the optimal capital structure of 80% equity and 20% debt; and assume further that the firm is worth only $99 under the capital structure of 50% equity and 50% debt that the firm has actually chosen. Then, all you need to do to get rich is to buy all old equity and all old debt, that is, the entire firm, for $99. Now issue claims duplicating the optimal capital structure (assumed to be 80% equity and 20% debt). These claims will sell for $100, and you pocket an instant arbitrage profit of $1.

Competition: Others would want to arbitrage, too—until the M&M proposition works.

Unfortunately, in a perfect market, you would not be the only one to discover this opportunity. After all, opinions are universally shared. Other arbitrageurs would compete, too. The only price at which no one will overbid you for the right to buy the firm's current claims is $100. But notice what this means: the value of the old claims is instantly bid up to the firm value under the optimal capital structure. The logical conclusion is that, regardless of the financial structure that managers choose, they can sell their claims for $100, that is, the present value of their projects.

	Bad Luck	Good Luck	Future	Today's
Prob:	1/2	1/2	Expected Value	Present Value
Firm	$60	$160	$110	$100
Capital Structure "Less Debt (LD)": Bond with Face Value = $55				
Debt	$55	$55	$55	$50
Equity	$5	$105	$55	$50
Capital Structure "More Debt (MD)": Bond with Face Value = $94				
Debt	$60	$94	$77	$70
Equity	$0	$66	$33	$30

Exhibit 17.1: *Illustration of the M&M Proposition with Risk-Neutral Investors.* The cost of capital in this example is 10% for all claims. (This is equivalent to assuming the financial markets are risk-neutral.) Later in this chapter, you will work out an example in which the cost of capital is higher for riskier projects. The table shows how the value of the firm remains the same, regardless of how it is financed—whether it is 100% equity-financed, 50% equity-financed, or 30% equity-financed. This is because the world is perfect.

Any capital structure would be bid up to the value of the hypothetically best capital structure.

Exhibit 17.1 shows the only logical arrangement for a firm whose project will be worth either $60 or $160. The expected future value is $110; the present value is $100. Under hypothetical capital structure LD ("less debt"), the firm issues debt with a face value of $55. Consequently, bondholders face no uncertainty, and they will pay $55/(1 + 10%) = $50. Equity holders will receive either $5 or $105, and they are thus prepared to pay $55/(1 + 10%) = $50. The value of all the firm's claims adds up to the same $100. Under hypothetical capital structure MD ("more debt"), the firm issues debt with a face value of

$94. Consequently, bondholders will now receive either $60 or $94, and they are willing to pay $70 today. Equity holders will receive $0 or $66, and they are willing to pay $30 for this privilege. Again, the value of all claims adds to $100.

Ignoring control rights, here is a "partial purchase and sale" M&M proof.

2. The homemade restructuring argument

A more surprising proof relies on the fact that outside investors can relever the claims themselves—you do not need to own the entire firm to do it. The idea is that you do not buy 100% of the firm, but only 1% of the firm. If you buy 1% of all the firm's claims, you receive 1% of the projects' payoffs. You can then repackage and sell claims that imitate the payoffs under the presumably better capital structure for 1% of the firm's higher value, receiving an arbitrage profit of 1% of the value difference.

For example, assume that the firm has chosen capital structure LD, but you and other investors would really, really like capital structure MD. Perhaps you would really, really like to own a claim that pays $0.60 in the bad state and $0.94 in the good state. This would cost you 1% of the bond's $70 price, or $0.70. How can you buy the existing LD claims to give you the MD-equivalent claim that you prefer *without* any cooperation by the LD-type firm?

You could sell synthetic MD securities if you can buy worse LD securities.

First, work out what your claims are if you buy d bonds and e stocks in the LD firm. You will receive payoffs of $d \cdot \$55 + e \cdot \$5$ in the bad scenario, and $d \cdot \$55 + e \cdot \$105$ in the good scenario. You want to end up with $0.60 in the bad scenario, and $0.94 in the good scenario—two equations, two unknowns:

$$\begin{array}{lrcll} \text{Bad Luck} & d \cdot \$55 + e \cdot \$5 & = & \$0.60 & d \approx 0.0106 \\ \text{Good Luck} & d \cdot \$55 + e \cdot \$105 & = & \$0.94 & e \approx 0.0034 \end{array}$$

If you buy 0.0106 LD bonds and 0.0034 of the LD equity, you will end up with $0.60 in the bad state, $0.94 in the good state—exactly the same as an MD firm would have given you! How much would you have to pay to get these payoffs? The cost today would be $d \cdot \$50 + e \cdot \$50 = 0.0106 \cdot \$50 + 0.0034 \cdot \$50 = \$0.70$, exactly the same as your desired payoffs would have cost you if the firm itself had chosen an MD capital structure.

In effect, you have manufactured the capital structure payoffs that you like without the cooperation of the firm itself. By repeating this exercise (buying some securities, selling others), you can replicate the payoffs of *any* financial claims in *any* kind of capital structure.

From here, it is an easy step to the M&M argument. If the value of the firm is higher under the MD capital structure than it is under the LD capital structure, you can yourself transform the lower-cost claims under the capital structure into the higher-value claims under a better capital structure. You could sell them, and thereby earn an arbitrage profit. This would contradict the conjecture that the firm value could depend on its capital structure—in a perfect world, this cannot be possible.

Beware: This homemade restructuring argument ignores control rights.

However, there is an important caveat to this homemade restructuring proof: Homemade leverage allows you to obtain only the cash flow rights of claims under any different arbitrary, and presumably better, capital structure. *It does not give you the control rights!* It can fail, for example, if a better capital structure has more value *only* if you obtain majority voting control that allows you to fire the management and change policy to what the firm should really be doing.

Destructive Securities?

Let me explain in more detail why the "full restructure" argument with control rights is more universal. The "homemade restructuring" argument must assume that the payoffs are not influenced by the capital structure. What happens if a firm finances itself with securities that are just bad—for example, with securities that have covenants requiring the firm to change management every week? Is the firm worth as much under this awful capital structure as it would be under a reasonable one?

There are two ways to think about this question:

1. You can avoid all control rights-related issues by assuming that the projects and cash flows of the firm are already fixed. Thus, it does not matter whether the management changes every week. Control rights are then irrelevant, too. Even if the firm changed its capital structure, its projects would still generate the same (lousy) cash flows. This is the path that the original M&M paper took—as we did above, too.

Fixed projects means control rights cannot change project cash flows.

2. You can rely on the full restructuring (takeover) argument, discussed above. It leans more heavily on the perfect market assumption, because you must be able to freely buy and sell enough securities not just to restructure 1% of the firm's payoff promises, but enough securities to take full control of the firm. And this is also the real reason why the M&M argument worked: It assumes that if you own all the shares, you own all the control rights. This allows you to fire the old management and restructure the firm's capital structure optimally. (It also assumes you can undo any damage this bad management may have begun to set into action.) Thus, a firm with the bad capital structure that requires changing management every week could simply not exist. Again, you would not be the only one to recognize that this creates value. Therefore, in this perfect world, firms not only end up with the optimal capital structure but also with the optimal set of projects. They are always priced at exactly what they should be worth under the optimal operating and financing policy that they would indeed be pursuing.

Full market perfection with full control rights means that firms always take the best projects.

Reflecting on The Arbitrage Argument

Let's recap it all. In a perfect M&M world, the value of all claims is the same, regardless of how much debt or equity the firm has issued.

- The value of the firm is independent of cash flow (or even control rights), because arbitrageurs can—and always will—rearrange claims into an optimal structure.
- An "absence of arbitrage" relationship ensures that the sum-total value of all the firm's claims is equal to the total underlying project values.
- Claims merely "partition" the firm's payoffs in future states of the world. For financial securities, this is often contractually arranged at inception.

The M&M implications are sometimes misunderstood. Yes, they do state that capital structure cannot influence value. But you should now realize why even the most awful possible capital structure would be worth just as much as the best capital structure. It is because the former would instantly disappear—competitive markets would bid to buy all the (badly aligned) securities and restructure them into something better. Therefore, it is more accurate to think of the M&M proposition as stating not only that all capital structures are worth the same (which is true), but that bad capital structures are immediately eliminated and thus never observed in real life. If a capital structure persists, it couldn't be really bad.

The bad capital structures would exist only for a short instant.

- Bad *capital structures* would be instantly eliminated and are thus never observed.

The same insight really applies to (reversible or avoidable) bad project choices:

- Bad *project choices* would also be instantly eliminated and are thus never observed.

Of course, if the world is *not* perfect, capital structure and dumb project choices could matter to the value of the firm.

To the extent that the M&M proposition has some degree of realism, it is both good news and bad news. It is good news that you now know where to focus your efforts. You should try to increase the value of your firm's underlying projects—by increasing their expected cash flows, reducing their costs of capital, or both. It is bad news because you now know that you cannot add too much value by fiddling around with how you finance your projects if your financial markets are reasonably close to perfect.

