Chapter 17

Risk Management and the Foreign Currency Hedging Decision

*F*irms hedge foreign exchange risk by using instruments such as forward and futures foreign exchange contracts, interest rate and currency swaps, and foreign currency options and by choosing to denominate assets and liabilities in foreign currencies. For example, Infosys, an Indian software firm, has a six-person Treasury team in Bangalore, India, that routinely hedges its currency risk one to two quarters ahead. The risk is substantive because the firm has most of its costs in Indian rupees and 98% of its revenue in foreign currencies. Infosys estimates that it loses 40 basis points of profit margin for each 1% that the Indian rupee depreciates against the U.S. dollar. This chapter examines why a firm would want to use these financial instruments to hedge foreign exchange risk.

We first show that hedging would be desirable for a risk-averse entrepreneur because it reduces the variance of profits. However, in a modern, publicly held corporation, the benefits of hedging are less clear. Indeed, the logic of Modigliani and Miller (1958, 1961) implies that hedging is irrelevant as investors can always undo any hedging a corporation does. Nevertheless, there are modern arguments for and against hedging, and we know that the assumptions of Modigliani and Miller probably do not hold for most situations.

After reviewing the Modigliani–Miller arguments, we examine three arguments against hedging: that hedging is costly, that hedging is impossible for equity-like cash flows, and that hedging increases the costs of financial distress by exposing bondholders to a possible bait and switch. However, hedging can be valuable!

Hedging is valuable because it can reduce the future taxes that a firm expects to pay. Hedging can lower the costs of financial distress, and it can improve the investment decisions the firm will face in the future. When there is asymmetric information between the managers of a firm and its stockholders, hedging may also affect the ability of stockholders to evaluate the quality of the management.

We end the chapter by taking a look at the practice of hedging. As a case study, we examine the logic behind Merck's decision to hedge its foreign exchange risk with foreign currency options. Then, we examine academic studies and surveys that have sought to determine why firms actually hedge.

17.1 To Hedge or Not to Hedge

This section examines the desirability of **hedging** foreign exchange risk in two situations: in an entrepreneurial venture and in a modern publicly held corporation. Hedging foreign exchange risk is one type of **risk management**. Generally, risk management is the use of **derivative securities** to take positions in financial markets that offset the underlying sources of risks that arise in a company's normal course of business. Derivative securities, or *derivatives* for short, are discussed in more detail in Chapter 20; they include financial contracts such as forwards, futures, swaps, and options whose value depends on the value of an underlying asset price. Taking positions in derivatives that increase in value when the firm would take a loss or decrease in value when the firm would experience a gain reduces the variance of the firm's profits.

Hedging in an Entrepreneurial Venture

One persistent theme of this book is that future foreign exchange rates are uncertain. The volatility of foreign exchange rates implies that firms choosing not to hedge foreign exchange risk will experience more volatility in their cash flows than firms choosing to hedge foreign exchange risks. This volatility makes it harder to predict the profitability of firms, in the sense that the forecast errors are bigger. While reducing the volatility of future cash flows might seem like a good reason to hedge, the volatility of foreign exchange rates provides a necessary but not a sufficient condition for a modern corporation to hedge foreign exchange risk. To understand why this is so, we must understand the goals of management and how these goals are affected by hedging.

The first time students encounter discussions of hedging, they are often surprised that reducing uncertainty is not a sufficient condition for hedging. One reason for this opinion may be that students tend to think of themselves as individual entrepreneurs facing the foreign exchange risks, and they react to the situation as risk-averse individuals. It turns out that in this case, their intuition is actually right.

Reducing the uncertainty of a firm's future cash flows does provide an appropriate motivation for hedging foreign exchange risk if the firm is privately owned and its owner-managers are risk averse. A risk-averse person prefers his or her cash inflows to have a higher mean and a lower variance. Because an entrepreneur's profits are a significant part of the entrepreneur's wealth, entrepreneurs are unable to diversify away such risks through transactions in their own portfolios. Hence, if forward rates are unbiased predictors of future spot rates, **risk-averse entrepreneurs** will choose to hedge their future foreign currency cash flows because doing so will reduce the variance of the flows without changing their expected values in the domestic currency. Therefore, reducing the variance of future profits would increase the entrepreneur's expected utility.[1]

Hedging in a Modern Corporation

For publicly held corporations, simply reducing the uncertainty of future cash flows by hedging becomes problematic. To understand why, let's review the sources of value

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[1]Chapter 7 indicates that whether forward rates are unbiased predictors of future spot rates is still unresolved. If the forward rate is a biased predictor but the bias is due to an equilibrium risk premium, investors in forward contracts experience either an expected profit or loss, depending on the position in the contract. In either case, the expected value of the profit or loss provides compensation for the riskiness of the position. If the bias in the forward contract is due to market inefficiency, the entrepreneur would possibly face a nontrivial trade-off between a reduced variance of profits and a reduced expected value of profits.

of a corporation using the adjusted net present value (ANPV) approach developed in Chapter 15:

$$\begin{aligned} \text{ANPV} = \quad & \text{Present value of future after-tax cash flows for the all equity firm} \\ & + \text{ Present value of future interest tax shields} \\ & + \text{ Present value of interest subsidies} \\ & - \text{ Present value of the costs of financial distress} \\ & + \text{ Present value of the firm's real options} \end{aligned}$$

To derive the equity value of the firm, we must subtract the market value of debt from the ANPV of the firm's overall value:

$$\text{Equity value of the firm} = \text{ANPV} - \text{Market value of the firm's debt}$$

If the goal of a corporation's management is to maximize stockholders value, hedging and other risk management activities should increase the equity value of the firm to be worthwhile. Consequently, these activities must affect one or more of the terms in the ANPV, or it must decrease the market value of the debt. Later on in this chapter, we will examine how the ANPV terms can be affected by hedging.

The Hedging-Is-Irrelevant Logic of Modigliani and Miller

In this section, we review the logic of the **Modigliani–Miller proposition** regarding the valuation of cash flows from a corporation. Modigliani and Miller argued that a corporation's financial policies, such as issuing debt, hedging foreign exchange risk, and other purely financial risk management activities, do not change the value of the firm's assets unless these financial transactions lower the firm's taxes, affect its investment decisions, or can be done more cheaply than individual investors' transactions can be done.

The reason that reducing the uncertainty of future cash flows, *per se*, does not lead to a rationale for hedging is that it may not change investors' perceptions of the firm's systematic risk. We know from modern portfolio theory that the required rate of return on the equity cash flows of a corporation does not depend on the standard deviation of the firm's cash flows but only on the systematic risk associated with those cash flows. The fact that a firm's cash flows are uncertain is a necessary but not a sufficient condition for discounting the cash flows at a discount rate higher than the risk-free interest rate. Hence, unlike the case of an entrepreneurial firm, if hedging merely reduces the unsystematic risk of the corporation's cash flows while leaving unchanged both the systematic risk and the expected value of the cash flows, hedging will not have any effect on the firm's value. Investors will still discount the same expected cash flows at the same required rate of return that is appropriate for the firm's systematic risk.[2]

Modigliani and Miller also argued that, if individuals have the same investment opportunities as firms, investors can "undo" the financial transactions of corporations. In other words, individuals can adjust the leverage of their portfolios to the levels they want. They can also buy and sell foreign exchange forward contracts or option contracts to match their desired hedging levels—regardless of the firm's preferred hedging level. Notice in each of these situations that transaction costs and taxes must be the same for both the corporation and the individual.

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[2]Essentially, the value of the hedged firm equals the value of the unhedged firm plus the value of any forward contracts. If the forward rate is an unbiased predictor of the future spot rate, the forward contracts have zero value when initiated. If the forward rate is biased, but the bias is due to an equilibrium risk premium, the forward contracts have value, and hedging changes the firm's expected cash flows. But hedging also changes the firm's systematic risk such that the expected value of the hedged firm is unchanged.

Because major corporations command better foreign exchange rate terms than the individual investors—that is, they transact at smaller bid–ask spreads—there is a rationale for corporations to hedge *for* investors. But we could easily argue that major institutional investors, such as the mutual fund investment companies Fidelity and Vanguard, who invest on behalf of individual investors, can deal in the foreign exchange market on terms comparable to, or even better than, those of a major corporation. As a result, we should look for reasons other than transaction costs as to why a firm might want to hedge.

17.2 ARGUMENTS AGAINST HEDGING

First, though, we take up three arguments against hedging. The first argument is that hedging is costly. The second argument against hedging is that most foreign exchange risk is equity related. Equity risk is long term in nature and effectively impossible to hedge away. The third argument is that hedging can create bad incentives. Let's look at each of these arguments in turn.

Hedging Is Costly

One frequently encountered argument against hedging is that it is costly, so firms should avoid doing it. People who make this argument often have in mind an incorrect notion of the cost of hedging. They argue that if the firm is selling foreign currency in the forward market, a forward discount on the foreign currency is a cost of hedging because the domestic currency forward price of foreign currency is less than the spot price. Conversely, a forward premium is viewed as providing a benefit or profit from hedging when the firm is selling foreign currency forward. In contrast, a forward premium is thought to increase the costs of the firm if it is buying foreign currency in the forward market.

