"Creating Value with Risk Management"

Chapter 3 of

Risk Management and Derivatives

By René Stulz

Chapter 3

Creating Value with Risk Management

Chapter 3 Objectives

At the end of this chapter, you will:

1. Understand when risk management creates value for firms.
2. Know which types of risks a corporation should hedge to create value.
3. Be able to evaluate how much value risk management can create in a corporation.

Mr. Smith is the CFO of Software Inc. He has worked hard to keep up with new developments in finance. He recently attended an advanced executive development program where much time was spent discussing the Modigliani and Miller propositions. Understanding that shareholders can hedge on their own account, he has paid scant attention to risk management. However, looking at his firm's situation, he discovers that it will not be able to make use of a valuable tax shield arising from past losses because exchange rate losses have unexpectedly reduced his firm's net income. The tax shield will be gone forever after this year. Yet, had the firm been profitable this year, the tax shield would have allowed the corporation to reduce its tax bill by $50 million. He realizes that if he had been able to hedge his income against exchange rate fluctuations, Software Inc. would have been richer by $50 million. Instead, because he had not hedged, $50 million of shareholder wealth walked out the door. In this chapter, we show that there are many reasons to hedge.

A risk management program cannot increase firm value when it costs the same to bear a risk within the firm or outside the firm. We established this result, called *the risk management irrelevance proposition*, in Chapter 2. The irrelevance proposition holds when financial markets are perfect. If the proposition holds, any risk management program that a firm puts in place can be replicated by any investor through "homemade" risk management. The risk management irrelevance proposition is useful because it allows us to find out when homemade risk management is not equivalent to risk management by the firm. This is the case whenever risk management by a firm affects firm value in a way that investors cannot mimic. In this chapter, we identify situations where there is a wedge between the cost of bearing a risk within the firm and the cost of bearing it outside the firm. Such a wedge requires the presence of financial markets imperfections (perfect markets have no frictions—no transactions costs, no taxes, perfect competition, no costs of writing contracts).

Chapter 2 uses the example of a gold-producing firm. We continue that example here. Pure Gold Inc. is exposed to gold price risk. It can bear that risk within the firm. This means the firm has lower income if the price of gold is unexpectedly low and higher income if it is unexpectedly high. If the irrelevance proposition holds, the only cost of bearing this risk within the firm is that shares are worth less if gold price risk is systematic risk, because in this case shareholders require a risk premium to compensate them for gold price risk. Similarly, the only cost to the firm of having gold price risk borne outside the firm is that the firm has to pay a risk premium to induce the capital markets to take that risk. The risk premium the capital markets require is the same the shareholders require. Consequently, it makes no difference for firm value whether the gold price risk is borne by shareholders or by the capital markets, which is what the risk management irrelevance proposition states.

For risk management to increase firm value, it must be more expensive to take a risk within the firm than to pay the capital markets to take it. For Pure Gold, risk management creates value if an unexpectedly low gold price entails costs for the firm that it would not have for the capital markets. Suppose that with an unexpectedly low gold price, the firm does not have funds to invest, and hence has to give up valuable projects because it would be expensive for the current

shareholders to raise funds in the capital markets with such a low gold price. Thus, shareholders not only lose income now with unexpected low gold prices, but they also lose future income because the firm cannot take advantage of investment opportunities. Pure Gold bears an extra, indirect, cost or burden from the low gold prices. Indirect costs resulting from financial losses are called **deadweight costs**.

To understand deadweight costs, suppose you asked yourself how Pure Gold could be put back in the situation it would have been in had gold prices not been low. If all it takes is to make up the loss Pure Gold experienced on its sales of gold, then there are no deadweight costs—no additional losses caused by the low gold prices. However, if, in addition, Pure Gold has to be compensated for profits it did not earn because of investments it could not make, there are deadweight costs.

The reason risk management creates value for Pure Gold if there are deadweight costs associated with gold price risk is that risk management reduces or eliminates deadweight costs. If the gold price risk is borne by the capital markets, Pure Gold does not incur additional costs resulting from low gold prices since it makes no losses from low gold prices. In this case, the cost of putting the gold price risk off on the capital markets is less than the cost the firm will pay if it bears the risk within the firm and sacrifices future opportunities by not being able to invest when the gold price is low.

In this chapter, we investigate how a firm can use risk management to increase firm value. We discuss the reasons why a firm might find it more expensive to bear a risk within the firm than pay the capital markets to bear that risk. We thus show the sources of the benefits of risk management.

In the previous chapter, we gave the example of Homestake as a gold mining firm that had a policy of not hedging its gold price exposure. As you saw, management based its policy on the belief that Homestake's shareholders value gold price exposure. We showed that this belief is wrong because investors can get gold price exposure without Homestake on terms at least as good as those that Homestake offers, and most likely better. So, is Hometake's value lower than it would have been with hedging? Throughout this chapter, for each source of value of hedging we document, we investigate whether this source of value applies to Homestake.

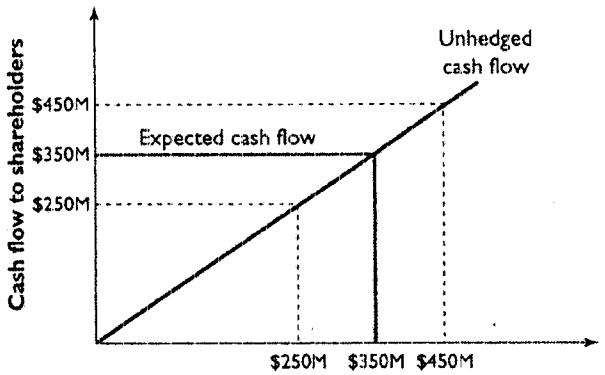
In the next chapter, we integrate these various sources of gain from risk management to build an integrated risk management strategy.

3.1. Bankruptcy costs and costs of financial distress

In our analysis of the value of risk management in Chapter 2, we take the distribution of Pure Gold's cash flow before hedging (the cash flow from operations) as a given. We assume that it sells one million ounces of gold at the end of the year and then liquidates. Pure Gold has no debt. The gold price is assumed to be normally distributed with a mean of $350 per ounce. There are no operating costs for simplicity. All the cash flow accrues to the firm's shareholders. This situation is represented by the straight line in Figure 3.1, where cash flow to

Figure 3.1 Cash flow to shareholders and operating cash flow

The firm sells one million ounces of gold at the end of the year and liquidates. There are no costs. The expected gold price is $350.



Pure Gold is on the horizontal axis and cash flow to the holders of financial claims against it is on the vertical axis. In this case, the only claimholders are the shareholders. In perfect financial markets, all cash flows to the firm accrue to the firm's claimholders, so there is no gain from risk management.

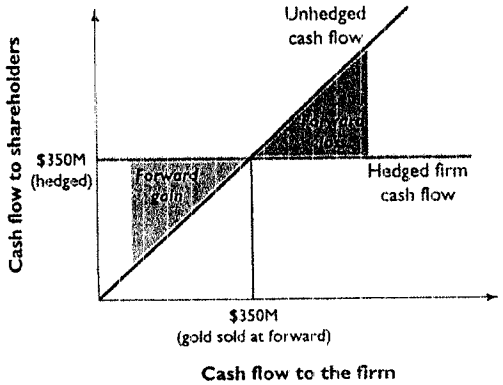
At the end of the year, Pure Gold distributes the cash flow to its owners, the shareholders, and liquidates. If the firm hedges by selling its production at the forward price, the shareholders get the proceeds from selling the firm's gold production at the forward price. Suppose the forward price is $350. If the gold price turns out to be $450, for example, the hedged firm receives $350 per ounce by delivering on the forward contract, while the unhedged firm would receive $450 per ounce.