Know what and what not to care about!

A very useful consequence of the perfect financial market assumption is that:

- Managers can make their real operations choices first without paying any attention to their debt and equity choices.

Perceived vs. Real Value

Real life?

How robust is the M&M premise when it comes to real-world financial claims? Here, we must distinguish between value and belief.

Corporate value is fairly flat in D/E ratios below, say 80%.

The value proposition holds quite well, unless firms have such high debt ratios that financial distress is a real possibility. This is true both theoretically and empirically. In normal times, it rarely matters whether a large, publicly traded firm has a debt ratio of 0%, 10%, or 20%. The value function is quite flat—despite what you will learn in the next few chapters. Similar firms in the same industry usually thrive quite well with rather different capital structures. Of course, low debt ratios are not the case for startup firms, near-bankrupt firms, or financial services firms, all of which regularly operate with leverage ratios of 90% or more.

...but managers still (wrongly) believe it matters and tinker with it all the time.

The belief proposition fares less well. Many large-firm managers seem to believe that capital structure matters and/or that they can add value by "trading" it. They spend too much attention to fine-tuning it—of course, firms with very high leverage ratios should, but for others the effects are likely to be small. This is not to say that worrying about capital structure is always a complete waste of time (e.g., when interest rates change, obtaining new competitive bids for a debt refinance is a good idea), but it is to say that managers would often be better off searching for better deals than fiddling with capital structure.

Q 17.4. Explain the M&M argument to your 10-year-old sibling, using Merton Miller's analogies.

Q 17.5. Under what assumptions does capital structure not matter?

Q 17.6. What does the assumption of risk neutrality "buy" in the M&M proof?

Q 17.7. In the example from Exhibit 17.1, how would you buy the equivalent of 5% of the hypothetical MD firm's equity if all that was traded were the claims of the LD firm? (Hint: if you have d of the LD debt and e of the LD equity, you should end up with $0 in the bad-luck state and 5% of $66 in the good-luck state. How much d and e should you own? You need to solve two equations for two unknowns.)

Q 17.8. Is the "homemade leverage restructuring" a full proof of the M&M proposition that capital structure is irrelevant? If not, what is missing?

Q 17.9. Under M&M, if contracts cannot be renegotiated, could existing managers destroy shareholder value? Does this change the value of the firm?

17.3 The Weighted Average Cost of Capital (WACC)

Revisit the contingent claims example under risk aversion. Equity now requires a higher expected rate of return.

Stating that "the value of the firm does not depend on the financing in a perfect market" is equivalent to stating that "the overall cost of capital to the firm does not depend on its debt ratio." To show that our capital-structure indifference proposition also works when the world is not risk-neutral, let's repeat the "building with mortgage" example from Section 6.4. However, we now allow riskier claims to have higher expected rates of return. You can draw on your knowledge of net present value, risk-averse benchmark pricing, the capital asset pricing model, and capital structure concepts as we revisit this example. Another reason why this example is important is that it reintroduces the "weighted average cost of capital" (WACC) in the corporate context. The next chapter will cover a generalized WACC formula if corporations pay income tax that is in wide practical use.

➤ Splitting building payoffs into debt and equity, Sect. 6.4, Pg.123.

Risk Aversion and Higher Equity Cost of Capital

All tools learned in Section 6.4 still apply under risk aversion.

When investors are risk-averse, riskier claims have to offer higher expected rates of return. To work them, our basic tools remain exactly the same as those in Section 6.4: payoff tables, promised rates of return, and expected rates of return.

The payoff table example applies to firms just as it did to buildings.

From Chapter 16, you know that debt and equity are contingent claims on the underlying project. Although we continue calling this project a building (to keep correspondence with Section 6.4), we now extend the metaphor. Consider the corporation to be the same as an unlevered building, the mortgage the same as corporate debt, the levered building equity ownership the same as corporate equity, and the possibilities of sun and rain as future good or bad product demand scenarios. There are no conceptual differences. However, we do take one shortcut: We ignore all nonfinancial liabilities and pretend that our firm is financed entirely by financial debt and equity.

Recap the example parameters.

The parameters of the problem are as follows:

- The probability of sun is $3/4$; the probability of rain is $1/4$.
- If it is sunny, the project is worth \$100; if it is rainy the project is worth only \$60.
- The appropriate cost of capital (at which investors are willing to borrow or save) is 20% for the overall project. We retain this cost of capital for the overall project (though not for the debt and equity). You had also computed earlier that the building must then be worth \$75:

The expected payoff on the project is $1/4 \cdot \$60 + 3/4 \cdot \$100 = \$90$, and the price today is $\$90/(1 + 20\%) = \$75$.

Risk aversion causes expected interest rates on debt to be lower than expected rates of return on the project.

The novelty is that we now assume that investors are risk-averse and thus U.S. Treasuries pay a lower *expected* rate of return. The debt on the building is not exactly risk-free, either. Let's assume that you want to raise \$65 today. Your investment banker informs you that you have to offer bond investors an interest rate of 16.92% if you want to raise so much. (Still, it's less than the 20% discount rate on the overall project.) If you do this, how much will you expect to get as the residual equity claimant? And what will be the firm's overall cost of capital? This will turn out to be like a fun crossword puzzle.

In Terms of Project Value

Step 0: Let's first collect all the inputs you have:

			Financing Scheme All Equity (AE): 100% Equity	Financing Scheme Debt and Equity (DE): Bond (promises 16.92%)	Financing Scheme Debt and Equity (DE): Levered Equity (after Bond)
Prob(Sun) =	3/4	\$100	\$100		
Prob(Rain) =	1/4	\$60	\$60		
E Future Payoff			\$90		
Price P Now			\$75	\$65	
E Rate of Return			20%		

Step 1: Figure out how much the bond holders are really getting. At the 16.92% interest rate, they will get $\$65 \cdot (1 + 16.92\%) \approx \$76$—but only if it's sunny. Otherwise, they get what's left: \$60. Thus, their expected return is

$$\mathcal{E}(\text{Return}) = \underbrace{1/4 \cdot \$60}_{\text{Rain}} + \underbrace{3/4 \cdot \$76}_{\text{Sun}} = \$72$$

and their *expected* rate of return is

$$\mathcal{E}(\text{Rate of Return}) = \mathcal{E}(r) = \$72/\$65 - 1 \approx 10.77\%$$

Add all these figures into the table:

		Financing Scheme AE	Financing Scheme DE	
		100% Equity	Bond promises $\boxed{\$76}$	Levered Equity after $\boxed{\$76}$ Bond
Prob(Sun)=3/4	\$100	\$100	$\boxed{\$76}$	
Prob(Rain)=1/4	\$60	\$60	$\boxed{\$60}$	
$\mathcal{E}$ Future Payoff		\$90	$\boxed{\$72}$	
Price P Now		\$75	\$65	
$\mathcal{E}$ Rate of Return		20%	$\boxed{10.77\%}$	

Step 2: How much is your levered equity going to get in each state? Here we invoke the perfect market assumptions. Everyone can buy or sell without transaction costs, taxes, or any other impediments. By "absence of arbitrage," the value of the building if financed by a bond plus levered equity must be the same as the value of the building if 100% equity-financed. Put differently, if you own all of the bond and levered equity, you own the same thing as the building—and vice-versa. Now use the arbitrage condition that the value of the levered equity plus the value of the bond should equal the total building value. The equity gets just what is left over, and the debt and equity together own the firm today. With the debt raising \$65 today and the firm being worth \$75, your equity must be worth \$10. Write all these quantities into the table:

		Financing Scheme AE	Financing Scheme DE	
		100% Equity	Bond promises \$76	Levered Equity after \$76 Bond
Prob(Sun)=3/4	\$100	\$100	\$76	$\boxed{\$24}$
Prob(Rain)=1/4	\$60	\$60	\$60	$\boxed{\$0}$
$\mathcal{E}$ Future Payoff		\$90	\$72	$\boxed{\$18}$
Price P Now		\$75	\$65	$\boxed{\$10}$
$\mathcal{E}$ Rate of Return		20%	10.77%	

Step 3: What is the expected rate of return on equity? Easy! Your equity is worth \$10 and expects to receive \$18. Thus, its rate of return is $\$18/\$10 - 1 = 80\%$.

		Financing Scheme AE	Financing Scheme DE	
		100% Equity	Bond promises \$76	Levered Equity after \$76 Bond
Prob(Sun)=3/4	\$100	\$100	\$76	\$24
Prob(Rain)=1/4	\$60	\$60	\$60	\$0
E Future Payoff		\$90	\$72	\$18
Price P Now		\$75	\$65	\$10
E Rate of Return		20%	10.77%	80%

In Terms of Cost of Capital (WACC)

Given the prices of the two claims and their payoffs in each state, you can work out all the rates of return:

Compute the riskiness of a dollar investment in each financial instrument.