This argument was first discussed in Chapter 3, where we noted that the argument is incorrect because it reflects an irrelevant accounting perspective on the nature of costs rather than an appropriate economic perspective. We know that the forward rate differs from the current spot rate because of differences in interest rates. The foreign currency cash flow is occurring in the future, not today. This makes the current spot rate irrelevant when it comes to valuing the future foreign currency cash flow unless the cash flow is first discounted to the present.

A True Hedging Cost: The Bid–Ask Spread
Bid–ask spreads are typically larger in the forward market than in the spot market. Thus, one of the true costs of hedging is that the costs of transacting in the forward market typically exceed the costs of transacting in the spot market. This incremental cost is small for near-term transactions. In near-term transactions, the difference is only a few hundredths of a percent of the current spot rate. But the bid–ask spread widens as one contracts more distantly in the future. In this sense, the cost of forward hedging increases with the maturity of the contract.

The Employee Cost
An additional cost of hedging is that a firm must use employees to determine the types and sizes of various hedging instruments. These employees must then be monitored to prevent them from engaging in speculative behavior. Their compensation also must not be based on the profitability of their transactions alone. Otherwise, they will be motivated to speculate, and they will take off hedges that become profitable so that they can book accounting profits. Of course, this will expose the underlying risk that was being hedged. The following example illustrates how this works.

Example 17.1 Incorrectly Booking Profit on a Hedge

Suppose that a firm will receive 5,000,000 Swiss francs in 1 year. Let the 1-year forward rate be CHF1.50/USD. Suppose the treasurer makes a forward contract to sell CHF5,000,000 such that the firm will receive

$$\frac{\text{CHF5,000,000}}{\text{CHF1.50/USD}} = \text{USD3,333,333.33}$$

in 1 year. Now, let 6 months pass and suppose that the 6-month forward rate is CHF1.70/USD. The value of the firm's underlying Swiss franc asset has fallen from USD3,333,333.33 to

$$\frac{\text{CHF5,000,000}}{\text{CHF1.70/USD}} = \text{USD2,941,176.47}$$

for a loss of USD392,156.86. Remember, though, that the firm is hedged because it sold the CHF5,000,000 forward, and the forward contract to sell CHF5,000,000 at CHF1.50/USD has increased in value by USD392,156.86.

If the treasurer of the company were trying to maximize profit on the contracts he makes, he could enter the 6-month forward market, say, by purchasing CHF5,000,000 to offset the firm's existing forward contract that has 6 months left to maturity. The dollar profit on this transaction would equal the fall in the forward rate of dollars per Swiss franc multiplied by the contractual amount of Swiss francs:

$$\left[\frac{1}{\text{CHF1.5/USD}} - \frac{1}{\text{CHF1.7/USD}} \right] \times \text{CHF5,000,000} = \text{USD392,156.86}$$

Because this is a hedging situation, we know that the dollar value of the CHF5,000,000 account receivable has fallen in value by this same amount. If the firm's cost accountants decide that the treasurer should receive a profit of USD392,156.86, the loss on the receivable must be booked somewhere. If the sales division is allocated the corresponding loss, some serious incentive problems will arise in terms of getting the treasurer to hedge correctly.

Instead of hedging, the treasurer will begin to speculate. Taking off the hedge by buying CHF5,000,000 in the 6-month forward market would lock in the "profit" for the treasurer, but it would expose the firm's original, underlying Swiss franc asset to the risk that the Swiss franc might weaken even more. It is unlikely that the treasurer of a corporation has the ability to make profitable calls about the direction of exchange rates. If he or she does, the person should be working for an investment bank or hedge fund, where this ability can be leveraged and where investors are hoping for superior performance.

Now, let's examine the second argument against hedging.

Hedging Equity Risk Is Difficult, if Not Impossible

People sometimes argue that it is effectively impossible for a corporation to hedge the change in the value of its equity with a change in the exchange rate because the value of equity is the present discounted value of an infinite series of cash flows. To understand this argument, let's consider an example.

The Weehawken Widget Project

Consider the situation of Weehawken Widget Works, a U.S. firm that has the opportunity to invest in a U.K. project. If the company spends $1,900 today, its project will return either £125 or £75 of free cash flow with equal probability for every year from next year into the infinite future. (Later, we treat each pound as £1 million to make the argument more forceful, but for now, let's just keep things simple.) The expected value of the cash flow each year is

$$0.5 \times £75 + 0.5 \times £125 = £100$$

If the appropriate pound discount rate is 10% per annum, the present value of the project is

$$\frac{£100}{1.1} + \frac{£100}{1.1^2} + \frac{£100}{1.1^3} + \ldots = \frac{£100}{0.1} = £1,000$$

If the current spot exchange rate is $2/£, the dollar present value of the project is

$$(\$2/£) \times £1,000 = \$2,000$$

To find the net present value (NPV) of the project, we must subtract its cost, which is $1,900. Hence, if Weehawken's investors pay $1,900 today, they obtain a project with a discounted expected value of $2,000. Accepting the project causes the value of Weehawken to increase by $100.

Changes in the Project's Value over Time

Now, let's see how the value of the project changes over time. Suppose, for simplicity, that the exchange rate in each year can either increase or decrease by $0.20/£ with equal probability. Then, next year, the exchange rate will be either $2.20/£ or $1.80/£. If forward rates are unbiased forecasts of future spot rates, the current forward rates for all maturities will be $2.00/£. Let's assume that the dollar discount rate for Weehawken's cash flows is also 10% and that the discount rates do not change over time. Finally, let's also assume that the realization of the project cash flow is independent of the realization of the exchange rate. These assumptions are simplistic, but they allow us to easily make the necessary calculations.

Exhibit 17.1 provides the four possible values for the project in 1 year, where by the value of the project we mean the payoff on the project in the first year, plus the ongoing value of the project, plus any gains or losses from hedging. For example, if the exchange rate turns out to be $2.20/£ and the project returns £125, the value of the project at time $t+1$ is

$$\begin{array}{cc} \text{Term A} & \text{Term B} \end{array}$$
$$[(\$2.20/£) \times £125] + [(\$2.20/£) \times £1,000] = \$2,475$$

Term A represents the dollar value of the time $t+1$ pound cash flow, and Term B is the dollar value of the infinite stream of future expected pound cash flows that still has a present value of £1,000. In general, if $S(t+1, \$/£)$ is the dollar–pound exchange rate and $CF(t+1, £)$ is the pound cash flow at time $t+1$, the dollar value of the unhedged project at time $t+1$ is

$$[S(t+1, \$/£) \times CF(t+1, £)] + [S(t+1, \$/£) \times £1,000]$$

Exhibit 17.1   The Value of Weehawken's Project with Unhedged Cash Flows

		Possible Future Exchange Rates	
		$2.20/£	**$1.80/£**
Possible Pound Returns	£125	$2,475	$2,025
	£75	$2,365	$1,935

Exhibit 17.2 The Value of Weehawken's Project with 1-Year Hedged Cash Flows

		Possible Future Exchange Rates	
		$2.20/£	**$1.80/£**
Possible Pound Returns	£125	$2,455	$2,045
	£75	$2,345	$1,955

The Project's Value with 1 Year of Hedged Cash Flows

Now, suppose Weehawken hedges 1 year of pound cash flows by selling the expected value of next year's cash flow, £100, at the 1-year forward rate of $2.00/£. The possible values of the project, including the time $t+1$ cash flow, are given in Exhibit 17.2 and are found just as they were in Exhibit 17.1. If the exchange rate turns out to be $2.20/£ and the project returns £125, the value of the project at time $t+1$ is

$$\underset{\text{Term C}}{[(\$2.00/£) \times £100]} + \underset{\text{Term D}}{[(\$2.20/£) \times £25]} + \underset{\text{Term B}}{[(\$2.20/£) \times £1,000]} = \$2,455$$

Term C represents the dollar value of the forward sale of pounds. Term D is the dollar value of the extra pound return that was not sold forward and that must therefore be sold in the spot market. Term B is, once again, the dollar value of the infinite stream of future expected pound cash flows that has a present value of £1,000. If the project returns only £75, Weehawken will have to purchase £25 in the spot market to deliver on the forward contract. In general, the value of the project at time $t+1$ with 1 year of hedged cash flows is

$$[(\$2.00/£) \times £100] + \{S(t+1, \$/£) \times [CF(t+1, £) - £100]\} + [S(t+1, \$/£) \times £1,000]$$

By rearranging this expression, we see that it is the dollar value of the underlying unhedged pound asset plus the dollar return on a forward contract to sell £100 at $2.00/£:

$$[S(t+1, \$/£) \times CF(t+1, £)] + [S(t+1, \$/£) \times £1,000]$$
$$+ [(\$2.00/£) - S(t+1, \$/£)] \times £100$$

By comparing the entries in Exhibit 17.1 with those in Exhibit 17.2, we see that the forward hedge transfers $20 from the good state of the world, in which the pound strengthens, to the bad state of the world, in which the pound weakens. This $20 represents the difference between the forward rate and the future exchange rate multiplied by the expected cash flow, which is sold forward.