The shareholders, however, can obtain for themselves the payoff of the unhedged firm when the firm is hedged and vice versa. This is shown in Figure 3.2. An investor who owns the hedged firm and takes a long forward position on personal account receives $350 per ounce of gold from the hedged firm plus ($450 – $350) per ounce from the forward contract, for a total payoff of $450 per ounce, which is the payoff per ounce for the unhedged firm. Hence, even though the firm is hedged, investors can create for themselves the payoff of the unhedged firm.

Now, suppose Pure Gold has some debt. We still assume that markets are perfect, that the distribution of the cash flow from operations is given, and that there are no taxes. At the end of the year, the cash flow to the firm is used first to pay off the debtholders, and then shareholders receive what is left over. The firm's claimholders still receive all of the firm's cash flow, and the firm's cash flow is not changed by leverage, but there are now two groups of claimholders, debtholders

Creating the unhedged firm out of the hedged firm *Figure 3.2*

The firm produces one million ounces of gold. It can hedge by selling one million ounces of gold forward. The expected gold price and the forward price are $350 per ounce. If the firm hedges and shareholders do not want the firm to hedge, they can recreate the unhedged firm by taking a long position forward in one million ounces of gold.



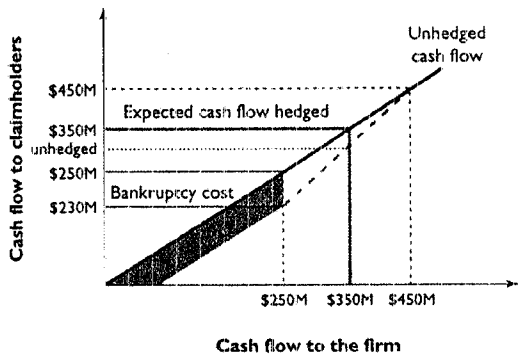
and shareholders. Leverage does not affect firm value. It simply specifies how the pie—the firm's operating cash flow—is divided among its claimants—the debtholders and the shareholders. Since the cash flow to claimholders is the firm's entire cash flow, risk management does not affect firm value.

In the real world, it is costly for firms to file for bankruptcy and renegotiate debt. Firms have to hire lawyers, incur court costs, and need to pay for all sorts of financial advice. Costs incurred as a result of a bankruptcy filing are called **bankruptcy costs**. The present value of future bankruptcy costs reduces the value of a firm that has debt relative to one that does not. While there are benefits to leverage, for the time being we ignore them. As shown in Figure 3.3, these bankruptcy costs create a "wedge" between cash flow to the firm and cash flow to the firm's claimholders. This wedge corresponds to the bankruptcy costs incurred by the owners.

The extent to which bankruptcy costs affect firm value depends on their extent and on the probability that the firm will have to file for bankruptcy. The probability that a firm will be bankrupt is the probability that it will not have enough cash flow to repay the debt. We know how to compute this probability for a normally distributed cash flow. Figure 3.4 shows how the distribution of cash flow from operations affects the probability of bankruptcy. If Pure Gold hedges its risk completely, it reduces its cash flow volatility to zero because the claimholders receive the present value of gold sold at the forward price. In this case, the probability of bankruptcy is zero and the present value of bankruptcy costs is also zero. As cash flow volatility increases, the present value of bankruptcy costs increases because bankruptcy becomes more likely. This means that the present value of cash flow to Pure Gold's claimholders falls as cash flow volatility increases.

Figure 3.3 Cash flow to claimholders and bankruptcy costs

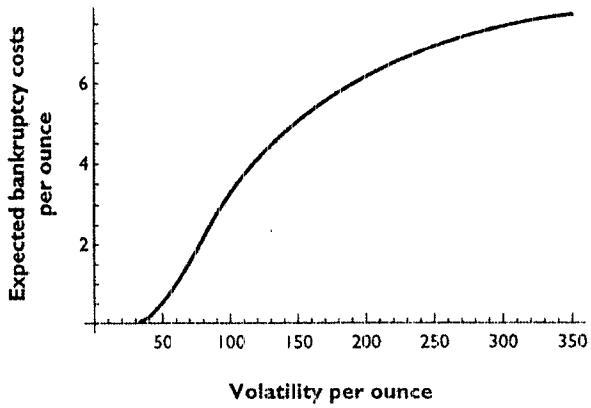
The firm sells one million ounces of gold at the end of the year and liquidates. There are no transactions costs. The expected gold price is $350. Bankruptcy costs are $20 million if cash flow to the firm is $250 million. Suppose that the firm can have a cash flow of $250 million with probability p or a cash flow of $450 million with probability 1 - p. Expected cash flow of the unhedged firm is given by the equation p x $230M + $(1 - p)$ x $450M and is plotted by the dotted line. The case where the forward price of gold is $350 and equal to expected gold price corresponds to p = 0.5. With this case, expected cash flow of the hedged firm is $350 million and expected cash flow of the unhedged firm is $340 million.



Therefore, by hedging, Pure Gold increases its value; that is, it does not have to pay bankruptcy costs, and hence its claimholders get all of the firm's cash flow. In this case, homemade risk management by the firm's claimholders is not a substitute for the firm's risk management. If the firm does not reduce its risk, its value

Figure 3.4 Expected bankruptcy costs as a function of volatility

The firm procuces one million ounces of gold and then liquidates. It is bankrupt if the price of gold is below $250 per ounce. The bankruptcy costs are $20 per ounce. The gold price is distributed normally with expected value of $350. The volatility is in dollars per ounce.



is lower by the present value of bankruptcy costs. Homemade risk management can do nothing about this deadweight cost of low gold prices.

3.1.1. Bankruptcy costs and firm value

We can use the present value equation to show that risk management increases firm value when the only financial market imperfection is the presence of bankruptcy costs that affect firm value. We therefore assume that markets are perfect for hedging instruments traded in capital markets, so that hedging involves no transaction costs. Remember that in the absence of bankruptcy costs, the firm's claimholders receive the cash flow at the end of the year when the firm is liquidated. Under our new assumptions, the claimholders receive the cash flow only if the firm is not bankrupt. Denote this cash flow by C. If the firm is bankrupt, the claimholders receive C minus the bankruptcy costs. Consequently, the value of the firm is now:

$$\textbf{Value of firm} = \textbf{PV(C} - \textbf{Bankruptcy costs)}$$

We know from Chapter 2 that the present value of a sum of cash flows is the sum of the present values of the cash flows. Consequently, the value of the firm is equal to:

$$\begin{aligned}\textbf{Value of firm} &= \textbf{PV(C)} - \textbf{PV(Bankruptcy costs)}\\ &= \textbf{Value of firm without bankruptcy costs}\\ &\quad - \textbf{Present value of bankruptcy costs}\end{aligned}$$

Let's now consider the impact of risk management on firm value. If the hedge eliminates all risk, then the firm does not incur the bankruptcy costs. Hence, the cash flow to the firm's owner is what the cash flow would be in the absence of bankruptcy costs, which is C. This means that with such a hedge the claimholders get the present value of C rather than the present value of C minus the present value of bankruptcy costs. Assuming that no market imperfections affect the cost of hedging instruments, the gain from risk management is:

$$\begin{aligned}\textbf{Gain from risk management} &= \textbf{Value of firm hedged}\\ &\quad - \textbf{Value of firm unhedged}\\ &= \textbf{PV(Bankruptcy costs)}\end{aligned}$$

A simple example of the benefit of hedging is as follows. We assume that the interest rate is 5 percent and that gold price risk is unsystematic risk. The forward price is \$350. Because gold price risk is unsystematic risk, the forward price is equal to the expected gold price (from the analysis in Chapter 2). As before, Pure Gold produces one million ounces of gold. Consequently, $PV(C)$ is equal to \$350M/1.05, or \$333.33 million. The present value of the hedged firm is the same (this is because expected cash flow, $E(C)$, is equal to one million times the expected gold price, which is the forward price).