	Contingent Rate of Return		Expected (Appropriate)
	Rain	Sun	Rate of Return
Unlevered (100% Equity)	$\frac{\$60}{\$75} - 1 = -20\%$	$\frac{\$100}{\$75} - 1 \approx 33\%$	$\frac{\$90}{\$75} - 1 = 20\%$
Loan (Bond)	$\frac{\$60}{\$65} - 1 \approx -7.69\%$	$\frac{\$76}{\$65} - 1 \approx 16.92\%$	$\frac{\$72}{\$65} - 1 \approx 10.77\%$
Shares (Levered Equity)	$\frac{\$0}{\$10} - 1 = -100.00\%$	$\frac{\$24}{\$10} - 1 = 140\%$	$\frac{\$18}{\$10} - 1 = 80\%$

Let's recap: You started knowing only the costs of capital for the firm (20%) and worked out the cost of capital of the firm's bond (10.77%). This allowed you to determine the cost of capital on the firm's levered equity (80%). Neat!

➤ Risk-neutral investors, Exhibit 6.7, Pg.127.

As was also the case in the example with risk-neutral investors in Exhibit 6.7, the rates of return to levered equity are riskier (–100% or +140%) than those to unlevered ownership (–20% or +33%), which in turn are riskier than those to the corporate loan (–7.69% or +16.92%). But whereas these risk differences did not affect the expected rates of return in the risk-neutral world, they do in a risk-averse world. The **cost of capital** (the expected rate of return at which you, the owner, can obtain financing) is now higher for levered equity ownership than it is for unlevered ownership, which in turn is higher than it is for loan ownership. Moreover, you could work out *exactly* how high this expected rate of return on levered equity ownership must be. You only needed the "absence of arbitrage" argument in the perfect M&M world: Given the expected rate of return on the building and on the bond, you could determine the expected rate of return on levered equity ownership. (Alternatively, if you had known the appropriate expected rate of return on levered equity ownership and the rate of return on the bond, you could have worked out the appropriate expected rate of return on unlevered ownership. Of course, the exact differences in expected rates of return should ultimately also be governed by some model—perhaps one similar to but better than the CAPM.)

Debt is less risky than unlevered ownership, which is less risky than levered equity ownership.

Q 17.10. In the text, we just stated that levered equity was riskier than unlevered ownership which was riskier than the bond. Let's confirm this. Work out the standard deviations of the rates of return for each of the three possible types of claims (full ownership, debt, and levered equity) in the building example in the text. What is their risk-ordering?

Q 17.11. If you can raise $60 in debt at an *expected* rate of return of 5%, what are the payoffs of debt and equity in rainy and sunny states, the appropriate expected rates of return, and the standard deviations?

Q 17.12. A firm can be worth $50 million, $150 million, or $400 million, each with equal probabilities. The firm is financed with one bond, expecting to pay its promised $100 million at an expected interest rate of 5%. If the firm's projects require an appropriate cost of capital of 10%, then what is the firm's equity cost of capital? What is the debt's expected payoff? What is the debt's promised rate of return?

Q 17.13. Assume that you have access to a project worth $100 that you cannot fully finance yourself. Moreover, you have only 20% of the project that you can finance and you need the money back next year, because you will have no other source of income. Can you fund the project?

The WACC Formula (without Taxes)

The WACC is independent of debt and equity distribution.

The **weighted average cost of capital** (**WACC**) is the value-weighted average cost of capital of all the firm's claims. Because the firm value is determined by the assets and is independent of how debt and equity are divided, the same independence should hold true for the cost of capital. Let's check, then, that if the perfect-market arbitrage condition holds—that is, if bonds and stocks together cost the same as the firm—then the cost of capital for the overall firm is the weighted cost of capital of stocks and bonds.

If you know any two costs of capital, you can deduce the third.

The constant WACC implies that the costs of capital of debt, equity, and the overall firm are directly linked. If you know the costs of capital for the debt and the equity, you can infer the cost of capital for the firm. Alternatively, if you know the cost of capital for the firm and the debt, you can infer the cost of capital for the equity. *If you know any two costs of capital, you can compute the third one.*

Here is a line-by-line derivation of the WACC formula.

Let's show this again to translate the numerical example into a formula for the WACC. In either state, the debt and equity together will own the firm:

$$\begin{array}{lcccc} \text{Sun } (3/4): & \$76 & + & \$24 & = \$100 \\ \text{Rain } (1/4): & \$60 & + & \$0 & = \$60 \\ & \text{Debt} & + & \text{Equity} & = \text{Firm} \end{array}$$

(I am omitting the time subscripts to avoid clutter.) Therefore, the expected value of debt and equity together must be equal to the expected value of the firm.

$$\begin{array}{ccccc} \$72 & + & \$18 & = & \$90 \\ \mathsf{E}(\text{Debt}) & + & \mathsf{E}(\text{Equity}) & = & \mathsf{E}(\text{Firm}) \end{array}$$

Rewrite this in terms of today's values and expected rates of return ($\mathsf{E}(r)$),

$$\begin{array}{rccccc} & \$72 & + & \$18 & = & \$90 \\ \approx & \$65 \cdot (1+10.77\%) & + & \$10 \cdot (1+80\%) & \approx & \$75 \cdot (1+20\%) \\ & \mathsf{E}(\text{Debt}) & + & \mathsf{E}(\text{Equity}) & = & \mathsf{E}(\text{Firm}) \\ = & \text{Debt} \cdot [1+\mathsf{E}(r_{\text{Debt}})] & + & \text{Equity} \cdot [1+\mathsf{E}(r_{\text{Equity}})] & = & \text{Firm} \cdot [1+\mathsf{E}(r_{\text{Firm}})] \end{array}$$

In the last row, debt, equity, and firm are now, and expected rates of return are from now to the future. Divide each term by the firm value today (Firm = \$75) to express this formula in terms of percentages of firm value:

$$\begin{array}{ccccc} \frac{\$65}{\$75} \cdot (1+10.77\%) & + & \frac{\$10}{\$75} \cdot (1+80\%) & \approx & \frac{\$75}{\$75} \cdot (1+20\%) \\ \left(\frac{\text{Debt}}{\text{Firm}}\right) \cdot [1+\mathsf{E}(r_{\text{Debt}})] & + & \left(\frac{\text{Equity}}{\text{Firm}}\right) \cdot [1+\mathsf{E}(r_{\text{Equity}})] & = & [1+\mathsf{E}(r_{\text{Firm}})] \end{array}$$

Compute the fractions: Debt/Firm ≈ 86.7% and Equity/Firm ≈ 13.3%. These are the financing weights of the two securities in the firm *today*. Therefore, you can write this formula as

$$\begin{array}{ccccc} 86.7\% \cdot (1+10.77\%) & + & 13.3\% \cdot (1+80\%) & \approx & 1+20\% \\ w_{\text{Debt}} \cdot [1+\mathsf{E}(r_{\text{Debt}})] & + & w_{\text{Equity}} \cdot [1+\mathsf{E}(r_{\text{Equity}})] & = & [1+\mathsf{E}(r_{\text{Firm}})] \end{array}$$

The "1+" cancels on both sides, because 86.7% + 13.3% = 100%. You have just discovered the perfect-market WACC formula:

$$\begin{array}{cccccc} \text{WACC} & \approx & 86.7\% \cdot 10.77\% & + & 13.3\% \cdot 80\% & \approx & 20\% \\ \text{WACC} & = & w_{\text{Debt}} \cdot \mathsf{E}(r_{\text{Debt}}) & + & w_{\text{Equity}} \cdot \mathsf{E}(r_{\text{Equity}}) & = & \mathsf{E}(r_{\text{Firm}}) \end{array}$$

No one bothers adding the expectation operator in front of the WACC, although this would be more accurate. The next two chapters will explain how WACC must be modified in the presence of corporate income taxes and other perfect-market distortions.

IMPORTANT

The Weighted Average Cost of Capital formula (when there are no corporate taxes) is

$$\text{WACC} = \mathsf{E}(r_{\text{Firm}}) = w_{\text{Debt}} \cdot \mathsf{E}(r_{\text{Debt}}) + w_{\text{Equity}} \cdot \mathsf{E}(r_{\text{Equity}}) \qquad (17.2)$$

Leverage, Cost of Capital, and Quoted Interest Rates

We want to consider different capital structures now.

You now understand how to compute costs of capital. But let's look at a few more trees to understand the forest better. How do shifts in capital structures generally influence individual securities' costs of capital? Return to the original debt-and-equity-only numerical example. In capital structure DE-0, the bond promises \$36; in DE-1, it promises \$76; and in DE-2, it promises \$88.

Medium leverage.

Everything included, we just worked out:

		Financing Scheme AE	Financing Scheme DE-1	
		100% Equity	Bond promises $76	Levered Equity after $76 Bond
Prob(Sun)=3/4	$100	$100	$76	$24
Prob(Rain)=1/4	$60	$60	$60	$0
E Future Payoff		$90	$72	$18
Price P Now		$75	$65	$10
E Rate of Return		20%	10.77%	80%
Financing Weight		100%	$65/$75 ≈ 87%	$10/$75 ≈ 13%

To generalize, I need to describe how the debt cost of capital varies with leverage.