The Project's Value with 2 Years of Hedged Cash Flows

Now, suppose that Weehawken hedges by selling the first and second years of expected future pound revenue in the forward market, and under our assumptions, the 2-year forward rate at time t is also $2.00/£. The possible values of the project at time $t+1$, including the time $t+1$ cash flow, are given in Exhibit 17.3. If the exchange rate turns out to be $2.20/£ and the project returns £125, the value of the project at time $t+1$ is

$$\underset{\text{Term C}}{[(\$2.00/£) \times £100]} + \underset{\text{Term D}}{[(\$2.20/£) \times £25]} + \underset{\text{Term E}}{\left[\frac{(\$2.00/£) \times £100}{1.1}\right]}$$

$$+ \underset{\text{Term F}}{\left[\frac{(\$2.20/£) \times £1,000}{1.1}\right]} = \$2,436.82$$

Exhibit 17.3 The Value of Weehawken's Project with 2-Year Hedged Cash Flows

		Possible Future Exchange Rates	
		$2.20/£	**$1.80/£**
Possible Pound Returns	£125	$2,436.82	$2,063.18
	£75	$2,326.82	$1,973.18

Terms C and D are again the dollar value of the 1-year forward contract and the dollar value of the extra pounds that must be sold in the spot market. Term E is the present value of the payment on the 2-year forward contract that has 1 year remaining, and Term F is the dollar value of the unhedged £100 perpetuity whose first cash flow begins 2 years from now discounted at the constant dollar discount rate of 10%. By making the 2-year forward contract, Weehawken transfers an additional ($20/1.1) = $18.18 from the good state, in which the pound strengthens, to the bad state, in which the pound weakens. The $18.18 represents the present value of the profit on a forward contract that could be locked in at time $t+1$ because the 1-year forward rate at that time would equal the spot rate of $2.20/£ because the two interest rates are assumed to be equal to each other.[3]

The Project's Value with an Infinite Sequence of Hedged Cash Flows

Say that Weehawken makes an infinite sequence of forward contracts at time t—that is, if it contracts to sell £100 in every year from time $t+1$ to the infinite future at the assumed forward rates of $2.00/£. The fully hedged values of the project at time $t+1$ are given in Exhibit 17.4. If the exchange rate turns out to be $2.20/£, and the project returns £125, the dollar value of the fully hedged project at time $t+1$ is

$$
\overset{\text{Term C}}{[(\$2.00/£) \times £100]} + \overset{\text{Term D}}{[(\$2.20/£) \times £25]} + \overset{\text{Term E}}{\left[\frac{(\$2.00/£) \times £100}{1.1}\right]}
$$

$$
+ \overset{\text{Term G}}{\left[\frac{(\$2.00/£) \times £100}{1.1^2}\right]} + \overset{\text{Term H}}{\left[\frac{(\$2.00/£) \times £100}{1.1^3}\right]} + \ldots = \$2,255
$$

Terms C and D are, once again, the values of the 1-year forward contract and the extra pounds that must be sold in the spot market. Term E represents the dollar value of the 2-year forward contract that has 1 year remaining. Terms G and H represent the present value

Exhibit 17.4 The Value of Weehawken's Project with Infinitely Hedged Cash Flows

		Possible Future Exchange Rates	
		$2.20/£	**$1.80/£**
Possible Pound Returns	£125	$2,255	$2,245
	£75	$2,145	$2,155

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[3]Because £100 was sold forward at time t for each of 2 years, at $t+1$, the present value of the profit or loss on the forward contract that could be locked in by buying £100 in the 1-year forward market is

$$
£100 \times \left[\frac{F(t,2) - F(t+1,1)}{(1 + i(t+1,1))}\right] = £100 \times \left[\frac{(2.00/£) - (2.20/£)}{1.1}\right] = -\$18.18
$$

in dollars of previously made forward contracts to sell £100 that now have 2 and 3 years remaining to maturity, and so on, into the indefinite future.

Of course, an infinite number of forward-contract maturities are not available to the firm in the real world. Also, the bid–ask spreads in the forward market start to widen with maturities beyond a few years. Hence, Weehawken would not be able to sell pounds forward at $2/£ for all maturities because the transaction costs would cause the rates to be lower and lower for future maturities. Consequently, it is possible to mitigate the fluctuations in the value of the pound revenue stream due to foreign exchange rates, but it is not possible to eliminate them completely.

The Project's Value with an Equity Hedge

An alternative way to hedge this situation would be for Weehawken to do a sequence of 1-year forward contracts in which it sells £1,100 forward, which is the expected future value of the equity in 1 year. The possible returns on the project at time $t+1$ in this case are actually the same as those in Exhibit 17.4, but they are calculated differently. The dollar value of the project at time $t+1$ would be

$$\overset{\text{Term I}}{[(\$2.00/£) \times £1,100]} - \overset{\text{Term J}}{\{S(t+1, \$/£) \times [£1,100 - CF(t+1, £)]\}}$$

$$+ \overset{\text{Term K}}{[S(t+1, \$/£) \times £1,100]}$$

Term I is the dollar value of the forward sale of £1,100. Term J subtracts the realization of the pound cash flow at time $t+1$ from the £1,100 that was sold forward to determine a net amount of pounds that must be purchased in the spot market to deliver the pounds that were sold forward. Weehawken would have only the return on the project at time $t+1$ as a pound cash flow and would have to purchase the rest in the spot market. Term K is the dollar value of the £100 into perpetuity that Weehawken still expects to receive. By rearranging terms and canceling, we can rewrite the value of the pound perpetuity as

$$(\$2.00/£) \times £1,100 + S(t+1, \$/£) \times [CF(t+1, £) - £100]$$

which is the same value as the sequence of infinite forward contracts. For example, when the spot exchange rate at time $t+1$ is $2.20/£ and the cash flow is £125, the value is $2,255, as before. The problem with this approach to hedging is that Weehawken must sell in the 1-year forward market more than 10 times the amount of pounds that it expects to receive in the next period. Then, after 1 year, it must enter the spot market and purchase a large amount of pounds to deliver on the forward contract.

In order to see the problem with this strategy more clearly, remember that the additional value to the firm from this project is only $100, which is the original $2,000 of projected cash flows minus the $1,900 initial cost. To put the issue in better perspective, think of each pound as representing 1 million pounds, with the value of the project representing the firm's entire value. Then, Weehawken would have an initial equity value of $2 billion. Initial investors would have invested $1.9 billion, and the firm's positive NPV project would increase its value to $2 billion. It is questionable whether a bank would allow a firm with an equity value of $2 billion to make a 1-year forward sale of £1.1 billion or a 1-year purchase of $2.2 billion. It is in this sense that the firm would have difficulty fully hedging the cash flows.

Reality Is More Complicated

The equity cash flows we have just examined are quite simple, fluctuating between only two values, year in and year out, and the firm confidently forecasts that this pattern will persist forever. Neither the dollar discount rate nor the pound discount rate fluctuates in the example, and the exchange rate is a simple process with an expected value that depends on

the realization of the exchange rate.[4] In a more realistic equity project, the pattern of cash flows would involve forecasts of growth and the possibility of total loss. The real profitability of the foreign project also would probably be related to the real exchange rate. In the simple example, however, Weehawken's nominal pound cash flows were simply being converted into dollars by the nominal exchange rate.

As you can see, the world is much more complicated and more uncertain than the Weehawken example indicates. Nevertheless, Weehawken's situation provides an important intuition: Because much of the value of a firm's equity is due to its cash flows in the relatively far distant future, Weehawken cannot fully hedge even simple equity cash flows.

Hedging Can Create Bad Incentives

Of course, as investors in firms, we must be aware of how changes in hedging policies can be used to the advantage of one class of stakeholders and the disadvantage of others. Chapter 16 describes how equity stockholders prefer projects with high variances to projects with low variances, especially when the firm is near financial distress. One way that a firm can increase the variance of its cash flows is to stop a hedging program that is already in place. For example, if a firm has foreign currency revenues and is having difficulty meeting its fixed obligations, it can leave the foreign currency cash flows unhedged and hope for a strengthening of the foreign currency. In such a situation, any weakening of the foreign currency when the firm is unhedged simply creates additional losses, most of which are borne by the firm's bondholders.

Of course, even though a firm is actively engaged in a financial hedging program, the financial officers who are in charge of the hedging program must be supervised to prevent them from speculating with the firm's money. Such a temptation would surely grow as the firm gets closer to financial distress.[5] After all, what better way is there to come up with the principal on a bond issue than to try to make some money in the "casinos" of foreign exchange futures and options markets? The chief financial officer (CFO) of a firm facing financial distress might think exactly this way.

In light of the arguments mentioned, some managers say that the firm simply should not try to hedge. But there are other arguments that support hedging. It is to those that we now turn.

17.3 ARGUMENTS FOR HEDGING

This section examines how hedging can enhance the value of a firm by affecting the various terms in an ANPV analysis. We begin by demonstrating that hedging can increase the after-tax value of a firm's cash flows under certain conditions.

Hedging Can Reduce the Firm's Expected Taxes

Hedging can increase the value of a firm by reducing its expected future income taxes. One way that expected income taxes can be decreased is by making sure that the firm does not experience losses. When a firm is unprofitable, it owes no current tax, but it does

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[4]We specified only the first year of the time series process for the exchange rate with plus or minus $0.20 increments. Obviously, the increments to this process cannot be constant because the exchange rate cannot be negative, but the expected value can depend on the current realization.