To get the present value of the bankruptcy costs, we must specify the debt payment and the distribution of the cash flow. Let's say that the bankruptcy costs are \$20 million, the face value of debt is \$250 million, the gold price is normally distributed, and its volatility is 20 percent. The firm is bankrupt if the gold price

falls below $250. The probability that the gold price will fall below $250 is 0.077 using the approach developed in Chapter 2. Consequently, the expected bankruptcy costs are 0.077 x $20M, or $1.54 million. By the use of risk management, Pure Gold ensures that it is never bankrupt, thus increasing its value by the present value of $1.54M. Since gold price risk is assumed to be unsystematic risk, we discount the expected bankruptcy costs at the risk-free rate of 5 percent to get a present value of bankruptcy costs of $1.47 million ($1.54M/1.05).

In the presence of bankruptcy costs, the risk management irrelevance theorem no longer holds. The cost to Pure Gold of bearing gold price risk is $1.47 million. Because we assume that gold price risk is diversifiable, the cost of having the capital markets bear this risk is zero. The capital markets therefore have a comparative advantage over the firm in bearing gold price risk.

Note that if gold price risk is systematic risk, capital markets will charge a risk premium for bearing the gold price risk—the same risk premium that shareholders charge in the absence of bankruptcy costs. Hence, the capital markets still have a comparative advantage for bearing risk; it is measured by the bankruptcy costs saved by having the capital markets bear the risk. There is nothing that shareholders can do on their own to avoid the impact of bankruptcy costs on Pure Gold's value, so homemade risk management cannot eliminate these costs.

3.1.2. Bankruptcy costs, financial distress costs, and the costs of risk management programs

A study of bankruptcy for 31 firms over the period from 1980 to 1986 by Weiss (1990) finds an average ratio of direct bankruptcy costs to total assets of 2.8 percent, with a high of 7 percent. Other researchers find similar estimates. Bankruptcy also entails large indirect costs. Managers spend much of their time dealing with the firm's bankruptcy proceedings instead of managing operations. Managers of a firm in bankruptcy lose control of some decisions. They might not be allowed to undertake costly new projects, for example.

Many of these indirect costs start accruing as soon as a firm's financial situation becomes unhealthy. The costs firms incur because of a poor financial situation are called **costs of financial distress**. Costs of financial distress can occur even if the firm never files for bankruptcy or never defaults. Managers have to think about finding ways to conserve cash to pay off debtholders. They might cut investment, which means the loss of future profits. Potential customers may become reluctant to deal with the firm, leading to losses in sales.

Our analysis of the benefits of risk management in reducing bankruptcy costs holds for all costs of financial distress also. Any time costs of financial distress divert cash flow away from the firm's claimholders, they reduce firm value. Reducing firm risk by minimizing the present value of costs of financial distress naturally increases firm value.

Reducing the costs of financial distress is one of the most important benefits of risk management. Consequently, we study in more detail how risk management can be used to reduce specific costs of financial distress in later sections in this chapter.

In the example, Pure Gold eliminates all of its bankruptcy costs through risk management. If managers identify other costs of financial distress that occur

when the firm's cash flow is low, they could eliminate them as well through risk management. Some risks, however, are too expensive to reduce through risk management. In the absence of risk management costs, though, we would always eliminate all bankruptcy and financial distress risks.

There are transaction costs of taking positions in forward contracts. The transaction costs of risk management increase the cost of paying the capital markets to take the risk. As transaction costs increase, risk management becomes less attractive. If the firm bears a risk internally, it does not pay these transaction costs.

3.1.3. Bankruptcy costs, Homestake, and Enron

At the end of the 1990 fiscal year, Homestake had cash balances of more than $300 million. Its long-term debt was $72 million, and it had unused credit lines amounting to $245 million. Homestake could have repaid all its long-term debt and still have had large cash balances. Bankruptcy was not likely. Suppose it had more long-term debt, though. Would bankruptcy and financial distress costs then be a serious issue?

Homestake's assets are its mines and its mining equipment. These assets do not lose value if Homestake defaults on its debt. If it makes sense to operate the mines, the mines will be operated, whoever owns them. Neither bankruptcy costs nor financial distress costs in this case provide an important reason for Homestake to practice risk management. Homestake is an example of a firm for which the reduction of financial distress costs is not an important benefit of risk management.

For many financial institutions, the mere appearance of some possibility of financial distress is enough to threaten the firm. In a bank, concerns of financial distress could prompt a run on the bank.

An example of how financial distress can lead to disaster is that of Enron. Enron was the seventh largest firm in the United States. It had a large and profitable online trading business—it traded energy, broadband, credit risks, and other goods. When its management lost credibility and its debt was downgraded from investment grade in November 2001, this started a sequence of events that led Enron to file for bankruptcy within weeks because financial distress removed the underpinnings of its trading business. Who wants to trade with an entity that has a significant probability of default?

3.2. Taxes and risk management

Risk management creates value when it is more expensive to take a risk within the firm than to pay the capital markets to bear that risk. Corporate taxes are a good example. These taxes can increase the cost of taking risks within the firm.

We all accept that if a dollar of taxes has to be paid, paying it later is better than paying it sooner. While derivatives are sometimes used to create strategies that move income to later years, for now we focus on how managing risk, as opposed to timing income, can reduce the present value of taxes.

To understand the argument, it is useful to think about one important tax planning practice. If you know that in some future year your tax rate will be lower, you should try to recognize income in that year rather than today or in

years your tax rate is higher. Pension plans are the prime example. If you can defer taxation on current income through a pension plan, you do so assuming that your retirement years' tax rate will be lower than the tax rate in your high-earning years.

Risk management, rather than altering in which tax year income is recognized, aims to alter the risks one takes to decrease expected tax payments in a given year. Suppose there are some outcomes—often called states of the world in finance—where this year's income is high and taxed at a high rate, and other outcomes where it is low and taxed at a low rate. For instance, if gold prices are high, gold companies have high income and a high tax rate. If we can rearrange the risks we take so that we have less income when the tax rate is high and more income when the tax rate is low, the present value of taxes paid is reduced.

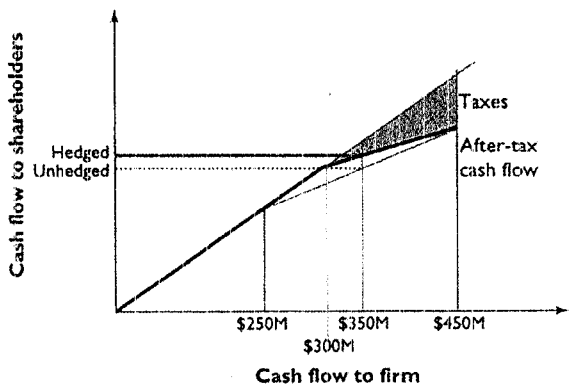
Let's consider Pure Gold again. A firm generally pays taxes only if its revenue exceeds some level. Let's assume that Pure Gold pays taxes at the rate of 50 percent on the cash flow in excess of $300 million and does not pay taxes if its cash flow is below $300 million. For simplicity, we assume in this section that it is an all-equity firm, so there are no bankruptcy costs.

Figure 3.5 graphs Pure Gold's after-tax cash flow as a function of the pretax cash flow. We see a difference between the firm's operating cash flow and what its shareholders receive, and this is due to taxes. Now, assume further that there is a 50 percent chance the gold price will be $250 per ounce and a 50 percent chance it will be $450, so the expected gold price is $350. Assuming that gold price risk is unsystematic risk, the forward price for gold is the expected gold price of $350. As before, the interest rate is 5 percent.