How would the promised rate of return, the expected rate of return, and the debt-equity ratio change if the firm changed the amount it borrowed? Let's say the firm has explored the capital markets and learned that in capital structure DE-2, a bond promising $88 in debt payments would raise $70 today. (Trust me that this is consistent with the same economy-wide risk-aversion that we used in the previous example.) The payoff table is now

		Scheme AE	Scheme DE-2	
		100% Equity	Bond promises $88	Levered Equity after $88
Prob(Sun)=3/4	$100	$100	$88	$12
Prob(Rain)=1/4	$60	$60	$60	$0
E Future Payoff		$90	$81	$9
Price P Now		$75	$70	$5
E Rate of Return		20%	15.71%	80%
Financing Weight		100%	93.3%	6.7%

Finally, let's determine what happens if debt promising $36 can be raised at a price of $35 today. This debt is risk-free.

		Scheme AE	Scheme DE-0	
		100% Equity	Bond promises $36	Levered Equity after $36
Prob(Sun)=3/4	$100	$100	$36	$64
Prob(Rain)=1/4	$60	$60	$36	$24
E Future Payoff		$90	$36	$54
Price P Now		$75	$35	$40
E Rate of Return		20%	2.86%	35%
Financing Weight		100%	46.7%	53.3%

Putting this together, here are the capital-structure tradeoffs:

Many different leverages.

	Debt Promises		Expected Rate of Return			Weight	
	Payoff	Interest Rate	Debt	Equity	Firm	Debt	Equity
No Debt	$0	2.86%	2.86%	20%	20%	0.0%	100.0%
Low Debt	$36	2.86%	2.86%	35%	20%	46.7%	53.3%
Med Debt	$76	16.92%	10.77%	80%	20%	86.7%	13.3%
High Debt	$88	25.71%	15.71%	80%	20%	93.3%	6.7%
All Debt	$100	33.33%	20.00%	-	20%	100.0%	0.0%

I also added that when you borrow nothing, your marginal interest rate is still the risk-free rate; and if you promise $100, you expect to deliver $75—the debt *is* the firm.

Do not confuse expected and quoted rates of return. For high debt ratios, equity may well have to offer seemingly astronomical *expected* rates of return. In our example, if the 20%-discount-rate firm raises $76 in debt, it has to offer an expected rate of return of 80% to the equity. This is common—for high leverage ratios, equity costs of capital often seem astronomical. This is not usury. It is simply fair.

Q 17.14. Can you think of some (really weird) cases, in which the equity cost of capital can be lower than the debt cost of capital? Hint: Here it is useful to think in CAPM terms.

Q 17.15. Can the equity cost of capital be lower than the *promised* interest rate?

Graphing Financing Schemes against Leverage Ratios

The binomial example "in pictures."

I have done the calculations for many more debt weights, and graphed the expected rates of return to both debt and equity in the upper graph in Exhibit 17.2. (This is the "forest" view I wanted to get to.) When leverage ratio is low, the debt is risk-free. Yet more debt still increases the risk of the equity and thus the equity's cost of capital. Eventually, with enough debt, the debt itself becomes risky, too. In this region, more debt means more risk for creditors, and thus a higher required rate of return on debt. (The promised rate of return is, of course, above the expected rate of return.)

A more normal example "in pictures."

In the real world, the plot can look a little different, because most projects do not have "binomial" but more "normally distributed" (bell-shaped) payoffs. This is the lower graph. In fact, it may well be possible that the firm may end up being worth nothing. Thus, it is impossible for the firm to issue truly risk-free debt. However, over a wide range, debt is "practically" risk-free, because the firm is very likely to be worth enough to pay its debt. Thus, the probability of default is tiny for modest debt loads. Eventually, as the debt ratio of the firm increases ever more, the debt's expected rate of return must increase noticeably, too. And again, the cost of equity rises with the fraction of debt of the firm over the whole domain. (Unlike the earlier graph, there is no sudden end to the riskiness of equity.) *Importantly, in both plots, the WACC is constant, regardless of the firm's mix of equity and debt.*

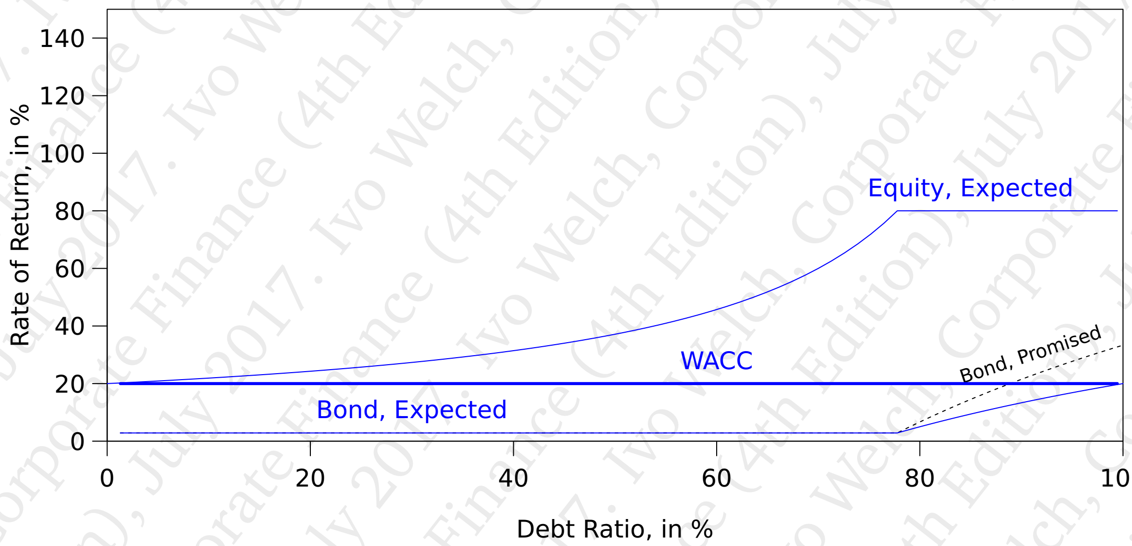
If all Securities are Riskier, is the Firm also Riskier?

If you remember nothing else from this chapter, please remember to avoid a common logical fallacy. Many practitioners start with two correct statements:

Does more debt increase the firm's cost of capital? Does it increase the debt cost of capital? Does it increase the equity cost of capital?

1. If the firm takes on more debt, the debt becomes riskier and the cost of capital for the debt ($\mathsf{E}(r_{\text{Debt}})$) increases.

Binomial Payoffs (as in the text)



Normally Distributed Payoffs

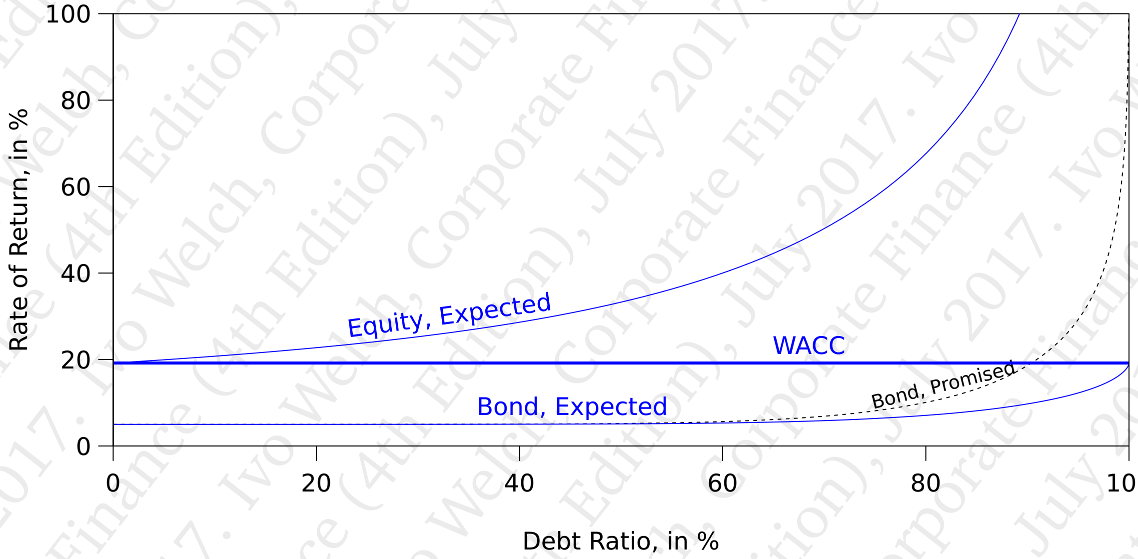


Exhibit 17.2: *The Cost of Capital in a Perfect World.* The top graph illustrates the binomial example worked out in the table in the text. Until the debt ratio reaches around 80% of the firm value, the debt is risk-free. However, more debt still increases the risk of equity, and therefore its expected rate of return. For debt ratios higher than 80%, the debt is risky and has to offer a higher promised and expected rate of return.
The lower graph plots a similar figure for a firm that has more than just two possible payoffs. Here, the firm has (almost) normally distributed payoffs (with mean \$90 and standard deviation \$17).
In both cases, the WACC is *always* the same, regardless of the mix of debt and equity.