[5]An interesting example of this phenomenon is provided by Ross et al. (2007, p. 458), who relate the following story. When Federal Express encountered severe financial difficulty a few years after its inception, Frederick Smith, the founder, is reputed to have taken $20,000 of corporate funds to gamble in Las Vegas. He apparently won enough money to save the firm from bankruptcy. Had he lost, the firm would have gone bankrupt, and the creditors of the firm would have received $20,000 less.

not get an immediate refund from the government. Instead, the firm generates a **tax-loss carry-forward** that allows it to offset the losses that were incurred against future income. Thus, the firm pays less tax in the future. But, a tax-loss carry-forward is an accounting convention that only allows a firm to offset $1 of future income against $1 of loss incurred today. Because the economic value of $1 of income in the future is worth less than $1 of income today, due to the time value of money, having $1 of future tax-loss carry-forward is not as valuable as avoiding $1 of tax today. Hence, there is a reason for avoiding losses today.

Tax-loss carry-forwards also usually have a statutory time limit. They cannot be extended beyond a certain future date. Any unused tax-loss carry-forwards simply expire if the firm is unable to generate sufficient taxable income by the expiration date. The fact that tax-loss carry-forwards can expire unused provides another reason for avoiding losses today. Consequently, if hedging can help a firm avoid losses, it is valuable. Avoiding financial losses also increases the probability that a firm's tax shields from depreciation and interest payments can be fully utilized in the future.

Finally, hedging reduces expected future taxes if the tax code is convex. A **convex tax code** imposes a larger tax rate on higher incomes and a smaller tax rate on lower incomes. Exhibit 17.5 provides a hypothetical convex tax code.

Although the corporate tax rates in many countries are a flat percentage of income, if the firm loses money, and those losses are not refunded immediately at the same rate as the rate for positive income, the tax function is effectively convex. Example 17.3, which appears a little later in the chapter, demonstrates this principal. Graham and Smith (1999) simulate the provisions of the U.S. tax code and find that, on average, it is convex. They find that a 5% reduction in volatility of taxable income implies a 5.4% reduction in expected tax liability.

In the presence of a convex tax code, a firm prefers to pay tax on its expected income with certainty rather than to determine its expected tax by taking the probability weighted average of the taxes on possible incomes in the uncertain future states of the world. Because hedging allows the firm to shift income across different states of the world, hedging reduces expected taxes and increases the firm's value. Some examples will help to clarify this discussion.

Exhibit 17.5   A Convex Income Tax
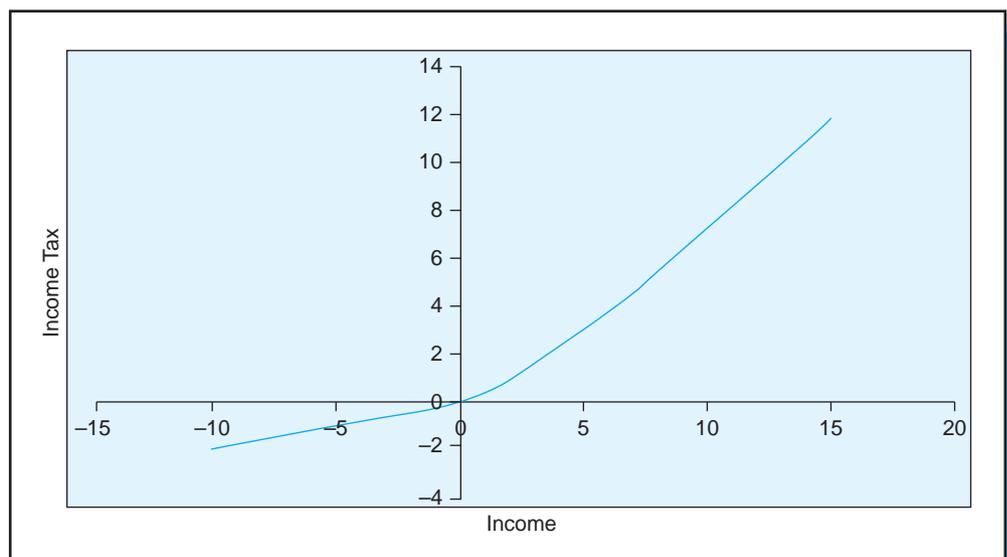
Example 17.2 Starpower's Swiss Project with Non-Convex Taxes

Assume that a U.S. firm, Starpower, has a project that provides revenue of CHF40,000,000 in 1 year. Starpower's project costs $19,000,000, and we assume this amount is paid in 1 year. Although the dollar cost of the project will be paid with certainty and the Swiss franc revenue from the project will be received with certainty, the dollar revenue from the project is uncertain because the future spot exchange rate is uncertain. Let's assume that there are only two possible future spot exchange rates. Either the spot rate in 1 year will be $0.55/CHF with 50% probability, or it will be $0.45/CHF, also with 50% probability. If Starpower is unhedged, it will experience a positive income of $3,000,000 with 50% probability because

$$[(\$0.55/\text{CHF}) \times \text{CHF}40,000,000] - \$19,000,000 = \$3,000,000$$

or Starpower will experience a loss of $1,000,000 because

$$[(\$0.45/\text{CHF}) \times \text{CHF}40,000,000] - \$19,000,000 = -\$1,000,00$$

The expected dollar value of Starpower's before-tax income on the unhedged project is therefore the probability weighted average of the two possibilities:

$$[0.5 \times \$3,000,000] + [0.5 \times (-\$1,000,000)] = \$1,000,000$$

Suppose that the tax rate is 35% and that the government also will immediately subsidize 35% of all losses. That is, the government refunds $35\% \times \$1,000,000 = \$350,000$ to the firm in the event of a loss. The expected value of Starpower's after-tax income on the unhedged project is the probability weighted average of the after-tax cash flows:

$$[0.5 \times \$3,000,000 \times (1 - 0.35)] + [0.5 \times (-\$1,000,000) \times (1 - 0.35)]$$
$$= \$650,000$$

Suppose that Starpower has the opportunity to hedge its CHF cash flow by selling CHF40,000,000 at the 1-year forward rate of $0.50/CHF. Note that this forward rate is also the expected future spot rate because

$$[0.5 \times (0.55/\text{CHF})] + [0.5 \times (0.45/\text{CHF})] = \$0.50/\text{CHF}$$

If Starpower fully hedges, it will receive

$$(\$0.50/\text{CHF}) \times \text{CHF}40,000,000 = \$20,000,000$$

of dollar revenue no matter what the future exchange rate turns out to be. Hence, Starpower will have a sure income of

$$\$20,000,000 - \$19,000,000 = \$1,000,000$$

Consequently, Starpower's after-tax income will be

$$\$1,000,000 \times (1 - 0.35) = \$650,000$$

Notice, in this example, that although hedging allows the firm to reduce the variance of its income while keeping its expected income the same, hedging provides no after-tax gain. Starpower's expected after-tax income is the same whether the firm hedges or not. This situation occurs because the tax treatment of losses is identical to the tax treatment of gains. The tax schedule is linear, not convex.

Example 17.3 Starpower's Swiss Project with Convex Taxes

Consider the same project as in Example 17.2, but now suppose that Starpower can claim only a 25% refund on its losses while the firm is taxed at a 35% rate on its positive income. With these tax rates, the expected value of the after-tax income on the unhedged project falls to

$$[0.5 \times \$3,000,000 \times (1 - 0.35)] + [0.5 \times (-\$1,000,000) \times (1 - 0.25)]$$
$$= \$600,000$$

The firm's expected tax bill is the difference between the expected before-tax income of $1,000,000 and the expected after-tax income of $600,000, or

$$\$1,000,000 - \$600,000 = \$400,000$$

Equivalently, the firm's expected tax bill is the probability weighted average of taxes that will be paid in the good state (35% of $3 million) minus subsidies that will be received in the bad state (25% of $1 million):

$$[\$0.5 \times \$1,050,000] - [0.5 \times \$250,000] = \$400,000$$

When Starpower has the ability to hedge, it takes no losses in this example, and its after-tax income is unchanged from the previous example. We calculated that Starpower's after-tax income was $650,000, which implies that the firm expects to pay taxes of only

$$\$1,000,000 - \$650,000 = \$350,000$$

if it hedges versus the $400,000 in taxes it expects to pay if it does not hedge. By reducing its expected income tax payment, Starpower increases its expected after-tax value by $50,000.

What happens to the expected tax saving if we increase the volatility of Starpower's income while leaving the expected value of its income the same? It will turn out that the expected tax savings from hedging increases. Next, we show how this is so.

Example 17.4 Starpower's Swiss Project with a Larger Variance

Let the possible equally probable values of the future exchange rate be $0.60/CHF and $0.40/CHF. The forward rate remains $0.50/CHF. The unhedged dollar income from Starpower's project will now be either

$$[(\$0.60/CHF) \times CHF40,000,000] - \$19,000,000 = \$5,000,000$$

or

$$[(\$0.40/CHF) \times CHF40,000,000] - \$19,000,000 = -\$3,000,000$$

The expected value of Starpower's before-tax income remains $1,000,000 because

$$[0.5 \times \$5,000,000] + [0.5 \times (-\$3,000,000)] = \$1,000,000$$

The expected value of the after-tax income on the project if Starpower does not hedge is now

$$[0.5 \times \$5,000,000 \times (1 - 0.35)] - [0.5 \times (\$3,000,000) \times (1 - 0.25)]$$
$$= \$500,000$$

Consequently, if Starpower does not hedge, it expects to pay tax of

$$\$1,000,000 - \$500,000 = \$500,000$$

On the other hand, if Starpower hedges as before, it sells CHF40,000,000 forward, has income of $1,000,000, and after-tax income of $650,000. The firm pays only $350,000 of tax instead of the $500,000 of expected tax if it does not hedge. Starpower saves $150,000 of expected tax payments when the possible returns on the project are $5,000,000 and –$3,000,000 versus the $50,000 of expected tax saving when the possible returns on the project were $3,000,000 and –$1,000,000. Hence, the more volatile Starpower's income, the greater is the expected tax saving from hedging.