In the absence of taxes, the value of Pure Gold is the present value of the expected cash flow, $350 million discounted at 5 percent, or $333.33 million.

Figure 3.5 Taxes and cash flow to the shareholders

The firm pays taxes at the rate of 50 percent on cash flow in excess of $300 per ounce. For simplicity, the price of gold is either $250 or $450 with equal probability. The forward price is $350.



With taxes, the present value of the firm for its shareholders is reduced, because the firm pays taxes when the gold price is \$450. In this case, the firm pays taxes of 0.5(\$450 – \$300)1M, or \$75 million. With taxes, the value of the firm's equity is:

$$\begin{aligned}\textbf{Value of firm with taxes} &= PV(\textbf{Gold sales} - \textbf{Taxes})\\ &= PV(\textbf{Gold sales}) - PV(\textbf{Taxes})\\ &= PV(\textbf{Firm without taxes}) - PV(\textbf{Taxes})\\ &= \$333.33\text{M} - 0.5 \times \$75\text{M}/1.05\\ &= \$333.33\text{M} - \$35.71\text{M}\\ &= \$297.62\text{M}\end{aligned}$$

Let's figure what it costs shareholders to have the firm bear gold price risk compared to having the firm lay off the gold price risk by selling gold forward. To do this, we have to compare firm value if gold is sold on the spot market after it is produced with firm value if gold is sold at the forward price. Remember that the gold price can be either \$250 or \$450. If the gold price is \$250, the shareholders get \$250 per ounce. If the gold price is \$450, they get \$375 per ounce (\$450 minus taxes at the rate of 50 percent on \$150). The expected cash flow to the shareholders is therefore (0.5 x \$250) + (0.5 x \$375), or \$312.5 per ounce. Since the expected cash flow would be \$350 absent taxes, expected taxes are \$37.5 per ounce. If the gold price is fixed at the forward price instead, so that cash flow is not volatile, shareholders receive \$325 per ounce once they pay taxes at the rate of 50 percent on \$50. In this case, expected taxes are \$25 per ounce. Taking present values, the equity value is \$309.52 per ounce if gold is sold at the forward price and \$297.62 if gold is sold at the spot market price. Hence, it costs the shareholders \$11.90 per ounce for having the firm bear the gold price risk, or \$11.90 million for the firm as a whole.

The reason the firm saves taxes through risk management is straightforward. If the firm's income is low, the firm pays no taxes. If the firm's income is high, it pays taxes. If Pure Gold shifts a dollar from when income is high to when income is low, it saves the taxes it would pay on that dollar when the income is high. In our example, shifting income of a dollar from when income is high to when income is low saves \$0.50 with probability 0.5.

Homemade risk management cannot work in this case. If the firm does not use risk management to eliminate its cash flow volatility, its expected taxes are higher by \$12.5 million. This is money that leaves the firm and does not accrue to shareholders. Through homemade risk management, shareholders can eliminate the volatility in the share price resulting from gold price volatility, but they cannot affect the taxes the firm pays, so that the tax saving from risk management at the firm level cannot be obtained by shareholders through homemade risk management.

Let's figure out how shareholders would practice homemade risk management. Shareholders receive \$375 per share or \$250 per share from the firm with equal probability. To eliminate the gold price risk resulting from holding a share of Pure Gold, a shareholder can take a forward position so that the hedged payoff is the

same whatever the gold price. Let h be the short forward position per ounce. Remember that the forward price is assumed to be $350 per ounce. Therefore, a short forward position of one unit pays $350 – $250 if the gold price is $250 and $350 – $450 if the gold price is $450. To eliminate the impact of gold price risk, the shareholder must choose h so that the income is the same whatever the gold price:

$$\$250 + h(\$350 - \$250) = \$375 + h(\$350 - \$450)$$

Solving for h, we get 0.625. By selling short 0.625 ounces forward, the shareholder guarantees a payoff of $312.5 per ounce at the end of the year. If the gold price is $250 per ounce, the shareholder receives $250 per share from the firm and 0.625 x ($350 – $250), or $62.50, from the forward position. This amounts to $312.50. The shareholder is clearly better off if the firm hedges directly, since in that case she gets $325, or $12.50 more than if the firm does not hedge and she practices homemade risk management.

3.2.1. The tax argument for risk management

The tax argument for risk management is straightforward: If it moves a dollar away from a possible outcome in which the taxpayer is subject to a high tax rate and shifts it to a possible outcome where the taxpayer incurs a low tax rate, a firm or an investor reduces the present value of taxes to be paid. The tax rationale for risk management applies whenever income is taxed differently at different levels. The tax code introduces complications in the analysis. Some of these complications decrease the value of hedging, whereas others increase it. Some of these complications are discussed next.

1. **Carrybacks and carryforwards.** A firm that has negative taxable income can offset future or past taxable income with a loss in this tax year, subject to limitations. One limitation is that losses can be carried back or carried forward only for a limited number of years. In addition, no allowance is made for the time value of money. To see the importance of the time value of money, suppose a firm makes a gain of $100,000 this year and then a loss of $100,000 in three years. It has no other income. The tax rate is 30 percent. Three years from now, the firm can offset the $100,000 gain of this year with its loss. But it must pay $30,000 in taxes this year, and it gets back only $30,000 in three years, so it loses the use of the money for three years.

2. **Tax shields.** There is a wide variety of tax shields. One is the tax shield on interest paid. Another is the tax shield on depreciation. Firms also have tax credits. All these complications mean that a firm's marginal tax rate can be quite variable. Further, tax laws change, so at various times firms and investors know that taxes will rise or fall. In such cases, the optimal risk management program is one that increases cash flows when taxes are low and reduces them when they are high.

3. **Personal taxes.** Our discussion ignored taxes paid by investors. Suppose that taxes paid by investors decreased the forward price. In this case, hedging would be less advantageous at the firm level because the forward price would be less attractive. There is no reason to suspect that taxes

create biases in the prices of forward contracts—or other derivative contracts—that make hedging at the firm level unattractive.

It is difficult to capture all real-life complications in an analytical model to evaluate the importance of the tax benefits of risk management. To cope with this problem, Graham and Smith (1999) use a simulation approach instead. They do not take into account personal taxes, but otherwise they incorporate all the relevant features of the tax code. They simulate a firm's income, and then evaluate the tax benefit of hedging. For about half the firms, there is a tax benefit from hedging. The typical benefit is that a 1 percent reduction in the volatility of taxable income for a given year reduces the present value of taxes by 1 percent.

3.2.2. The tax benefits of risk management and Homestake

In 1990, Homestake paid taxes of $5.827 million. It made a loss on continuing operations because it wrote down its investment in North American Metals Corporation. Taxation in extraction industries like minerals and oil and gas companies is notoriously complicated. However, the annual report shows why Homestake's tax rate differs from the statutory tax rate of 34 percent as follows (in thousands of dollars):

Homestake loss: $13,500 at 34% would yield taxes of	$ (4,600)
Depletion allowance	(8,398)
State income taxes, net of federal benefit	(224)
Nondeductible foreign losses	18,191
Other, net	858
Total	$ 5,827

Homestake paid taxes even though it lost money. The exact details of the nondeductible foreign losses are not available from the annual report. Therefore, we cannot say for sure that risk management could have decreased taxes paid by Homestake. However, risk management enables a firm to shift income from states of the world with high tax rates to states of the world with low tax rates. Perhaps risk management could have enabled Homestake to avoid paying taxes while it was making a loss.