2. If the firm takes on more debt, the equity becomes riskier and the cost of capital for the equity ($E(r_{Equity})$) increases.

However, they then commit a serious logical error when they argue:

3. Because the firm consists of only debt and equity, the firm also becomes riskier when the firm takes on more debt, which must mean that the firm's cost of capital ($E(r_{Firm})$) increases. A financier may even want to reduce the firm's debt in order to avoid such increases in volatility of the firm.

The first two statements are correct. With more debt, the cost of capital on debt increases because it becomes riskier. In corporate default, the debt is less likely to receive what it was promised. The equity also becomes riskier: The cost of capital on equity rises, because in financial default, which is now more likely to occur, more cash goes to the creditors before equity holders receive anything.

The fact that both debt and equity become riskier as the firm takes on more debt does not mean that the overall firm becomes riskier.

But the final conclusion—"the firm also becomes riskier"—is wrong. When the firm takes on more debt, the weight of the (safer) debt (w_{Debt}) increases and the weight of the (riskier) equity ($w_{Equity} = 1 - w_{Debt}$) decreases. Because the cost of capital for debt ($E(r_{Debt})$) is lower than the cost of capital for equity ($E(r_{Equity})$), the weighted sum remains the same. Confirm this:

$$\begin{array}{lcl} \text{Low Debt} & 46.7\% \cdot 2.86\% \;+\; 53.5\% \cdot 35\% & \approx 20\% \\ \text{Med Debt} & 86.7\% \cdot 10.77\% \;+\; 13.3\% \cdot 80\% & \approx 20\% \\ \text{High Debt} & 93.3\% \cdot 15.71\% \;+\; 6.7\% \cdot 80\% & \approx 20\% \end{array}$$

Check that statements 1 and 2 are correct and that statement 3 is incorrect: The costs of capital for both debt and equity are (weakly) higher when the firm has more debt, but the overall cost of capital for the firm has not changed. In the perfect M&M world, the overall cost of capital is independent of the mix between debt and equity.

Q 17.16. Continue with Q 17.11, in which the firm raised \$60 in debt by promising to pay \$64 (resulting in an expected rate of return of 5%). What are the debt and equity investment weights? Is the WACC 20% for this capital structure?

Q 17.17. In the sun/rain example, if the firm can raise \$62.50 in debt by promising \$70, show that the WACC is still 20%.

Q 17.18. Compared to hypothetical firm B, hypothetical firm A has both a higher cost of capital for its debt and a higher cost of capital for its equity. Does this necessarily imply that firm A has a higher overall cost of capital than firm B?

Leverage, Earnings Per Share, and Price/Earnings Ratios

What is the effect of debt on earnings per share (EPS)? This is a meaningless question, because EPS depends not on the firm but on the number of shares. The same capital structure can exist under different numbers of shares. Equity can be worth \$7 million with 1 million shares valued at \$7/share (an expected EPS of \$0.70/share) or with 100,000 shares valued at \$70/share (an expected EPS of \$7/share). Any EPS figure is possible.

EPS is meaningless.

A more meaningful question is how leverage influences P/E ratios. I had already sneaked this into Section 15.4, but you had to trust me blindly that debt offers a lower expected rate of return than equity. The examples in that section satisfied the M&M constant WACC —and showed that more debt can sometimes cause lower P/E ratios (especially in value firms) and sometimes cause higher P/E ratios (especially in high-growth firms).

P/E is a more sensible ratio. It can go up or down. Ultimately, P/E is not important, though—only value is.

➤ Debt adjustment for P/E ratios, Sect. 15.4, Pg.409.

Q 17.19. Is a firm making a mistake if it uses a weighted average cost of capital that is lower than the interest rate it has to pay to the bank?

Q 17.20. If a firm has a 5% cost of debt capital, a 10% cost of project capital, and a 20% cost of equity capital, what is its debt-equity ratio?

Q 17.21. How can it be possible for a firm with a positive cost of project capital to have a negative cost of equity capital? How high can the cost of project capital be in this case?

17.4 State Prices and Credit Derivatives

How about some insurance?

➤ Credit Derivatives, Sect. 6.2, Pg.119.

Credit derivatives are a multi-trillion dollar financial business. The easiest way to think of this market is as one party (like a hedge fund) writing insurance to another party (like a pension fund) in case the bond fails to pay. For example, go back to our example:

		Bond promises $88	Levered Equity after $88
Prob(Sun) = 3/4	$100	$88	$12
Prob(Rain) = 1/4	$60	$60	$0
Price P Now		$70	$5
E Rate of Return		15.71%	80%

What would you think if I was willing to sell you a CDS that paid $1 when it rains and $0 when the sun shines?

Pure State-Contingent Prices (Claims)

We already worked the example of the opposite, the $1-Sun state claim: If $12 of Sun-promise cost $5 today, then $1 of Sun-promise must cost $5/12 \approx \$0.4167$ today. Thus, the $88 bond promise for the Sun-state is worth $5/12 \cdot \$88 \approx \$36.67$ today. The remaining $60 Rain-promise must therefore be worth $\$70 - \$36.67 = \$33.33$ today. And if $60 of Rain-promise cost $33.33, then $1 of Rain-promise must cost $\$33.33/\$60 \approx \$0.5555$ today. You can now check that the $88-promise bond is indeed worth $70:

$$P(\$88 \text{ Par Bond}) \approx \$0.4167 \cdot \$88 + \$0.5555 \cdot \$60 \approx \$70 \ .$$

Transforming the bond into a risk-free claim.

The prices of such pure state claims are not just of academic interest. If you purchased the debt plus $28 of my Rain-promise, you would hold a risk-free position paying off $88, no matter what! These $28 of "bond insurance" would cost you about $\$0.5555 \cdot \$28 \approx \$15.56$ today. The aforementioned desire by pension funds to transform risky securities into risk-free securities has been the main reason for the large size of the CDS market.

The expected rates of return for the two pure state-contingent claims.

What are the expected rates of return of the two pure state claims?

$$\begin{aligned} \text{Sun State} \quad & 3/4 \cdot (\$12/\$5 - 1) + 1/4 \cdot (-1) &=& \ 80\% \\ \text{Rain State} \quad & 3/4 \cdot (-1) + 1/4 \cdot (\$28/\$15.55 - 1) &=& \ -55\% \end{aligned}$$

This is not an error: investors are willing to purchase the rain-claim even at a stark negative rate of return! After all, insurance is not free.

The alternative risk-free transform's expected rate of return.

If you buy a combined portfolio of one $70 bond and $15.56 worth of rain-claim, you have 81.82% investment in the bond and 18.18% in the CDS–and your portfolio has become risk-free! And this portfolio has the correct risk-free rate of return,

$$81.82\% \cdot (+15.71\%) + 18.2\% \cdot (-55\%) \approx 2.86\% \ ,$$

well, ignoring the 0.01% rounding error!

17.5 Cost of Capital Nuances and Non-Financial Liabilities

There are some small subtleties, however, when it comes to nonfinancial claims. Product markets are often not perfect. In these cases, the firm's average and marginal costs of capital can be different. Nevertheless, if the financial claims exist in a perfect market, then it is often still the case that the firm's marginal cost of capital—which is what managers ultimately want to know—is that of its financial claims. The financial claims' weighted average cost of capital would then still be the firm's marginal cost of capital. (However, this cost of capital would *not* be the firm's average cost of capital.)

In Exhibit 16.3, you saw that Intel's total liabilities were about half as large as its financial debt. This is typical for many U.S. companies. Does the M&M proposition—that firm value is not influenced by capital structure and thus that capital structure is irrelevant—still apply in the presence of nonfinancial claims?

Firms have many nonfinancial liabilities.

➤ Intel, Exhibit 16.3, Pg.445.

Value Irrelevance With Nonfinancial Liabilities?

The argument is actually somewhat subtle. Start by recalling the logic of the M&M perfect-market argument: The value of the firm's financing does not depend on how it is divided between debt and equity. The proof was by contradiction. If a firm instituted a capital structure with a dumb debt covenant—that is, one that forced it to pay all its future cash flows to charity—could this firm be worth less than a more intelligently financed firm? No! A horde of arbitrageurs would immediately compete to buy all these bad claims (at their presumably lower value) and undo the dumb capital structure. Therefore, this dumb capital structure could not trade for a lower price than the optimal capital structure. It would have the same value as the best capital structure, but it would exist for only half an instant before it was undone. The perfect market provided two aspects important to the M&M argument:

The logic of the perfect-market M&M proposition.