The tax benefit of hedging also increases if the convexity of the tax rates is greater. In our two-state example, greater convexity amounts to a greater difference between the tax rate on positive income and the refund rate on losses.

Example 17.5 Starpower's Swiss Project with a More Convex Tax Schedule

Suppose in Example 17.3 that positive income is taxed at a rate of 45% instead of 35%, whereas losses are again refunded at the 25% rate. Then, if Starpower does not hedge, its expected after-tax income is

$$[0.5 \times (\$5,000,000) \times (1 - 0.45)] + [0.5 \times (-\$3,000,000) \times (1 - 0.25)]$$
$$= \$250,000$$

Hence, the firm now expects to pay tax of

$$\$1,000,000 - \$250,000 = \$750,000$$

If Starpower hedges by selling CHF40,000,000 forward at $0.50/$, it will again pay taxes on the $1,000,000 of sure income, giving it an after-tax income of

$$\$1,000,000 \times (1 - 0.45) = \$550,000$$

When Starpower hedges, it pays $450,000 of tax instead of the expected tax of $750,000 when it does not hedge. Starpower therefore saves $300,000 of expected tax payments.

General Principles

Examples 17.2 through 17.5 illustrate some general principles. First, risk management or hedging has definite tax benefits when the tax code is convex. Progressive tax rates on positive income are one source of convexity in tax codes. Most countries, though, do not have progressive corporate income taxes on positive income. The same percentage tax rate is applied to all positive income and to losses. But other factors in tax codes, such as tax-loss carry-forwards, alternative minimum taxes, and investment tax credits, do impart convexity

to tax schedules in their treatment of losses and their encouragement to undertake certain transactions.

The general principles revealed by the examples are that the tax benefits of hedging require the tax code to be convex and are larger the more convex, or progressive, is the tax code, and the more volatile is a firm's pretax income.

Hedging Can Lower the Costs of Financial Distress

Hedging can increase the value of a firm by reducing the expected costs of financial distress (see Smith and Stulz, 1985). Chapter 15 explains that the costs of financial distress are the losses of value that a firm experiences because it may experience bankruptcy in the future. These costs are distinct from the losses of value experienced by a firm that trigger an actual default or a declaration of bankruptcy. As explained in Chapter 15, the costs of financial distress include the direct costs of bankruptcy, such as the legal and administrative expenses. But they also include indirect costs, such as a firm's inability to make binding commitments to its customers, suppliers, workers, and managers and vice versa. In addition, the managers of a firm may be led to act selfishly in the interest of stockholders at the expense of bondholders. Hedging reduces the probability that a firm will encounter financial distress and thus mitigates these problems.

Graham and Rodgers (2002) find that by reducing costs of financial distress, hedging allows firms to take on more debt. In their sample of firms, the increase in value due to the additional interest tax shields averages 1.1% of firm value.

Hedging Can Improve the Firm's Future Investment Decisions

Chapter 16 describes how firms that are near financial distress can be led to reject a positive NPV project because too much of the return on the project accrues to the bondholders and not enough to the stockholders. If hedging avoids the fall in firm value that would place the firm in a state in which it would make such a poor investment decision, then hedging improves the firm's future investment decisions.

More generally, Bolton et al. (2011) develop a dynamic model that builds on the intuition of Froot et al. (1993) demonstrating that imperfections in capital markets provide a strong rationale for hedging. Whenever externally generated funds for investment projects are more costly to the firm than internally generated funds from retained earnings, hedging increases the firm's value by providing it with a reliable, less volatile stream of internally generated cash, which it can use to finance its research and development and capital expenditures. Hedging provides a source of cash flow that allows a firm to exercise its investment opportunities and its growth options at the point in time when it is optimal to invest.

The Basic Logic of the Argument

Suppose that a firm does not hedge. Then, variability in cash flow from assets in place will be reflected in variability in free cash flow to equity holders. Now, remember that free cash flow to equity cannot be negative. If free cash flow to equity were to begin to be negative, the firm would either have to raise cash externally, or it would have to cut back on the firm's investment policy. Because variability in investment or research and development is generally undesirable, the firm would normally use external capital markets to finance investment, when the firm has insufficient internally generated cash. However, in imperfect capital markets, the marginal cost of raising external funds may increase with the amount of funds raised. In that case, the firm will find it optimal to cut back on investments and research and development when internally generated cash flow is low. If the firm hedges, it can avoid the shortfall in internally generated cash and avoid the drop in investment.

Asymmetric Information Is the Problem

The managers of a firm usually know more about the firm's future prospects than investors do. This asymmetric information consequently makes it difficult and sometimes impossible for financial markets to price a firm's new offerings of debt or equity. This uncertainty leads investors to demand a premium for financing new projects, and the premium may increase with the amount of funds the company is trying to raise. As a result, the cost of raising externally generated funds is high, and firms prefer to finance their investment projects from internally generated funds.

A corporation in an industry that relies heavily on internally generated funds for its investment projects should definitely consider instituting a hedging program. This appears to be Merck's rationale for hedging, as we will see later in the chapter.

Hedging Can Change the Assessment of a Firm's Managers

Another argument for financial hedging that relies on asymmetric information between the managers of the firm and its stockholders has been offered by DeMarzo and Duffie (1995). Stockholders must gauge the quality of the managers based on their observations of the firm's profitability and earnings, as disclosed in its accounting data. From this perspective, hedging makes good sense at first glance. Hedging reduces the amount of "noise" in earnings data that is not due to actions of the managers. In other words, hedging increases the informational content of a firm's profits about a manager's ability. DeMarzo and Duffie demonstrate that in this situation, the accounting treatment of hedging and the optimal hedging policy are intimately linked. Because managers are better able to gauge the different financial risks the company faces, they have an incentive to hedge these risks to reduce the variability of the firm's earnings and, with that, the variability of their own income stream, which will be linked to the firm's earnings. A manager does not want to face an unexpected currency depreciation that adversely affects the firm's profits.

The disclosure of information, though, will make stockholders better able to gauge the true ability of a manager. Stockholders can then make the managers' compensation more sensitive to the firm's performance. To avoid this additional variability in their income, managers may choose not to hedge. If the additional informational content of hedged earnings is sufficiently high, the stockholders may optimally decide not to disclose the firm's hedging activities, to give managers an incentive to hedge.

POINT–COUNTERPOINT

Asymmetric Information and the Pecking Order

Ante, Freedy, and Suttle are visiting Berlin, strolling by the Brandenburg Gate, discussing the fall of the Berlin Wall and the collapse of communism in 1989. Freedy says, "Isn't capitalism great? Look at all the new buildings in what used to be East Germany." Ante replies, "The buildings are cool, and the architecture is fantastic, but capitalism would be a lot better if we could just stop managers from ripping off investors. I don't know why anybody buys equity." Freedy says, "What's the big deal, Ante? Equity markets are efficient. Any information that is out there pretty quickly finds its way into market prices." Ante, getting hot under the collar, blurts, "Well, if that's true, why do Bekaert and Hodrick argue that asymmetric information is a big deal in risk management? If managers know more than investors when it comes to risk management, they also know more than investors when it comes to issuing equity. The managers would issue equity when it is overvalued, and they would buy back equity when it is undervalued. Markets are stupid!"

At this point, Suttle sees that the brothers are about to really get into it, so he feels it is necessary to intervene. "Hey, you guys need to understand something," says Suttle. "Markets can't know everything. Indeed, there is good reason to think that managers know more than the stockholders about the prospects of the firm. Some pretty good economists have figured out the implications of these ideas for corporate finance."

"For example," says Suttle, "Ross (1977) developed one of the first models of corporate finance to rely on asymmetric information. In the Ross model, managers know the prospects of the firm better than the financial markets. Without a signal from the managers, investors view all firms as the same. To signal a firm's good prospects, the managers of the good firm must do something that is costly and cannot be mimicked by the managers of the firms with poorer prospects. Managers can signal the prospects of the firm to the capital markets by choosing an appropriate level of debt. Thus, Ross argues that the firms with good prospects signal this information by taking on more debt than firms with bad prospects. This action is an effective signal because bankruptcy is costly. A high-debt firm that has good prospects is less likely to incur bankruptcy costs than a similarly levered firm with poorer prospects."

Freedy and Ante smile at how loquacious Suttle can be. Ante pipes up, "That's fine for debt, but I was talking about equity." Suttle replies, "Well, Stewart Myers wrote two important papers extending this asymmetric information intuition to the decision to issue equity. His **'pecking order' theory of financing**[6] states that investments should be financed with the least information-sensitive source of funds. Myers argues that managers are better informed about the prospects of their firm than the capital markets, but the capital markets understand this. Managers consequently will not want to issue equity to finance a project when they think the firm is undervalued by capital markets. In fact, they will try to issue equity when it's overvalued. Because capital markets understand this logic, capital markets will view issuing equity as a very bad signal.