Decreases in the price of gold could easily lead to a situation where Homestake would make losses. Avoiding these losses would smooth out taxes over time and hence would increase firm value. Based on the information in the annual report, we cannot quantify this benefit. Petersen and Thiagarajan (2000) compare American Barrick and Homestake in great detail. They find that Homestake has a tendency to time the recognition of expenses when gold prices are high to smooth income. Obviously, in the year discussed here, smoothing income that way did not prevent Homestake from having to pay taxes while it was making a loss.

3.3. Optimal capital structure and risk management

Generally, interest paid is deductible from income. A levered firm that pays interest on debt therefore pays less in taxes than one without interest payments for the

same operating cash flow. Debt has a tax benefit, which increases the value of the levered firm relative to the value of the unlevered firm. In the presence of costs of financial distress, an increase in the firm's debt has an offsetting cost resulting from the increased likelihood of financial distress. Risk management enables the firm to have a higher debt level, and hence a greater tax shield from debt, for any likelihood of financial distress.

3.3.1. The tax shield of debt, costs of financial distress, and risk management

Let's see how risk management enables a firm to increase its tax benefits from debt without increasing its probability of financial distress. Suppose that the costs of financial distress are so high for Pure Gold that it is never worthwhile for Pure Gold to issue an amount of debt so that it defaults when it sells gold for $250. Absent risk management, Pure Gold can issue risk-free debt so that its debt payments at maturity are $250 million. It can use the proceeds of the debt issue to pay a dividend to shareholders. With that debt level, the interest rate on debt is the risk-free rate of 5 percent, so that Pure Gold pays interest of $11.90 million and borrows $239.10 million. The firm's value for its shareholders is the present value of 0.5 x $250M + 0.5 x [$450M – 0.5 x ($450M – $300M – $11.90M)], or $315.475 million.

Using risk management, Pure Gold can issue more risk-free debt and therefore reduce the present value of its tax payments. With risk management, it can lock in pre-tax income of $350 million and therefore can commit to pay $350 million in the form of debt principal, debt interest, and tax payments.

Since the tax shield increases with the debt principal outstanding, Pure Gold wants to issue as much debt as it can without incurring costs of financial distress. Since Pure Gold does not need the cash raised through debt for investment, it pays it out to the shareholders as a dividend. Figure 3.6 plots firm value imposing the constraint that total debt and tax payments cannot exceed $350 million. In this case, Pure Gold can always make its debt payments, so that we assume that there are no costs of financial distress. If the firm sells more debt, it is bankrupt. Consequently, if F is the principal amount of the debt issued, it must be that:

$$\textbf{Debt principal + Debt interest + Taxes = \$350M}$$

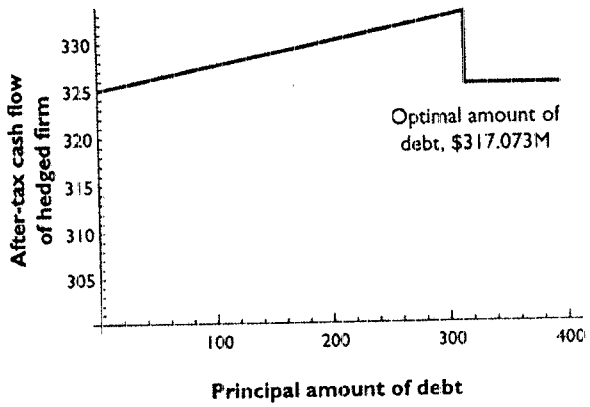
$$F + 0.05F + 0.5 \times (\$350M - \$300M - 0.05F) = \$350M$$

Solving for F, we get $317.073 million. To see that this works, note that the firm has to pay taxes on income of $350M – $300M – 0.05 x $317.073M, corresponding to $17.073 million. The debt payments are $317.073M + 0.05 x $317.073, or $332.927 million. The sum of debt payments and taxes is therefore exactly $350 million.

By issuing more debt than F, Pure Gold would always be bankrupt as we have seen already. If it issued less debt instead, it could increase debt and make the shareholders better off. To see this, suppose the firm had $1 million less of debt. Its dividend to shareholders would fall by $1 million and it would have $1.05 million less of debt payments at the end of the year. The decrease in debt payments would reduce the tax shield of debt by $0.25 million, so that the shareholders would receive $1.025 million at the end of the year instead of $1 million

Firm after-tax cash flow and debt issue *Figure 3.6*

The firm has an expected pre-tax cash flow of $350 million. The tax rate is 0.5 and the risk-free rate is 5 percent. The figure shows the impact on after-tax cash flow of issuing more debt, assuming that the IRS disallows a deduction for interest of debt when the firm is highly likely to default.



today if the firm issued debt instead. The present value of $1.025 million is less than $1 million, so that shareholders are worse off.

In general, firms cannot eliminate all risk, so that debt is risky. By having more debt, firms increase their **tax shield from debt** but increase the present value of costs of financial distress. The **optimal capital structure** of a firm balances the tax benefits of debt against the costs of financial distress. A firm can reduce the present value of the costs of financial distress through risk management by making financial distress less likely. As a result, it can take on more debt. This is the case even if the firm cannot eliminate all risk as in the case of Pure Gold.

One complication we have ignored is that investors pay taxes too. Miller (1978) has emphasized that this complication can change the analysis. Suppose investors pay taxes on bond income but not on capital gains. In this case, they will want a higher return on debt than on equity to offset the high taxes. A higher yield would reduce the tax benefit of debt to the firm. The consensus among financial economists is that personal taxes may limit the corporate benefits from debt but not eliminate them. Whether there are personal taxes or not, the corporation will want to maximize the value of its tax shields.

3.3.2. Does Homestake have too little debt?

Homestake pays taxes every year. Most years, its tax rate is close to the statutory rate of 34 percent. In 1990, as we saw, Homestake paid taxes at a rate that exceeded the statutory rate. It has almost no debt, and its long-term debt is dwarfed by its cash balances. It surely has too little debt.

By increasing its debt, Homestake takes advantage of the tax shield of debt and reduces its taxes. An increase in debt similarly amplifies the importance of risk management.

3.4. Should the firm hedge to reduce the risk of large undiversified shareholders?

Investors who own well-diversified portfolios are relatively unaffected by firm-specific events. On average, their risks balance out, except for the systematic risks of the economy as a whole, which can be controlled by investors through their asset allocation. For other investors who have a large position in a firm, these risks do not balance out. Managers, for example, may have a large stake in the firm for control reasons or because of a compensation plan. Other large investors might value a control position. Investors who cannot diversify firm-specific risk care about the risks that the firm bears. They might want the firm to reduce risk, unless they can reduce it more cheaply through homemade risk management.

Suppose Pure Gold has only one large shareholder who holds 10 percent of the shares and nothing else. This undiversified shareholder cares about the diversifiable risk of the gold mining firm. She wants to reduce the risk of her investment. To do this, she could sell her stake and invest in a diversified portfolio and the risk-free asset. Second, she could keep her stake but use homemade hedging. Third, she could try to convince the firm to hedge.

The firm may have a comparative advantage in hedging and homemade hedging may not be possible for this large investor. Why should the firm expend resources to hedge to please that large investor? If the only benefit of hedging is that this large investor does not have to hedge on her own, the firm uses resources to hedge without increasing firm value. If the firm gains from having the large shareholder, however, then it can make sense to hedge to make it possible for the large shareholder to keep her investment in the firm.

3.4.1. Large undiversified shareholders can increase firm value

Large shareholders can increase firm value. Smaller and highly diversified shareholders have little reason to pay much attention to what a particular firm is doing. Their smaller stakes give them little benefit from evaluating carefully the actions of managers. A shareholder with a large undiversified stake in a firm will follow the actions of management carefully with an interest in increasing the value of the firm. Evaluating managers and trying to improve what they do is called monitoring management. Larger shareholders get greater financial benefits from monitoring management than smaller ones.