1. The capital market is perfectly elastic. All financial claims that the firm could dream up would be snatched up by a perfect capital market at an appropriate price.
2. There is no link between the firm's operations and the financial claims that a firm is able to take on. (In the original M&M paper, the authors assumed that all operating decisions were already made.)

These two assumptions can fail on nonfinancial liabilities. Let me give you two respective examples:

Nonfinancial financing can add value. Thus, M&M breaks down. In effect, its financing now takes on the characteristics of its nonfinancial market imperfections.

1. **Income tax liabilities:** If you do not pay your taxes until April 15 (tax day), you can use your tax liability for your own investment purposes. Your effective cost of capital on these funds is zero. However, you cannot raise more funds at will at this same zero interest rate from Uncle Sam. You also cannot return this financing to the provider at a fair market cost of capital. If you prepay your taxes, Uncle Sam will not credit you with interest for early payment.
2. **Trade credit:** It is not uncommon for suppliers to give firms 0% financing as trade credit. This is *not* the perfect-market appropriate price for financing and you would want to take as much of this trade credit as possible. However, this trade credit is usually only available to you if you buy more of the underlying good. Your supplier would not provide you more trade credit in order to pay your rent if you did not buy his goods. Consequently, if you were to buy your supplier's goods, a capital structure with more trade credit would be better than one without. Conversely, you may not even buy these goods without trade credit.

Now think back to how the value of your firm was determined by the net present values of your project. Formula 17.1 stated that

➤ Firm=Project+Financing, Formula 17.1, Pg.460.

$$\text{Firm Value} = \text{Project Value} + \text{(Trade Credit) Financing Value}$$

Under M&M, the financing NPV was always zero. However, your trade credit in this example would be a positive-NPV project in itself. The consequence is that you might choose different real operations (buying the supplier's goods) if you were financed with rather than without trade credit. The separation between operations and financing has just broken down. On the contrary, if trade credit is a bargain, it now makes sense to think of a bundle that includes the project and the project-specific financing that comes with it.

M&M for operations and nonfinancial liabilities would be less plausible and not very useful.

It is possible to put forth a perfect-market scenario for operations that unlinks their nonfinancial claims in order to get a full M&M proposition also for nonfinancial claims. However, this is not particularly useful for two reasons: First, we are interested primarily in finance, not in operations. Second, nonfinancial markets are generally far from perfect—much more so than financial markets—and many operational choices are irreversible once made. With such a large discrepancy between the necessary perfect-market conditions and reality, such a proposition would not be very helpful in thinking about real-world problems. But you do need to understand how to think of the firm's financing claims in a broader real-world perspective. Fortunately, this is easy.

IMPORTANT

- The M&M proposition is helpful for thinking about the division of claims into debt and equity. This is because the markets for raising financing through these claims are fairly perfect, and the firm pays fair prices either way.
- Thus, for financial claims, managers can think about financing and operational choices separately.
- The M&M proposition is less helpful for thinking about the division of claims between financial and non-financial liabilities. This is because the markets for raising financing through non-financial liabilities are rarely perfect. Such financing, e.g., trade credit or delayed tax payments, often offer better deals but are available only together with certain project choices.
- Thus, for non-financial claims, managers need to think about financing and operational choices together.

Q 17.22. In a world of perfect financial markets, is the value of the firm independent of how it is financed if there are also nonfinancial liabilities?

Q 17.23. In a world of perfect financial markets, is the value of the firm's financial claims independent of how it is financed?

The Marginal vs. The Average Cost of Capital

Perfect world: The average cost of capital is the marginal cost of capital.

There is one more important issue that you did not yet have to worry about in the M&M world. The **marginal cost of capital** applies to the next dollar of capital the firm would raise; the **average cost of capital** is the financing cost for all of the firm's existing projects. As a manager, you ultimately want to learn your projects' marginal costs of capital, because these rates are what you would compare to your projects' marginal rates of return. The firm's average cost of capital is really quite irrelevant. Fortunately, under M&M, the two are the same. Thus, if you compute the weighted average cost of capital, you know the marginal cost of capital for raising one more dollar.

Unfortunately, in the real and imperfect world, the average and marginal costs of capital can be different. For example, it could be that the first dollar of financing obtained by the firm is internal (or trade credit) and thus cheaper than the billionth dollar of financing if the firm had to search for investors first. Thus, when you compute a WACC from a firm's existing capital providers (and published in the financial data), be aware that even if the project is typical for the firm, it may only be your average cost of capital—not the marginal cost of capital that you may need.

Real world: The two costs of capital can be different.

Now recall that the firm's weighted average cost of capital is

The natural definition of the firm's WACC with nonfinancial liabilities.

$$\text{Firm's Average Cost of Capital} = \text{Sum of Value-Weighted Claims' Costs of Capital}$$

In the context of a firm financed only with financial capital (debt and equity),

$$\text{Firm's Average Cost of Capital} = w_{\text{Debt}} \cdot \mathsf{E}(r_{\text{Debt}}) + w_{\text{Equity}} \cdot \mathsf{E}(r_{\text{Equity}})$$

The original M&M proposition states that this cost of financial capital is not affected by shifting w_{Debt} to w_{Equity}. A convenient way to think about the cost of capital is that neither debt nor equity are positive-NPV or negative-NPV projects. Thus, shifting between them does not change the value of the firm.

In the presence of nonfinancial liabilities (NFL), the definition of the firm's weighted average cost of capital expands into

Unfortunately, most nonfinancial liabilities are not zero NPV.

$$\text{Firm's Average Cost of Capital} = w_{\text{NFL}} \cdot \mathsf{E}(r_{\text{NFL}}) + w_{\text{FL}} \cdot \mathsf{E}(r_{\text{FL}}) + w_{\text{Equity}} \cdot \mathsf{E}(r_{\text{Equity}})$$

where FL are the financial liabilities. Unfortunately, you cannot expand or contract the nonfinancial liabilities at will. Consequently, even if you finance and operate your projects optimally, you will probably not face the same risk-adjusted cost of capital on the margin for your nonfinancial liabilities as you will for your financial liabilities. Think about income tax liabilities. They have an interest rate of 0% if you delay paying before April 15 (the tax-due date). But you cannot expand the amount borrowed from Uncle Sam. Thus, you have a fixed and nonexpandable pool of financing at a cost of capital of 0% until you reach your tax liabilities, and an infinite cost of capital thereafter. Put differently, your average cost of capital would increase if you shifted financing from w_{NFL} to w_{Debt} or w_{Equity} by paying your taxes unnecessarily early.

Nonfinancial liabilities should be used until their costs of capital reach those of the financial claims.

The firm's best financing strategy now is to select the lowest-cost marginal source of financing.

- If your source of financing is tied to the firm (but not to particular projects), it may not influence your selection of projects. In this case, you should first finance projects with the lowest cost of capital (e.g., delay paying income taxes or suppliers) before you proceed to more expensive sources of financing. Eventually, once you have gone up the ladder of financing costs, you reach the cost of financing via financial claims. Assuming debt and equity exist in a perfect capital market, you can then raise as much capital as you wish at their appropriate marginal costs of capital.

Nonfinancial sources of funding tied to the firm: Step up the ladder.

- If your cheapest source of financing is tied to a particular project, it may be best to include it in the costs and benefits of the project. For example, if a retail branch can be financed with trade credit from suppliers, and if this is cheaper than financial capital, then you could count the trade-credit NPV as part of the retail store project NPV. If trade credit is not cheaper, you would not use it and rely on the perfect capital market instead. (In the real world, it may also be difficult to measure the cost of capital. For example, what is your cost of capital for accounts payable, given that delaying payment can cost you goodwill among your suppliers?)

Nonfinancial sources of funding tied to the project: Potentially include NPV of nonfinancial funds in the project.

Note that in both cases, you use the cheapest nonfinancial sources of funds until you reach the cost of your financial capital. At this point, you rely solely on the perfect-market financial capital as your source of marginal funding. The financial cost of capital then becomes your firm's marginal cost of capital.

IMPORTANT

- If a source of low-cost (nonfinancial) financing is tied to a specific project, it is usually convenient to consider it as part of the project. You would include the financing's net present value in the project's return.
- If financing is not tied to specific projects, firms should first use up all sources of capital that are cheaper than what the financial capital markets are demanding.
- If the financial capital markets are perfect, and *after* the firm has already exhausted all cheaper sources of financing from the imperfect nonfinancial markets, then the firm's *marginal* cost of capital is determined by the cost of capital of debt and equity. In other words, for a firm that has optimized its nonfinancial sources of funding, the plain WACC formula holds,

$$\begin{array}{c}\text{Optimized Firm's}\\ \text{Marginal Cost of Capital}\end{array} = \begin{array}{c}\text{Firm's Cost}\\ \text{of Financial Capital}\end{array}$$

$$= w_{\text{Debt}} \cdot \mathcal{E}(r_{\text{Debt}}) + w_{\text{Equity}} \cdot \mathcal{E}(r_{\text{Equity}})$$

  You would compare this marginal cost of financial capital to the rate of return of your marginal project.
- You can still use the original M&M proposition, but only within the context of financial claims—that is, the value of the firm's *financial* claims is indifferent to whether the firm is financed by debt or equity.
- This *marginal* cost of *financial* capital is also the *average* cost of *financial* capital in a perfect capital market. However, it is decidedly *not* the firm's *overall average* cost of capital. The firm's average cost of capital is lower, because the nonfinancial financing that the firm would accept would have to come with a lower cost of capital.