"The pecking order for financing investments is the result. Internally generated cash is used first because no explanation has to be given to the capital markets about why or how it is being used. Debt is the next source of finance because the cash flows paid to the debt holders are fixed and insensitive to future cash flows of the firm. Firms without enough internally generated funds but good future prospects should issue debt. Resorting to equity to finance investment projects is the least preferred method because it is such a bad signal. Consequently, only firms with insufficient internally generated funds and no ability to issue debt will rely on issuing equity."

Freedy and Ante grab Suttle and say, "Come on. We've had enough of this asymmetric information economics. Let's go get a good German bratwurst. We're hungry!"

17.4 THE HEDGING RATIONALE OF REAL FIRMS

Only a few firms have actually written down why they chose to institute a hedging program and to explain the logic of their analysis. This section first describes Merck's decision to use foreign currency options to hedge its foreign currency revenue.[7] We then discuss the findings of Brown (2001) who reports on the management of foreign exchange risk at HDG Inc., a pseudonym for a U.S.–based durable goods manufacturer.

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[6]See Myers (1984) and Myers and Majluf (1984).
[7]Merck's decision is described in detail in Lewent and Kearney (1990). At the time of the analysis, Ms. Lewent was Merck's vice president and treasurer, and in 2006, she was executive vice president and chief financial officer. The following section summarizes their argument.

Merck's Hedging Rationale

At the time that Merck decided to institute a hedging policy in 1988, it had sales of $6.6 billion in a pharmaceutical industry with total sales of roughly $103.7 billion. No one firm in the industry commanded more than a 5% share of total sales. Approximately 50% of Merck's revenue came from foreign sales of its drugs. Merck had approximately 70 subsidiaries around the world that imported semi-finished product and were responsible for finishing, marketing, and distributing final product in the countries in which they were incorporated. The competitive nature of the business dictated that final sale prices were usually denominated in local currencies. In addition, many of the local prices were regulated. Therefore, if a local currency weakened relative to the dollar, Merck had limited ability to increase the local price of its products.

The dividends repatriated from Merck's foreign subsidiaries formed a substantial fraction of its earnings and profits. It was from these internally generated funds that Merck usually financed its research and development and its capital expenditures.

Merck's decision to hedge came in the mid-1980s, following a rough patch when the dollar strengthened. The dollar appreciation really hurt Merck; the company developed a sales index that measured the strength of the dollar relative to a basket of currencies weighted by the revenue it produced in that currency. The index declined from a base level of 100 in 1978 to 60 in 1984. During that time, Merck experienced a cumulative loss of revenue of approximately $900 million. In response, Merck cut back on its research and development and investment projects.

However, after reviewing the performance of the firm during this period, Merck's managers decided that this was a flawed decision. One important aspect of the competitive nature of the industry is its emphasis on the development of new drugs. By decreasing its research and development, Merck risked becoming uncompetitive in the global marketplace.

Merck's Five-Step Procedure

Merck first considered using an **operating currency hedge**, that is, shifting the company's operations across countries to provide a better balance between the costs and revenues denominated in different currencies. Unfortunately, because Merck wanted to conduct most of its research and development in the United States as well as keep its corporate headquarters there, this option was not really feasible.

Merck then developed a five-step procedure to help decide whether to hedge with financial contracts and what types of financial hedges to choose. The five steps were as follows:

1. Develop forecasts of the distributions of future exchange rates to determine the probabilities of adverse movements in exchange rates.
2. Assess the impact of exchange rate changes on the firm's 5-year strategic plan.
3. Decide whether to hedge the firm's exchange rate exposure.
4. Select the appropriate hedging instruments.
5. Simulate alternative hedging programs to determine those most cost effective, given the risk tolerance of Merck's managers.

We next consider the factors that enter into each of these steps.

Step 1: Develop Forecasts of the Distributions of Future Exchange Rates to Determine the Probability of Adverse Movements Related to Them

Merck considered four main factors in determining the probability of future changes in exchange rates: economic fundamentals, government interference in the setting of exchange rates, past exchange rates, and professional forecasts. Lewent and Kearney (1990) note that the economic fundamentals include variables such as the trade balance deficit, international

capital flows, and government budget deficits, which are used to define an "equilibrium" exchange rate, but they are not specific about the equilibrium model. Merck's model also recognizes that central bankers often set explicit or implicit target zones for currency prices, which they stand ready to defend with intervention. In addition, Lewent and Kearney note that the Merck model is "mean reverting" in the sense that when there have been several large movements of the exchange rate in the same direction, the probability of future movements in that direction is reduced. The idea is that such a large movement in the nominal exchange rate would most surely be associated with a large movement in the real exchange rate. Such a large change in the real exchange rate would create forces in the trade balance that would limit the likelihood of an additional change in the same direction. The fourth factor affecting Merck's assessment of future exchange rates involved obtaining the opinions of various professional forecasting services. The staffs of the world's major investment and commercial banks routinely supply forecasts of future exchange rates.

Step 2: Assess the Impact of Exchange Rate Changes on the Firm's 5-Year Strategic Plan

Merck's second step involved assessing the impact of adverse changes in exchange rates on the firm's strategic plan. This involved examining cash flow and earnings projections for 5 years into the future under various exchange rate scenarios. These forecasts had to incorporate the effects that past profitability would have on the firm's future investment decisions.

Step 3: Decide Whether to Hedge the Firm's Exchange Rate Exposure

The issue here is whether the firm generates enough cash in all states of the world to pursue its research and development (R&D) and investments. Suppose that in some scenarios, exchange rate movements are forecast to adversely affect the firm's operating profits so that they fall below the level needed to finance its desired R&D and capital expenditures. How, then, will the firm finance its investment projects? The firm could turn to the external capital markets for financing, but the firm may find it difficult to raise the needed funds at reasonable required rates of return in those states of the world when it is unprofitable. Financial markets might ascribe the lack of profitability not to adverse fluctuations in exchange rates, but to poor managerial decisions. In the latter case, the firm's managers will find it difficult to pursue the projects they believe will keep the firm competitive. Hedging would prevent this from happening.

Examining the cash flow projections in the previous step gave Merck an idea about the likelihood that it would encounter adverse circumstances and how these situations would affect the firm's future investment decisions. Merck came to the conclusion that it should hedge against exchange rate volatility because a large proportion (typically 50% or more) of the company's earnings are generated overseas, and the volatility of the cash flows potentially adversely affects the firm's ability to execute its strategic plan—namely invest in R&D. In addition, the pharmaceutical industry has a very long planning horizon, one that reflects the complexity of the research involved as well as the lengthy process of product registration. It often takes more than 10 years between the discovery of a product and its market launch. Success in the industry generally requires a continuous, long-term commitment to a steadily increasing level of research funding. In this regard, it made sense for Merck to hedge.

Step 4: Select the Appropriate Hedging Instrument

The available financial hedging instruments are forward and futures contracts, foreign currency debts, currency swaps, and currency options. Forward foreign exchange contracts, futures contracts, foreign currency debt, and currency swaps "fix" the value of domestic currency that will be received in the future in return for a *given* amount of foreign currency

delivered. In other words, the amount of the domestic currency received cannot be increased or decreased. In contrast, put options provide insurance against a strengthening of the dollar against the foreign currency because they give the firm the right, but not the obligation, to sell foreign currency at a contractual price. (We discuss put options in Chapter 20.) The firm can either exercise this right or, if the exchange rate in the market is better, it can experience higher dollar payoffs by ignoring its option. Of course, the firm must pay the option premium for this privilege. Merck decided that it was unwilling to forgo the potential gains if the dollar weakened, so options were the company's preferred hedging vehicle.

Step 5: Simulate Alternative Hedging Programs to Determine Those Most Cost Effective, Given the Risk Tolerance of Merck's Managers

After deciding to hedge with options, the issue of how exactly to implement a 5-year hedging plan remained to be determined. Several questions had to be addressed, including the following: What term of the hedge is appropriate? Should it be multiyear or year-by-year? What strike prices (contractual exchange rates) should the put options have? What percentage of income should be covered? In other words, can the firm afford partially to "self-insure" its risks—that is, to leave part of the exposure unhedged, thereby reducing current expenditures to implement the hedge?

Merck used a privately developed Monte Carlo simulation model to analyze these questions. A Monte Carlo simulation model generates alternative cash flow scenarios and exchange rates. From the simulations, Merck determined that (1) it should hedge for several years, using long-term options, (2) it should use "out-of-the-money" options[8] as a means of reducing costs, but the options should not be "too far" out of the money, and (3) it should partially self-insure.

Merck's strategy worked well throughout the 1990s, as its profitability remained high and its stock price went from $12.40 in the beginning of 1990 to $90.50 a share in terms of current prices (that is, adjusted for stock splits) in December 2000. As the general market fell in the early 2000s, Merck's stock price fell also. Then, unfortunately, one of Merck's most important pain-relief drugs, Vioxx, had to be taken off the market in 2004, when it was reported that Vioxx caused heart attacks. Although Merck vowed to fight all the subsequent lawsuits, its stock price suffered when the firm lost in court. By June 2006, the stock price had fallen to $36.43 per share. By December 2007, the price was back to $60.67 per share, but during the financial crisis, Merck's share price fell to $23.45 in April 2009, and it was only $31.08 in March 2011.

Analysis of Hedging at HDG Inc.