There are two reasons why shareholder monitoring can increase firm value. First, an investor might become a large shareholder because he has some ability in evaluating the actions of management in a particular firm. Such an investor has knowledge and skills that are valuable to the firm. If management chooses to maximize firm value, management welcomes such an investor and listens to him carefully.

Second, managers do not necessarily maximize firm value; they maximize their welfare like all economic agents. Doing so sometimes involves maximizing firm value. What a manager does depends on the incentives. If an action increases firm value but is very risky, a manager on a fixed salary may decide against it because a firm that is bankrupt cannot pay her salary. Monitoring can make it more likely that managers maximize firm value.

A large shareholder who finds that management failed to take an action that maximizes firm value might draw the attention of other shareholders to this fact. In some cases, a large shareholder may even convince another firm to attempt a takeover to remove management and take actions that maximize firm value.

A firm's risk generally makes it unattractive for a shareholder to have a stake large enough to make monitoring worthwhile. If it hedges, a firm may make ownership more attractive to a shareholder who has some advantage in monitoring management. As the large shareholder takes such a larger stake, all other shareholders benefit from the monitoring.

3.4.2. Risk and the incentives of managers

One way shareholders can ensure that managers are motivated to maximize the value of the company's shares is through a managerial compensation contract that gives managers a stake in how well the firm does. If managers earn more when the firm does better, this induces them to work harder. Managerial compensation related to the stock price also can have adverse implications for managers. In fact, making managerial compensation depend strongly on any part of the stock return that is not under control of management could be counterproductive. Suppose a firm has large stocks of raw materials that are required for production. In the absence of a risk management program, the value of these raw materials fluctuates over time. Random changes in the value of raw materials may be the main contributors to the volatility of a firm's stock price, yet managers have no control over the price of raw materials. Making managerial compensation depend strongly on the stock price in this case forces management to bear risks, but provides no incentive effects and does not align management's incentives with those of shareholders.

In general, it makes sense to tie managerial compensation to some measure of value created without trying to figure out what is and is not under management's control. If the firm can reduce its risk through hedging, firm value depends on variables that management controls; in this case, relating compensation to firm value does not force managers to bear too much risk and does not induce them to make decisions that are not in the interest of shareholders to eliminate this risk. When managers work hard to increase their compensation, they also work hard to increase shareholder wealth.

Ownership of shares in the firm ties managers' welfare more closely to shareholders' welfare. If they own shares, managers bear risk. Since managers are not diversified shareholders, they care about the firm's total risk. This may lead them to be conservative in their actions. To the degree risk is reduced through risk management, the total risk of the firm falls, and managers become more willing to take risks. Firmwide hedging thereby makes managerial stock ownership a more effective device to induce managers to maximize firm value.

A risk management program eliminates sources of fluctuation in market value due to forces that are not under management's control. This reduces the risk attached to management's human capital and makes it less likely that managers will undertake risk-reducing activities that diminish firm value. If the risk attached to management's human capital is lower, there may be a willingness to accept a lower compensation. Saving compensation enhances firm value.

Not every form of compensation that depends on firm value motivates management to reduce firm risk. Managerial compensation contracts that include call options on the firm's stock create incentives to take risks. To see how options might induce management not to hedge when hedging would maximize firm value, suppose Pure Gold's management owns a call option on 1,000 shares with exercise price of $350 per share. For simplicity, we assume that management received these options in the past and that exercise of the options does not affect firm value. Assuming a tax advantage to hedging, as we have discussed, firm value is maximized if the firm hedges. Hedging locks in a firm value before managerial compensation of $309.52. Management's options are worthless in this case. If the firm does not hedge, there is a 50 percent chance that the shares will be worth $375, which represents a 50 percent chance that the options will pay off. In this case, management chooses not to hedge even though shareholders would be better off otherwise.

3.4.3. Large shareholders, managerial incentives, and Homestake

The Homestake proxy statement for 1990 shows that the directors own 1.1 percent of the shares. Homestake's CEO, Harry Conger, owns 137,004 shares directly and has the right to acquire 243,542 shares through an option plan. The shares in the option plan have an average exercise price of $14.43, but the share price in 1990 never dropped below $15.30. Managers and directors hold few shares directly and less than is typical for a firm of that size; most of managers' ownership is in the form of options. There is not much incentive for management to protect its stake in the firm through hedging.

A large shareholder who monitors management might be able to increase firm value. To attract such a shareholder, the firm might have to commit to a risk management program. Yet it does not seem that management would want such an outcome. Homestake has one large shareholder, Case, Pomeroy and Co. This company owns 8.2 percent of the shares. Two executives of that company are on the board of directors. Case has been decreasing its stake in Homestake and has a standstill agreement with Homestake that prevents it from buying more shares and gives Homestake rights of first refusal when Case sells shares.

3.5. Stakeholders

Besides large undiversified shareholders, there are individuals and companies whose welfare depends on how well a firm is doing but who cannot diversify the impact of firm risks on their welfare. They can be workers, suppliers, or customers. Such individuals and firms are often called stakeholders. Does it make sense to reduce firmwide risk to reduce the risk borne by these individuals and companies?

3.5.1. When should firms care about stakeholders?

It is not unusual to hear that a firm should be managed for its stakeholders. In general, though, owners of the firm want the firm to be managed to make them better off, so that maximizing the welfare of stakeholders cannot be a legitimate corporate goal. Yet it is sometimes advantageous for shareholders to reduce the risks that stakeholders bear. Shareholders may want stakeholders to make long-term firm-specific investments. The firm, for instance, might want workers to

learn skills that would have minimal value outside the firm. Or it might want a supplier to devote R&D to design parts that only the firm will use. In another case, the value of a product customers buy depends on the firm's implicit warranty. In all these cases, the stakeholders will be reluctant to make firm-specific investments if they question the firm's financial health. If the firm gets in financial trouble, it may not be able to live up to its part of the bargain—that the stakeholders are investing in exchange for benefits from the firm over the long term.

Hedging makes it easier for the firm to honor its bargain with stakeholders. It can hedge at lower cost than the monetary compensation it would have to give to stakeholders to offset the impact on their welfare of the firm's risk. Without reducing risk, a firm may be able to get the stakeholders to make the requisite investments only by "bribing" them to do so. This means paying workers more so that they will learn the requisite skills, paying the suppliers directly to invest in R&D, and selling products more cheaply to compensate for the risks associated with the warranty. Such economic incentives are more expensive than hedging. Managing risk can therefore help the firm in getting others to make firm-specific investments and lower its costs of doing so.

3.5.2. Stakeholders and Homestake

Are stakeholders important for Homestake? Most likely, no. There is no reason to suspect that workers or suppliers have to make important firm-specific investments whose value would be seriously damaged if Homestake had financial difficulties. The welfare of Homestake's workers and suppliers depends on whether it makes sense to exploit Homestake's mines, not on whether Homestake is financially healthy. Should Homestake fail financially and file for bankruptcy, the new owners of the mine would still want to take advantage of the firm-specific investments made by workers and suppliers if it makes sense to extract gold from Homestake's mines.

A risk management program cannot make it profitable for Homestake to extract gold from its mines when otherwise it would not be. To understand this, suppose the price of gold falls to $150 per ounce, Homestake's extraction cost is $300, and Homestake hedged so that it sold gold forward for $350 per ounce. Rather than extract gold, Homestake is better off buying gold on the spot market to deliver on its forward contracts. It makes a profit of $200 per ounce this way. Producing gold, it only makes a profit of $50 per ounce.

Buyers of gold do not care about its provenance, so Homestake does not have to worry about relationships with customers.