Don't think these propositions are too realistic.

Again, don't get too carried away. The M&M propositions are helpful only for thinking about the subject of capital structure. They are not intended to be realistic. They are thought experiments. In the real world, capital structure can matter, and you have to think about how your cost of capital changes with different capital structures, whether it is financial or nonfinancial claims. This is the subject of the next chapters.

Q 17.24. If you observe a firm with nonfinancial claims that have a zero marginal cost of capital (such as delayed income tax obligations), does it make sense to compute a cost of capital based only on the firm's financial capital (debt and equity)?

Summary

This chapter covered the following major points:

- *Ex-ante* entrepreneurs have an incentive to set up a capital structure that maximizes firm value, not equity shareholder value. This is because capital providers know that entrepreneurs later would want themselves or their managers to behave opportunistically. If entrepreneurs fail to set up the proper incentive structures for themselves and their managers, they lose value *now*. If possible, entrepreneurs would often even like to write contracts today that forbid their managers to favor them (the entrepreneurs) tomorrow.
- The Modigliani-Miller (M&M) capital structure proposition states that it makes no difference in a perfect market whether a firm finances itself with debt or equity.
  - Competitive arbitrageurs can own all cash flow and control rights if they buy all debt and equity.
  - Arbitrageurs can instantly eliminate and undo any bad capital structure choices (and/or any bad project choices).
  - Arbitrageurs would compete to bid up the value of any bad capital structure to the value of the firm under the optimal capital structure (and/or optimal operating policy).
  - The value of all claims under *any* capital structure is therefore that of the value under the *best* capital structure. It is the value of the underlying projects. Claims simply partition who gets how much in what state of the world.
  - The firm's cost of capital is therefore invariant to the split between debt and equity. It is always equal to the same weighted average cost of capital (WACC).

  An even simpler version assumes that project choices were already fixed and are now immutable. The M&M propositions are interesting not because they are realistic, but because they are benchmarks that point out when capital structure (and/or operating policy) would not matter.
- More debt does not imply that the overall cost of capital increases, even though both debt and equity become riskier.
- The bank may demand an interest rate that is higher than the expected cost of capital on the equity. This does not mean that the cost of debt capital is higher than the cost of equity capital, because the debt's cost of capital is not its *promised* interest rate.
- For most securities, equity requires higher expected rates of return than debt. (In a CAPM world, this is the case for securities with positive market betas.)
- Assuming that the firm is financed only with debt and equity, the absence of arbitrage implies that the capitalization-weighted average expected rate of return (WACC) is:

$$\begin{aligned}\text{WACC} &= \mathsf{E}(r_{\text{Firm}}) \\ &= w_{\text{Equity}} \cdot \mathsf{E}(r_{\text{Equity}}) + w_{\text{Debt}} \cdot \mathsf{E}(r_{\text{Debt}})\end{aligned}$$

  where the weights w_{Equity} and w_{Debt} are the values of equity and debt when quoted as a fraction of the overall firm value *today*. The project's WACC remains the same, no matter how the firm is financed. It is determined by the underlying projects.
- A model like the CAPM is compatible with the M&M perfect-market point of view. It can provide costs of capital for financial debt and equity. However, it cannot provide costs of capital for other liabilities that do not originate in a perfectly competitive market, such as tax obligations. Such loans could even be interest-free.
- The marginal and average costs of capital are the same for claims that arise in a perfect market.
- Nonfinancial liabilities usually do not arise in a perfect capital market. Thus, their average costs of capital are often lower than their marginal costs of capital.
- When cheap financing (such as special trade credit) is tied to a particular project, it is often convenient to combine it with the project.
- If an optimizing firm has exhausted all its lower-cost nonfinancial sources of funding, then the infinitely elastic perfect capital markets' financial funding becomes the marginal source of capital.

Preview of the Chapter Appendix in the Companion

The appendix to this chapter is conceptual. It shows that the CAPM, WACC, and NPV all seamlessly fit together. There are no inconsistencies between them. (I used this when I made up the required costs of capital in the WACC example for different leverage ratios.)

Keywords

Answers

Q 17.1 Ex ante means "before the fact"; ex post means "after the fact." To the extent that the original owner-entrepreneur can set up a situation (charter) that encourages best (i.e., from the perspective of the firm) ex-post behavior, the ex-ante value (for which the firm can be sold right now) is maximized. However, if the situation (charter) is such that owners themselves or their managers will later try to expropriate capital providers, or such that the managers will make bad decisions in the future, then the ex-ante value today for which the firm can be sold would be less.

Q 17.2 Yes, an ex-post maximizing choice can be bad from an ex-ante perspective. The example of the \$3-for-\$1 transaction in the text shows that you would want to restrain yourself.

Q 17.3 Clearly, managers in the future would not want to pay back debt if they could weasel out of it. However, such behavior could have repercussions for their future attempts to borrow money. The firm would have to weigh the gains from reneging on this particular loan (and the ethical implications of doing so!) against the costs of a lost creditor relationship and thus more expensive credit in the future.

Q 17.4 The idea is to explain it really simply. Milk, cream, pizza, and pockets in the anecdote in Section 17.2 are handy metaphors.

Q 17.5 Capital structure does not matter in a perfect market: No transaction costs, perfect competition, no taxes, and no differences in opinion and information.

Q 17.6 The risk-neutrality assumption really buys nothing. We do not need it. We only use it because it makes the tables simpler to compute.

Q 17.7 Work out the following:

$$\begin{aligned}
\text{Bad Luck:} \quad & d \cdot \$55 + e \cdot \$5 = \$0 \cdot 5\% \\
\text{Good Luck:} \quad & d \cdot \$55 + e \cdot \$105 = \$66 \cdot 5\% \\
\text{(subtract)} \quad \Longrightarrow \quad & (\$105 - \$5) \cdot e = (\$66 - \$0) \cdot 5\% \\
\Longrightarrow \quad & d = -0.003 \;,\; e = +0.033
\end{aligned}$$

You would buy 3.3% of the LD equity and sell (issue) 0.3% of the equivalent of the LD debt. The equity would cost you $e \cdot \$50 = \$1.65$; the debt issue would give you \$0.15 in proceeds. Your net cost would thus be \$1.50—as it should be, because buying 5% of the MD equity would have cost you 5% of \$30, which also comes to \$1.50.

Q 17.8 The "homemade leverage restructuring" argument is not a complete proof, because it ignores the potentially important real-world aspect of control rights.

Q 17.9 Yes, they can destroy shareholder value. If existing management gives away debt claims at too low a price, creditors will own more of the firm. New management cannot undo this, because the contract cannot be renegotiated. Giving away debt too cheaply would not change the value of the firm. It only changes who owns more or less of the firm.

Q 17.10 You need to recall the standard deviation formula (Formula 8.2) on Page 170. First compute the deviations from the mean, and their squares

	Deviation		Squared	
	1/4	3/4	1/4	3/4
Own	–40%	+13%	1,600%%	169%%
Bond	–18.46%	+6.15%	340.8%%	37.82%%
Lev Eq	–180%	+60%	32,400%%	3,600%%

Thus, the standard deviations are

$$\begin{aligned}
\text{Own} \quad & \sqrt{1/4 \cdot 1{,}600\%\% + 3/4 \cdot 1{,}69\%\%} \approx 23\% \\
\text{Bond} \quad & \sqrt{1/4 \cdot 340.8\%\% + 3/4 \cdot 37.82\%\%} \approx 11\%
\end{aligned}$$

$$\text{Lev Eq} \quad \sqrt{1/4 \cdot 32,400\%\% + 3/4 \cdot 3,600\%\%} \quad \approx \ 104\%$$

The bond is safest, the levered equity is riskiest, and full ownership is in between.

Q 17.11 The solution is (the two new inputs are in blue):

	AE	DE Bond promises \$64	DE Equity after \$64
Prob(Sun) = 3/4	\$100	\$64	\$36
Prob(Rain) = 1/4	\$60	\$60	\$0
E Future Payoff	\$90	\$63	\$27
Price P Now	\$75	\$60	\$15
E(r)	20%	5%	80%

The standard deviation of the rate of return on debt (either 0% with 1/4 probability, or 6.67% with 3/4 probability) is ≈ 2.9%. The standard deviation of the rate of return on equity (either –100% or +140%) is about ≈ 104%.