Brown (2001) describes what he learned spending 3 months during 1998 observing the foreign exchange hedging operations in the Treasury Department of HDG Inc. (a pseudonym), which is a U.S. durable goods manufacturer. The company operates in more than 50 countries, and foreign sales account for just under half of its 1997 revenue of $10 billion.

Oversight, Control, and Operations

The overall structure of HDG's risk management operations is typical of how multinational corporations organize the operations. The Board of Directors has broad oversight and ultimate responsibility for HDG's foreign exchange policies. The Finance Committee, which reports to the Board of Directors, does quarterly and annual policy reviews and performance reviews, while the Foreign Exchange Management Committee (FXMC), which is chaired by the CFO and reports to the Finance Commitee, provides most of the oversight. The FXMC

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[8]Foreign currency options are covered in Chapter 20. An out-of-the-money option means that the strike price, which is the contractual exchange rate in the option, is fewer dollars per foreign currency than the current exchange rate.

meets monthly, and its primary function is to review foreign exchange exposures and formally approve the hedging strategy of the firm. Hedging strategy essentially means the types of derivative hedges and their amounts.

The Accounting and Control Group reports to the FXMC and has the responsibility to confirm foreign exchange transactions including all derivative trades. Importantly, none of the employees of this group are allowed to enter trades on the firm's behalf, which is a safeguard against rogue trading.

The Treasury Foreign Exchange Group also reports to the FXMC and has operational responsibility for foreign exchange risk management. These employees are responsible for executing the approved hedging strategy. This group consists of 11 full-time employees, and HDG management estimates that their foreign exchange risk management operations cost $1.5 million annually, which is roughly split between employee compensation and overhead for systems and space. Clearly, no one is getting rich working at HDG's foreign exchange operations.

HDG's Motivations for Risk Management

Brown first investigated whether HDG was speculating or hedging. In an interview with the Manager of Foreign Exchange, this explanation was offered to Brown (2001): "We do not take speculative positions, but the extent (to which) we are hedged depends on our views" (p. 413). While Brown found no evidence of active trading, HDG clearly thinks that it can sometimes beat the market.

We noted earlier that convexity of the tax code is a possible motivation for hedging. Brown (2001) found the historical data provided by HDG to indicate consistent profitability of sufficient magnitude that the tax code is essentially linear. Hence, this potential motivation did not apply. Analogously, HDG has relatively large cash holdings and low debt, implying that hedging to avoid costs of financial distress is also not a motivation.

The relatively large cash holdings also appeared to Brown to be sufficient to fund HDG's possible investment projects, making Merck's motivation for hedging less compelling as well. Although this situation may have been the case during the time period examined by Brown, the 1990s were considerably different than the 1980s, and it is not obvious that this motivation for hedging can be dismissed.

Brown (2001) notes that the stated goal of HDG's hedging program is "to increase the certainty of operating margins" (p. 417). He argues that, in practice, HDG management seeks to minimize the impact of changes in exchange rates on reported earnings to have earnings grow linearly. Such "earnings smoothing" is difficult to rationalize in a perfect information world, but with asymmetric information, it can be value enhancing. Brown also spoke to the firm's outside equity analysts, and although they were aware that HDG had a hedging program, they were generally not well informed about the specifics of the program. It was just expected that HDG would manage its exposure and avoid large losses.

A second positive motivation for hedging at HDG centers on competitiveness. It is thought that the hedging program allows the local managers to price competitively without sacrificing margins. Such a motivation may arise if HDG has little competitive ability to pass-through exchange rate changes to its customers and the nature of competition requires consistent competitive product pricing. The relatively short-term horizon (generally less than 1 year) of hedges suggests that this explanation is not very important.

The last motivation that Brown (2001) mentions is the facilitation of internal contracting. One of the primary responsibilities of HDG's forex group is to establish the "hedge rate." This exchange rate is a weighted average of various forward and option hedges and serves as a basis of internal planning and evaluation. The regional managers lobby the central treasury for a "better" hedge rate. Brown (2001) quotes the Manager of Foreign Exchange who stated, "I spend more time managing managers than I do managing currencies" (p. 425). Chapter 9 explored the issue of assessing the performance of foreign subsidiaries. This quote indicates that it is a difficult task to accomplish.

17.5 HEDGING TRENDS

Until recently, it was difficult to obtain data on a firm's use of derivatives. Accountants treated many hedges as off–balance sheet items, and because only balance sheets and income statements tend to get reported, gathering information about hedge activity and trends had to be done some other way. Some scholars used survey data, and others directly read the footnotes of annual reports and other regulatory filings. More recently, reporting standards have changed, and more information is directly obtainable in computer databases. We discuss each of these sources of information in turn.

Information from Surveys

Nance et al. (1993) were among the first to use surveys to attempt to determine the characteristics of firms that actively hedge versus those that do not. Their findings provide some support for the framework developed in this chapter.

In particular, Nance, Smith, and Smithson find that firms with large R&D expenditures are active hedgers. This may be because it is more difficult for high-R&D firms to raise external financing either because their principal assets are intangible and cannot be used as collateral or because there is more asymmetric information about the quality of their new projects. There is also some evidence that more highly levered firms (ones with larger debt–equity ratios) hedge more. Firms that are highly levered do not want to encounter financial distress, so they actively manage their risks to prevent it.

One interesting finding is that firms with higher dividend payouts are also more likely to hedge. Apparently, these firms have a substantial amount of free cash flow and are not constrained in a traditional sense. Yet managers may view a dividend policy as a commitment to the firm's stockholders that cannot be violated. Hedging allows the firm both to maintain its dividend policy and to fund its future investments.

The Wharton/CIBC Survey

A Wharton/CIBC Survey, conducted by Bodnar et al. (1998), obtained responses from 399 non-financial firms on their use of derivatives and their risk management practices. Bodnar et al. found that 83% of large firms and only 12% of small firms used derivatives to hedge. The fact that the larger firms in the study tended to hedge and the smaller ones tended not to hedge is consistent with the argument that the cost of hedging contains a fixed cost. Only when a firm is sufficiently large to overcome the fixed costs of hedging does the firm institute a hedging policy.

The foreign exchange exposures of the firms in the study varied widely. Some 40% of the firms with foreign exchange exposure reported that their foreign currency revenues constituted at least 20% or more of their total revenues. Almost 40% of firms reported that their foreign currency expenses were 20% or more of their total expenses. On the other hand, 60% of the firms reported that their total foreign currency revenues and expenses were effectively balanced. It is possible that these firms were naturally operationally hedged.

The Wharton/CIBC Survey does not explicitly explore the reasons for hedging, but it nonetheless offers some insights. The results indicate that firms employed only partial hedges and did not hedge very far into the future. In fact, Bodnar et al. (1998) found that firms with a significant amount of regularly recurring foreign exchange exposure tended to hedge only a small fraction of their exposure. Most of the firms used short-term hedges; the vast majority of the hedges matured in 90 days or less. One potential explanation for this phenomenon is that the transaction costs of longer-term hedges are higher.

Finally, the Wharton/CIBC Survey finds that some firms use derivatives more for speculative purposes than for hedging. In fact, Bodnar et al. (1998) find that a little under

one-third of firms using derivatives reported that their market view of exchange rates leads them to do so at least occasionally. Pramborg (2005) finds similar evidence for firms in Korea and Sweden.

Empirical Analysis of Why Firms Hedge

Géczy et al. (1997) examined the footnotes of firms' annual reports and their periodic reports to the Securities and Exchange Commission (SEC) for 372 non-financial Fortune 500 firms in 1990 to determine their use of currency derivatives. Approximately 41% of these firms used currency swaps, forwards, futures, options, or combinations of these derivative instruments. The econometric analysis indicates that firms with greater growth opportunities are more likely to use currency derivatives for hedging purposes. This finding is consistent with the notion that firms use derivatives to reduce the volatility of their cash flow to avoid being in a situation in which they might otherwise be precluded from investing in one of their growth opportunities.

Géczy et al. (1997) also found an important difference between firms that had foreign currency exposures because they had foreign operations and firms that had foreign operations and also had foreign currency debt. R&D expenses were high among the group of firms that did not have foreign currency debt, but R&D expenses were no longer a significant determinant of the use of currency derivatives for the firms with debt. This suggests that issuing debt in a foreign currency can serve the same function as hedging.

Bartram et al. (2009) examine data from 50 countries and 7,319 companies that cover about 80% of the global market capitalization of non-financial firms. They find that tax factors and high leverage are important reasons for the use of any financial derivative. Additionally, they find that larger and more profitable firms use financial derivatives, consistent with there being a fixed cost. Firms with high market values relative to book values also have a lower probability of using financial derivatives and foreign exchange derivatives in particular, which is inconsistent with the theoretical prediction that growth firms would want to assure themselves of adequate cash flow to fund investment projects. Finally, firms with larger foreign exchange exposures, larger foreign currency debts, and equity listings in a foreign country have a higher probability of using foreign exchange derivatives. This is consistent with the earlier finding in Allayannis and Ofek (2001) that the levels of firms' foreign sales and trade are the only determinants of the amount of currency hedging that firms do.