3.6. Risk management, financial distress, and investment

So far, we have paid little attention to the fact that firms are ongoing entities that have opportunities to invest in valuable projects. Suppose Pure Gold has the opportunity to open a profitable new mine a year from now. A large investment must be made first. Without sufficient internal resources, the firm has to borrow or sell equity to finance the opening of the mine. If the costs of external financing are too high, Pure Gold might not be able to open the mine, and shareholders would lose the expected profits.

We investigate the main reasons why firms might not be able to invest in profitable projects because the cost of external financing is too high, and show how risk management can help avoid such situations.

3.6.1. Debt overhang

Too much debt induces shareholders to take on negative net present value projects and to avoid investing in valuable projects because they require issuing equity that dilutes their stake in the firm. When a firm has so much debt that it leads it to make investment decisions that benefit shareholders but affect its total value adversely, the firm has a **debt overhang**. As long as a firm has debt and risk, there is some possibility it may end up with a debt overhang. The probability that the firm might experience a debt overhang in the future reduces its value today. Consequently, risk management that reduces this probability increases firm value today.

A debt overhang can make shareholders take actions that reduce firm value but increase the value of the firm's equity. To see this, consider a firm, Highly Levered Gold (HLG). HLG never intended to have high leverage, but after successive mining disasters, it became highly levered because losses ate away at its equity. Suppose that the financial situation of HLG is such that if firm value does not increase sharply before the maturity of its debt, shareholders will receive nothing and the creditors will own the firm. Suppose further that if shareholders do nothing, HLG's value cannot increase sufficiently to enable it to repay its creditors. To make it more likely that firm value will increase sufficiently to make their shares valuable, shareholders can increase HLG's risk. If they take projects that have some chance of a large payoff but otherwise lose money, shareholders make money if the projects do well but do not lose money if the projects do poorly since they would have received nothing anyway. In fact, shareholders will be willing to take these long-shot projects even if they have a negative net present value.

When a firm has a large debt overhang, its shareholders may decide against raising funds to finance valuable new projects. Suppose that HLG has a valuable investment opportunity: By investing $10 million, the firm acquires a project that has a positive net present value of $5 million. The project is small enough that it will not enable HLG to repay its debt. The firm has no cash. The only way it can invest is by raising funds.

Borrowing is not an option. Consequently, HLG would have to sell equity to raise funds. Consider the impact of having an investor invest one dollar in new equity. The investor will only invest the dollar if she can expect to earn an appropriate return given the risk she takes. If an investor invests one dollar in a new share, that money most likely will end up in the pockets of the creditors since the most likely outcome is that the firm will not have money left after paying the creditors. This extra dollar will be a windfall for the creditors. Since the creditors will receive that dollar without having to pay for it, the old shareholders will have to pay for it through a reduction in the value of their stake brought about by the fact that they have to share the equity payoffs with the new investor. Hence, even though the project would increase firm value, the current shareholders will not want the firm to take it because it will not benefit them. The only way the firm would take the project is for shareholders to renegotiate with creditors so that they get more of the payoff of the project. Such a renegotiation is difficult and costly, and sometimes, no such renegotiation succeeds.

To understand why the debt overhang leads to underinvestment, let's look at a simple example. Suppose HLG can sell one million ounces of gold at either \$450 or \$250 at the end of the year. Each outcome has a probability of 0.5. Gold price risk is not systematic risk. HLG has debt payments of \$400 million. The value of the debt is therefore [(0.5 x \$250M) + (0.5 x \$400M)]/1.05, or \$309.524 million. The value of equity is 0.5 x \$50M/1.05, or \$23.8095 million. Now, HLG receives an investment opportunity that pays \$10 million for sure but costs \$5 million. It has to raise \$5 million to finance the investment opportunity.

Firm value without the investment opportunity is \$350M/1.05, or \$333.33 million. With the investment opportunity, it is \$360M/1.05, or \$342.857 million. Taking the investment opportunity increases firm value, but who benefits from the investment opportunity? If the gold price is \$250, the bondholders get all the benefit of the funds raised—they get \$10 million more. If the gold price is \$450, the shareholders get all the benefit of the funds raised. The value of equity therefore increases by 0.5 x 10M/1.05, or \$4.7619 million. The shareholders raise \$5 million, but equity increases by less. Since the new shareholders must receive \$5 million worth of claims against the firm, the value of the claims of the old shareholders must fall from \$23.8095 million to \$23.5714 million. The share price must fall as the firm takes advantage of the new investment opportunity even though firm value increases. The old shareholders therefore prefer that the firm does not raise funds and does not invest in the investment opportunity. The firm therefore underinvests—it does not invest in a project that is a positive net present value project for the firm.

The value of a firm in the capital markets is lower when there is a probability that it may not enter into valuable projects because its financial health might be poor. Reducing this probability through risk management increases firm value as long as risk management is cheap enough.

3.6.2. Information asymmetries and agency costs of managerial discretion

The key problem management faces in raising funds is that managers know more about the firm's projects than the outsiders they are dealing with. When one party to a deal knows more than the other, we call this an **information asymmetry**. Suppose that the firm's equity with its current projects is \$100 million. Managers believe that by raising \$100 million of new equity and investing the proceeds, they can invest in a project with a net present value of \$50 million. If they ask you to invest, you have to figure out the return on your investment based on the information provided to you by management.

Generally, managers benefit from firm growth, so that they have much to gain by undertaking new projects, which can lead to biases. They may tend to minimize problems. Even if they are completely unbiased and reveal all the information they have to potential investors, you as an investor cannot easily tell that. Often, management has enough to gain from undertaking a project that it might want to invest even if the chance of success is low enough that the project is a negative net present value project.

The costs associated with management's opportunity to undertake projects that have a negative net present value when it is advantageous for them to do so are called **agency costs of managerial discretion**. When managers have

discretion to take actions, they can pursue their own objectives, which creates agency costs. That is, the agent's interests, or management's interests, are not aligned with the interests of the principals who hire management, namely, the shareholders.

Agency costs of managerial discretion make it harder for a firm to raise funds and increase the cost of funds. If outsiders are not sure that the project is as likely to pay off as management claims, they want more compensation for providing the funds. Even if the project is as described, having to pay a higher expected compensation reduces the profits from the project. The project may not be profitable because the cost of capital for the firm is too high.

There is more than one way to reduce the costs of managerial discretion and hence reduce the costs of the funds raised. A firm could entice a large shareholder to come on board. This shareholder would see the company from the inside, and would be better able to assess whether the project is valuable. Or a risk management strategy might preserve ongoing firm value and hence might enable the firm to take the project. A firm whose value is not in doubt may be able to borrow against assets rather than try to borrow against the future project.

A risk management strategy that preserves firm value might help the firm to finance the project for another reason. Investors who look at a firm's history have to figure out what a loss in firm value implies. In general, it will be difficult for outsiders to see exactly what is going on. They will therefore always worry that the true explanation for the losses is incompetent management. There could be many explanations for a loss in firm value. Firm value could fall because a stock of raw materials fell in value, because the economy is in a recession, because a plant burned down, or because management is incompetent. Outsiders cannot be sure. If it reduces risk through risk management, the firm makes it easier for investors to assess the ability of management since it eliminates some sources of unexpected losses.

3.6.3. The cost of external funding and Homestake

Is it really the case that external funding can be more expensive than internal funding? The answer is yes. There is much empirical evidence that shows that firms with poor cash flow have to cut back investment. The problem with that evidence is that poor cash flow might signal bad investment opportunities, in which case it would not be surprising to see that firms with poor cash flow cut investment. However, this is not the whole story. Lamont (1997) shows that drops in oil prices led oil companies to cut back investment in their non-oil activities. An oil company that sees its cash flow drop has no reason to reduce investment in the department stores it owns unless external financing is more costly than internal financing, so that when the firm has to switch from internal financing to outside financing, the cost of capital increases and some investments are no longer worthwhile.