Q 17.12 To work out the firm's equity cost of capital and the debt's promised rate of return, imitate the payoff tables from the text (dollars are in millions):

		AE	DE Bond prom. \$100m	DE Equity after \$100m
1/3	\$50	\$50	\$50	\$0
1/3	\$150	\$150	\$100	\$50
1/3	\$400	\$400	\$100	\$300
E Future Payoff		\$200	\$83.33	\$116.67
Price P Now		\$181.82	\$79.37	\$102.45
E(r)		10%	5%	13.88%

The debt's promised rate of return is \$100/\$79.37 – 1 ≈ 26%.

Q 17.13 Most likely, you can fund the project. In a perfect market, you can hold low-risk debt that has first dibs on all proceeds.

Q 17.14 This could be the case for some insurance products. If you think back to the CAPM, these are projects that have very negative market betas. In this case, they can have overall costs of capital that are lower than the risk-free interest rate. In this case, levered equity would have an even more negative market beta and thus an even lower expected rate of return. In cases in which market beta is positive, the equity cost of capital should always be higher than the debt cost of capital.

Q 17.15 Barring some really weird cases (e.g., hugely negative market betas in a CAPM world), the equity cost of capital should always be higher than the debt cost of capital. However, the debt cost of capital is not the promised interest rate, but the expected interest rate. The promised interest rate can be astronomical and indeed be much higher than the expected interest rate. So, the answer is yes: the equity cost of capital can be lower than the *promised* interest rate. This is a common mistake made by some practitioners—they compare CAPM-expected rates of return for equity (bad idea) to quoted interest rates from the bank (bad idea).

Q 17.16 The debt weight is \$60/\$75 = 80%; the equity weight is 20%. Recall that the debt had an expected rate of return of 5%, the equity of 80%. Thus, the WACC is 80% · 5% + 20% · 80% = 20%. Indeed, this is still the same.

Q 17.17 Debt that raises \$62.50 and promises \$70 offers a quoted rate of return of 12%. However, if it rains, the debt pays only \$60, which is –4%. Thus, its expected rate of return is 1/4 · (–4%) + 3/4 · (12%) = 8%. Its weight in the capital structure is \$62.50/\$75 ≈ 83.3%. The equity receives \$30 or \$0, for an expected rate of return of 80%. Thus, it is worth \$12.50 today, which is \$12.50/\$75 ≈ 16.7% of the firm value today. The WACC is 83.3% · 8% + 16.7% · 80% ≈ 20%.

Q 17.18 No. Firm A need not have a higher overall cost of capital than firm B. The example on Page 471 section illustrates this fallacy. The relative weights of debt and equity also change, therefore falsifying this claim.

Q 17.19 No! It is quite possible that the weighted average cost of capital is lower than the interest rate that it has to pay to the bank. After all, the bank rate is promised, not expected.

Q 17.20 In a perfect market, the cost of capital under a 100% equity financing strategy with a cost of 10% must be the same as it is under a mixed debt and equity strategy. Therefore, $w_{\text{Debt}} \cdot 0.05 + (1 - w_{\text{Debt}}) \cdot 0.2 = 0.1 \Longrightarrow w_{\text{Debt}} = 2/3$. This firm is 2 parts debt, 1 part equity, so the debt-equity ratio is 2.

Q 17.21 Though obscure, a firm with a very negative beta can indeed be in this situation. It must be the case, then, that the firm's project cost of capital is lower than the risk-free rate. (For example, a firm may have 90% debt at the risk-free rate of 5%, 10% equity at a rate of –1%, and a WACC of 4.4%—this is indeed less than the risk-free rate.)

Q 17.22 No, the value of the firm may be linked to its financing, because its financing is linked to its projects. You also need to break the link between nonfinancial liabilities and operations.

Q 17.23 Yes, the value of the firm's *financial* claims is independent of how the financial claims are arranged in an M&M world. This is because no financial security offers a positive or negative NPV—all financial securities are fairly priced.

Q 17.24 Yes, it may still make sense to compute a cost of capital based only on the firm's financial capital (debt and equity) if the firm has exhausted all its nonfinancial low-cost sources of capital. It is then an estimate of the marginal cost of another dollar of capital raised, which is now financial capital.

End of Chapter Problems

Q 17.25. Explain when "shareholder maximization" is the right goal and when it is the wrong goal for management.

Q 17.26. Comment on the following statement: "New shareholders would be worse off if management destroyed wealth by capturing the board and paying themselves much higher executive compensation without better performance."

Q 17.27. In a world that is not perfect but risk-neutral, assume that the firm has projects worth $100 in the down-state, $500 in the up-state. The cost of capital for projects is 25%. However, if you could finance it with 50-50 debt, the cash flow rights alone are enough to make the cost of capital a lower 20%. Managers are intransigent and do not want to switch to this new capital structure. You only have $60 of capital and cannot borrow more to take over the firm. What can you do?

Q 17.28. A firm can be worth $100 million (with 20% probability), $200 million (with 60% probability), or $300 million (with 20% probability). The firm has one senior bond outstanding, promising to pay $80 million. It also has one junior bond outstanding, promising to pay $70 million. The senior bond promises an interest rate of 5%. The junior bond promises an interest rate of 26%. If the firm's projects require an appropriate cost of capital of 10%, then what is the firm's levered equity cost of capital?

Q 17.29. If a change in capital structure increases the risk both of the firm's equity and debt, and there are no other financial claims, does it imply that the firm's risk has increased?

Q 17.30. Work the example from Page 470 (sun [$100] with 3/4 probability, rain [$60] with 1/4 probability), if the debt promises $65 and offers an expected rate of 3%. What is the weight of equity in the capital structure?

Q 17.31. M&M states that, in a perfect market, although both debt and equity become riskier due to an increase in the firm's leverage, both the firm's value and risk remain exactly the same. Conceptually, what would it take for the firm to become worth more and/or be safer even when both debt and equity become riskier due to an increase in the firm's leverage?

Q 17.32. Compute a graph similar to Exhibit 17.2. Use a spreadsheet. Your firm will be worth either $50,000 or $100,000 with equal probabilities. The cost of capital on your debt is given by the formula $\mathsf{E}(r_{\text{Debt}}) = 5\% + 10\% \cdot \omega_{\text{Debt}}$—but only if the debt is risky. (Hint: The risk-free rate of return is 11.85%. What is the WACC of the firm if it is 100% debt-financed?)

Q 17.33. Show how a firm can increase its cost of equity and cost of debt capital, yet still come out with an overall cost of capital that is unchanged.

Q 17.34. Does the standard M&M proposition apply to nonfinancial liabilities?

Q 17.35. In a world of perfect financial markets, is the cost of capital of the firm's financial claims independent of how it is financed?

Q 17.36. In a world of perfect financial markets (but not necessarily product markets), is the cost of capital of the firm independent of how it is operated and financed?

Q 17.37. You expect your firm to be worth $50, $100, or $120 with probabilities 1/10, 6/10 and 3/10, respectively. You can raise $75 in debt proceeds today if you promise an interest rate of 10%. If this is how you finance your firm, then your cost of equity capital is 20%.

1. What is the expected payoff of your firm?
2. What is the promised value of the debt?
3. What is the cost of capital of this debt?
4. What is the value of your equity?
5. What is the value of your firm?
6. What is your firm's WACC?
7. If you raise $50 in debt proceeds today, your friendly investment banker tells you that you can get away promising an interest rate of 3%. What is your debt cost of capital in this case?
8. How much would then be financed through equity (in the $50-debt financing scenario)?
9. What would be the debt-to-capital ratio of this firm (in the $50-debt financing scenario)?
10. What would be the cost-of-equity-capital for this firm (in the $50-debt financing scenario)?
11. Is the $75 debt-financing scenario cost-of-debt capital higher, or is the $50 debt-financing scenario cost-of-debt capital higher? What does this mean for the relative risk of the two types of debt?
12. Is the $75 debt-financing scenario cost-of-equity capital higher, or is the $50 debt-financing scenario cost-of-equity capital higher? What does this mean for the relative risk of the two types of equity?
13. Is the $75 debt-financing scenario cost-of-firm capital higher, or is the $50 debt-financing scenario cost-of-firm capital higher?

Data and Programming for Masters Students

Unlike stocks, corporate bonds tend to come only in larger denominations and do not trade frequently. (The holders tend to be pension or insurance funds who hold them until maturity.) However, CDS securities on corporate bonds are very liquid, and combining one of these with a Treasury creates essentially a synthetic corporate bond.

Unfortunately, the key data bases for corporate bonds are so expensive that they are beyond the reach of all but the most wealthy investors and universities.

- The premier vendor of data for bond prices is FINRA's *Trace*. Some of its data is available for free (!), although some other enhanced data requires deep pockets.
- The premier vendor of data for CDS prices is *Markit*.
- The premier vendor of corporate issuing data is Thomson Reuters' Securities Data Corporation Platinum.

(Assignment have been deliberately omitted. Previous assignments have been sufficiently brutal.)