Financial Effects of Hedging

While the aforementioned studies explore why and how much firms hedge, Allayannis and Weston (2001) attempt to quantify whether firms that use foreign currency derivatives have an increased market value compared to firms that do not use derivatives. Allayannis and Weston find evidence consistent with the hypothesis that hedging increases a firm's value by a little under 5%. This conclusion must be considered with some caution because it assumes that some managers are smart and increase the value of their firms while others are not acting in the best interests of the firm's owners. The alternative hypothesis is that the econometrician has failed to hold constant all the aspects that make the firms different.

A related question is why foreign exchange exposure and equity value appear to be so poorly linked. A number of studies have regressed individual firm equity returns on returns on the overall market return and rates of change in exchange rates typically finding small or insignificant exchange rate exposures. Bartram et al. (2010) offer an explanation. First, they show that exchange rate pass-through and operational hedging are important, and they estimate that each of these channels reduces equity exposure by 10% to 15%. Use of foreign exchange derivatives and foreign currency debt reduces exposure by an additional 40%.

Consequently, the three channels tend to reduce exposure by 70%. The results of this study clearly show that firms understand that they have foreign exchange exposure, and they adopt policies to mitigate it.

Campello et al. (2010) examine whether financial hedging has real effects on firms. From hand-collected data on private loan arrangements and SEC filings on derivative usage, they infer that hedging is associated with lower interest rate spreads on loans and fewer loan covenants restricting capital expenditures. Both effects lead to additional investment by firms that hedge.

To Hedge or Not to Hedge: Understanding Your Competitors

Unfortunately, no clear-cut economic model exists to explain why different firms in different industries and countries hedge a particular amount or don't hedge at all. That said, when choosing a hedging policy for your firm, it pays to keep an eye on what your competition is doing. You should ask yourself if there is any gain to be had by deviating from the accepted industry practice. If you do not hedge and everyone else does, what will happen to you in the bad and good states of the world? Similarly, if everyone else is not hedging, is there a gain to be had by being the first in your industry to hedge? When would the gains arise? Would you have a competitive advantage in that state of the world if you were more profitable?

It is also important to understand the nature of your competition. Is your competition domestic or foreign? How will changes in real exchange rates affect your ability to compete? Hedging cannot change the fact that changes in real exchange rates will change the competitive position of firms in different countries, but hedging can mitigate some of the losses that a firm would otherwise suffer.

17.6 SUMMARY

This chapter examines risk management and hedging of foreign exchange risk. The main points in the chapter are as follows:

1. Hedging foreign exchange risk reduces the uncertainty of a firm's future cash flows. This makes sense for entrepreneurial firms run by risk-averse owner-managers who are unable to diversify their risks as regular investors can.
2. Modigliani and Miller argue that a corporation's financial policies, such as hedging foreign exchange risk, will not change the value of a firm unless they affect the firm's taxes, affect its investment decisions, or introduce costs savings relative to an individual's transaction costs. Thus, for large, publicly held corporations, hedging is valuable if it increases the discounted present value of expected after-tax cash flows, increases the present value of financial tax shields, reduces the present value of any costs of financial distress, or improves the present value of the firm's future growth options.
3. Hedging is costly because the firm must allocate time and effort to making the hedging decision and because transaction costs in the forward market exceed transaction costs in the spot market. The forward discount on a foreign currency, if the firm is selling foreign currency forward, and the option premium on a foreign currency option are not legitimate costs of hedging.
4. Hedging the foreign exchange risk of an equity position is difficult because much of equity value depends on the indefinite future. Also, equity values are affected by real foreign exchange risk, but most hedges are nominal.
5. Hedging foreign exchange risk reduces a firm's expected future taxes if the corporate tax code is convex. A convex tax code imposes larger tax rates on higher incomes and smaller tax rates on lower incomes. Although the corporate tax rates in most countries are flat, if the government doesn't immediately refund the losses a firm experiences at the same rate as it taxes its income, the tax code is effectively convex.
6. The tax benefits of hedging are larger the more convex or progressive is the tax code and the more volatile is a firm's pretax income.

7. Hedging is valuable because it can reduce the future taxes that a firm expects to pay, lower the costs of financial distress, and improve the investment decisions that the firm will face in the future.

8. Under asymmetric information, hedging affects the ability of stockholders to assess the quality of management. Managers may hedge more or less depending on whether profits and losses from financial hedges are pooled with the firm's earnings and whether their hedging activities are discerned.

9. Surveys and empirical research generally support the idea that managers hedge foreign currency risks to ensure that their firms will have a sufficient amount of cash flow to fund important projects.

QUESTIONS

1. Why would an entrepreneur find it desirable to hedge his or her foreign exchange risk?

2. Explain Modigliani and Miller's argument that hedging is irrelevant. What are the most likely violations of Modigliani and Miller's assumptions in actual markets?

3. Suppose that after joining the treasury department of a large corporation, you find out that it avoids hedging because the cost of hedging comes out of the treasury department's budget. What argument could you make to the CFO to get the firm interested in letting you be the firm's hedging guru?

4. Your CFO thinks that the value of your firm fluctuates enormously with the yen–dollar exchange rate, but he does not want to hedge because he thinks it is an impossible risk to hedge. Can you convince him otherwise?

5. What does it mean for a tax code to be convex? If a country's corporate tax rate is flat, does it make sense for a firm to hedge?

6. If the tax code is convex and the forward rate equals the expected future spot rate, why would a firm prefer to pay taxes on the hedged value of a foreign currency cash flow rather than wait to pay the taxes on the realized foreign currency cash flow?

7. Why is the gain in a firm's value greater when more of its future foreign currency income is in the low tax region of the tax code?

8. Why would the managers of a firm take a foreign project with a lower domestic currency NPV and a higher return variance rather than a foreign project with a higher domestic currency NPV but a lower return variance?

9. Why would a firm ever forgo a positive NPV project? How can hedging help prevent this situation from arising?

10. Suppose the cash flows from financial hedging are pooled with the cash flows from a firm's operations and that the stockholders cannot ascertain the ultimate sources of profits and losses. Would the managers of the firm want to hedge or to speculate in the forward foreign exchange market?

11. Why is internally generated cash flow of such importance to Merck? Can't Merck use the financial markets as a source of funds?

12. True or false: The cost or benefit of hedging foreign exchange risk when a firm is selling the foreign currency forward is accurately measured by the forward discount or premium on the foreign currency.

PROBLEMS

1. Chapeau Rouge has a Swiss project that will return either CHF300 million or CHF250 million per year of free cash flow indefinitely. Each of the possible CHF cash flows is equally likely. Chapeau Rouge's CHF discount rate for these cash flows is 13% per annum, the cost of the project is €1,100 million, and the current exchange rate is CHF1.67/EUR. Should Chapeau Rouge accept the project? Suppose that Chapeau Rouge has a €400 million line of credit with its bank. Will Chapeau Rouge have trouble hedging the CHF cash flows?

2. Fleur de France has a project that will provide £20 million in revenue in 1 year. The project has a euro cost of €30 million that will be paid in 1 year. The cost of the project is certain, but the future spot exchange rate is not. Assume that there are only two possible future spot exchange rates. Either the spot rate in 1 year will be €1.54/£ with 55% probability, or it will be €1.48/£ with 45% probability. Assume that the French tax rate on positive income is 45%, that a firm's losses are immediately refunded at a rate of 35%, and that

the forward rate of euros per pound equals the expected future spot rate.

  a. If Fleur de France chooses not to hedge its foreign exchange risk, what is the expected value of its after-tax income on the unhedged project?

  b. If Fleur de France chooses to hedge its foreign exchange risk, what is the expected value of its after-tax income on the hedged project?

  c. How much does Fleur de France gain by hedging?

3. How would your answer to problem 2 change if instead of allowing refunds at 35%, the refund rate were only 25%?

4. How would your answer to problem 2 change if the possible exchange rates in the future were €1.56/£ and 1.46/£?

5. Assume that U.S. Machine Tool has $50 million of debt outstanding that will mature next year. It currently has cash flows that fluctuate with the dollar–pound exchange rate. Over the next year, the possible exchange rates are $1.50/£ and $1.90/£, and each exchange rate is equally likely. The company thinks that it will generate $30 million of cash flow from its U.S. operations, and its expected pound cash flow is £12 million.

  a. If U.S. Machine Tool does not hedge its foreign exchange risk, what will be the current market value of its debt and equity, assuming, for simplicity, that the appropriate discount rates are 0?

  b. Suppose that U.S. Machine Tool has access to forward contracts at a price of $1.70/£. What is the value of the firm's debt and equity if it hedges its foreign exchange risk? Would the stockholders want the management to hedge?

  c. Suppose U.S. Machine Tool could invest $1 million today in a project that returns £1million next period. Is this a good project for the firm?

  d. Suppose that U.S. Machine Tool is unhedged, that its managers are trying to maximize the value of the firm's equity, and that the $1 million must be raised from current stockholders. Will the managers accept the project?

  e. If U.S. Machine Tool hedges its foreign exchange risk, would the firm accept the project?

6. Example 17.5 demonstrates that hedging is profitable for the Starpower Corporation. Demonstrate that the benefit to hedging is less if Starpower is more profitable. Do this by redoing Example 17.5 with possible exchange rates of $0.65/CHF and $0.45/CHF.

7. Web Question: Go to the Web site of Oanda fx-Consulting at http://fxconsulting.oanda.com and examine their Forex Hedging Policy Statements document. Do you agree or disagree with their approach? Can you make suggestions for improving their approach?

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