Box 3.1, Warren Buffett and Catastrophe Insurance, provides an example where an insurance product is priced in a way that can be explained only by the existence of steep costs of external finance because of agency costs. The example also shows that the agency costs and information asymmetries discussed in this section can make risk management products more expensive.

Warren Buffet and Catastrophe Insurance — *Box 3.1*

Insurance companies hedge some of their exposure to catastrophes such as earthquakes, hurricanes, or tornadoes by insuring themselves with reinsurers. A typical reinsurance contract promises to reimburse an insurance company for claims due to a catastrophe within some range. For example, an insurance company could be reimbursed for up to $1 billion of California earthquake claims in excess of $2 billion. Catastrophe insurance risks are diversifiable risks, so bearing these risks should not earn a risk premium. This means that the price of the insurance should be the expected losses discounted at the risk-free rate. Yet, in practice, the pricing of reinsurance does not work this way.

Let's look at an example. In the fall of 1996, Berkshire Hathaway, Warren Buffett's company, sold reinsurance to the California Earthquake Authority in the amount of $1.05 billion insured for four years. The annual premium was 10.75 percent of the annual limit, or $113 million. The probability that the reinsurance would be triggered was estimated at 1.7 percent at inception by EQE International, a catastrophe risk modeling firm. Ignoring discounting, the annual premium was therefore 530 percent of the expected loss (0.1075 is 530 percent of 0.017). If the capital asset pricing model had been used to price the reinsurance contract, the premium would have been $17.85 million in the absence of discounting and somewhat less with discounting.

How can we make sense of this huge difference between the actual premium and the premium predicted by the capital asset pricing model? A reinsurance contract is useless if there is credit risk, that is, the reinsurer has to have liquid assets that enable it to pay the claims. The problem is that holding liquid assets creates managerial discretion agency costs. It is difficult to ensure that a reinsurer will indeed have the money when needed. Once the catastrophe has occurred, the underinvestment problem would prevent the reinsurer from raising the funds because the benefit from raising the funds would accrue to the policyholders rather than to the investors. The reinsurer therefore has to raise funds when the policy is agreed upon. Hence, in the case of this example, the reinsurer would need, if it did not have the capital, to raise $1.05 billion minus the premium.

The investors have to be convinced that the reinsurer will not take the money and run or take the money and invest it in risky securities. Yet the reinsurer has strong incentives to take risks unless its reputational capital is extremely valuable. In the absence of valuable reputational capital, the reinsurer can gamble with the investors' money. If the reinsurer wins, it makes an additional profit. If it loses, the investors or the insurer's clients lose.

Another problem with reinsurance is due to information asymmetries and agency costs in the investment industry. The reinsurer has to raise money from investors, but the funds provided would be lost if a catastrophe occurs. Most investment takes place through money managers who act as agents for individual investors. In the case of funds raised by reinsurance companies, the money manager is in a difficult position. Suppose that he decides that investing with a reinsurance firm is a superb investment. How can the individual

(continued)

Box 3.1 (continued)

investors who hire the money manager know that he has acted in their interest if a catastrophe occurs? They will have a difficult time deciding whether the money manager was right and they were unlucky or the money manager was wrong. This problem leads the money manager to require ample compensation for investing with the reinsurance firm.

Berkshire Hathaway has reputational capital that makes it unprofitable to gamble with investors' money. Consequently, it does not have to write a complicated contract to ensure that there will not be credit risk. Since it has already large reserves, it does not have to deal with the problems of raising large amounts of funds for reinsurance purpose. Could these advantages be worth as much as it seems in the great difference between the California premium and the theoretical price? There is no evidence that there were credible reinsurers willing to enter cheaper contracts. With perfect markets, such reinsurers would have been too numerous to count."

Source: Kenneth Froot, "The limited financing of catastrophe risk: An overview," *The Financing of Property Casualty Risks*, University of Chicago Press, 1997.

Homestake could repay all its debt with its cash reserves, so that debt overhang is not an immediate issue. The firm also has enough cash that it could finance large investments out of internal resources. Yet if gold prices fell, Homestake's resources would shrink over time. At some point, its ability to undertake new projects might be compromised. When gold prices are low, Homestake might have few good investment opportunities. However, if it expects to have more valuable investment opportunities if gold prices fall, it might want to put in place a risk management program that insures that it will have appropriate financial resources to finance these investment opportunities.

3.7. Summary

In this chapter, we have investigated ways that firms without risk management can leave money on the table. They can:

1. Bear more bankruptcy costs and financial distress costs than they should.
2. Pay more taxes than they should.
3. Have less leverage than they should.
4. Have managers provided with poor incentives.
5. Fail to retain valuable large shareholders.
6. Fail to get stakeholders to make firm-specific investments.
7. Find it unprofitable to invest in positive net present value projects.

8. Find it profitable to take bad projects.

We have identified benefits from risk management that can increase firm value. In the next chapter, we move on to the question of whether and how such benefits can provide the basis for the design of a risk management program.

Key Concepts

agency costs of managerial discretion, 71
bankruptcy costs, 55
costs of financial distress, 58
deadweight costs, 53
debt overhang, 70
information asymmetry, 71
optimal capital structure, 65
stakeholders, 68
tax shield from debt, 65

Review Questions

1. How does risk management affect the present value of bankruptcy costs?
2. Why do the tax benefits of risk management depend on the firm having a tax rate that depends on cash flow?
3. How do carrybacks and carryforwards affect the tax benefits of risk management?
4. How does risk management affect the tax shield of debt?
5. Does risk management affect the optimal capital structure of a firm? Why?
6. Does it pay to reduce firm risk because a large shareholder wants the firm to do so?
7. How does the impact of risk management on managerial incentives depend on the nature of management's compensation contract?
8. Is risk management profitable for the shareholders of a firm that has a debt overhang?
9. How do costs of external funding affect the benefits of risk management?

Literature Note

Smith and Stulz (1985) provide an analysis of the determinants of hedging policies that covers the issues of bankruptcy costs, costs of financial distress, stakeholders, and managerial compensation. Diamond (1981) shows how hedging makes it possible for investors to evaluate managerial performance more effectively. DeMarzo and Duffie (1991) and Breeden and Viswanathan (1998) show that hedging is valuable because of information asymmetries between managers and investors. Froot, Scharfstein, and Stein (1993) derive explicit hedging policies when firms would have to invest suboptimally in the absence of hedging because of difficulties in securing funds to finance investment. Stulz (1990, 1996) discusses how hedging can enable firms to have higher leverage. Stulz (1990) focuses on the agency costs of managerial discretion. Hedging makes it less likely that the firm will not be able to invest in valuable projects, so it can support higher leverage. One reason debt is valuable is because it prevents managers from

making bad investments. Tufano (1998) makes the point that reducing the need to go to the external capital markets also enables managers to avoid the scrutiny of the market. This will be the case if greater hedging is not accompanied by greater leverage. Myers (1977) was the first one to provide an analysis of debt overhang, showing how it can lead shareholders to be unwilling to raise funds for valuable new projects. The empirical evidence on the positive relation between investment and cash flow is discussed in Hubbard (1998). Bessembinder (1991) and Mayers and Smith (1987) analyze how hedging can reduce the underinvestment problem. Leland (1998) provides a model where hedging increases firm value because (1) it increases the tax benefits from debt and (2) it reduces the probability of default and the probability of incurring distress costs. Ross (1997) also models the tax benefits of hedging. Petersen and Thiagarajan (1998) provide a detailed comparison of how hedging theories apply to Homestake and American Barrick.