Managing Corporate FX Risk: A Value-Maximizing Approach

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Minimizing the probability of business disruption is presented as an objective for FX hedging programs. Within this context firms hedge when the benefits, defined as the reduction in the expected costs of business disruption, exceed the expected costs. This policy is value-maximizing for the firm. Minimization of the variance of hedged operating cash flows, the usual approach, is an insufficient condition for minimizing the probability of business disruption within a predetermined period of time. In addition to the variance of hedged cash flows, two additional variables are important: 1) the ratio of operating cash inflows to cash outflows that represent the business disruption boundary—a coverage ratio, and 2) the reduction in the drift in operating cash flows caused by FX hedging costs. These factors are found to be important in the empirical literature that examines motivations for hedging.

■The main contribution of this paper is the introduction of a value-maximizing approach to hedging, namely maximization of the value of the firm by trading off reductions in the expected cost of business disruption against the expected cost of the hedge. Stultz (1996) proposed a related objective function, "the elimination of costly lower-tail outcomes." Our approach first finds the hedge ratio that minimizes the probability of business disruption within a predetermined interval of time, then evaluates a benefit-cost ratio given the hedge. The benefit is defined as the expected reduction in business disruption cost provided by the hedge, and the cost is the direct cost of the hedging program.

Other recent papers on hedging use different approaches, but obtain similar results. Mello and Parsons (1999) develop a value-maximizing hedging policy wherein business disruption costs are proportional to the value of the firm and hedging changes the probability of exhausting the firm's cash balances, thereby changing the firm's value. Thus, hedging creates value by relaxing a constraint. Froot, Sharfstein, and Stein (1993) motivate rational hedging by assuming that external financing is more expensive than internal financing due to additional (deadweight) costs that are reduced by (costless) hedging.[1]

Our paper also places hedging within a value-maximizing context and draws out the salient empirical implications. We show that variance reduction per se is neither a necessary nor a sufficient condition for reducing the risk of business disruption. Other factors, including the change in the drift in cash flows induced by the FX position (e.g., transaction costs) and a cash-flow-coverage ratio, must also be considered. For example, if the FX-induced change in drift is negative and the variance reduction from the hedge is low, then the FX hedge can easily increase the probability of business disruption, and therefore its expected cost.

I. The Costs of Business Disruption and Hedging

Support for the point of view that business disruption costs are large is growing. Warner (1977)

The authors wish to thank the UCLA Conference on Risk Management and the Centre for Economic Policy Research for the opportunity to present our paper, and Peter Carr, Hayne Leland, Bill Margrabe, Tim Opler, David Shimko, Antonio Mello, and Todd Milbourn for their comments. Special thanks to Yash Joshi, who contributed the calculations for Exhibit 1 as well as useful comments.

[1]See Stulz (1984) and Smith and Stulz (1985) for a discussion of hedging motives.

analyzed the direct costs (e.g., lawyer's and accountant's fees, other professional fees, and lost managerial time) of 11 railroad bankruptcies between 1933 and 1955 and found that they averaged 1% of the market value of the firm seven years prior to bankruptcy and 5.3% of the value immediately prior to bankruptcy. Altman (1984) studied 12 retailers and seven industrials that went bankrupt between 1970 and 1978 and found that indirect bankruptcy costs were 8.1% of the value of the firm three years prior to bankruptcy and 10.5% the year of the bankruptcy. Altman also studied seven firms that went bankrupt during the 1980-1982 interval, finding that average indirect bankruptcy costs were 17.5% of the value of the firm one year prior to bankruptcy. Froot, Sharfstein, and Stein (1993) argue that positive-NPV opportunities (e.g., R&D projects) may be lost when business disruption occurs because cash flows are unexpectedly low. Other examples of indirect costs are that suppliers may be slow to deliver when dealing with a customer firm that is in distress, customers may shy away from a firm that may not survive to be in business when its products need servicing, and workers may abandon an employer that is distressed. Furthermore, many business activities need to be continuous to avoid shut down and restart costs. Opler and Titman (1994) found that more highly leveraged firms tend to lose market share and experience lower operating profits than their competitors during an industry downturn—evidence of significant business distress costs.

Although business disruption costs are large, the probability of incurring them is small. On the other hand, the costs of hedging are small but the probability of incurring them is certain if one hedges. The direct costs of hedging, exclusive of management time, are 50 to 100 basis points per year for programs that use forward contracts.

The remainder of this paper turns to a discussion of how to evaluate hedging programs, while maintaining the assumption that hedging policy is determined by the trade-off between the expected costs of business disruption and the expected cost of the hedge. Potential tax motives, increased debt capacity, and the creation of new business opportunities are not considered in our model.

II. The Expected Time to Business Disruption

Many articles on hedging focus on variance reduction, e.g., Howard and DíAntonio (1984), Kerkvliet and Moffet (1991), and Lindahl (1989). However, in this section, we suggest that the optimal hedge ratio is determined by minimizing the probability of business disruption in a predetermined period of time, e.g., one year. This is isomorphic to maximizing the time to ruin and different from the textbook suggestion of variance reduction. In fact, variance reduction is neither a necessary nor a sufficient condition for reducing the probability of business disruption.

What matters about the pattern of cash flows in particular is the probability that cash flow will decline to a point at which business disruption costs are incurred. Mathematicians call this the "expected time to ruin." For a hedging program to be beneficial, it must lengthen the time to ruin.

Sometimes a hedge is totally unnecessary. If cash flows are well above and trending upward faster than fixed cash charges and if the variability of operating cash flows is low, then the expected time to ruin may already be virtually infinite. This is why wealthy individuals do not buy automobile collision insurance and why many large companies self-insure against minor unexpected losses. Exxon, for example, can self-insure against refinery explosions because the company as a whole experiences little or no business disruption. Smaller or less profitable companies might, however, need to hedge against the same risk.

Figure 1 illustrates the problem that we are tackling. The hedged operating cash flows of the firm, P_t, are assumed to move randomly through time according to a Gauss-Wiener process.[2] Thus μ is the drift per unit time of the hedged cash flows, and σ is the instantaneous standard deviation.

$$\frac{dP_t}{P} = \mu dt + \sigma dz_t \tag{1}$$

$$P_t = P_o e^{(\mu - \sigma^2/2)t + \sigma z t} \tag{2}$$

The firm finds its business disrupted if its hedged cash flows touch a lower bound. This limit may be determined by the level of cash commitments, e.g., interest on debt, or simply a level of discomfort regarding the disruption of research and development expenses or the inability to take on positive-NPV projects. For simplicity, we assume that this boundary is not random and that it grows through time at rate r.

$$h_t = h_o e^{rt} \tag{3}$$

Business disruption occurs when $P_t = h_t$. This is called a "touching condition," and it may be written as

$$P_t = h_t \text{ iff} \left(\mu - \frac{\sigma^2}{2} - r\right)t + \sigma z_t = \ln \frac{h_0}{P_o} \tag{4}$$

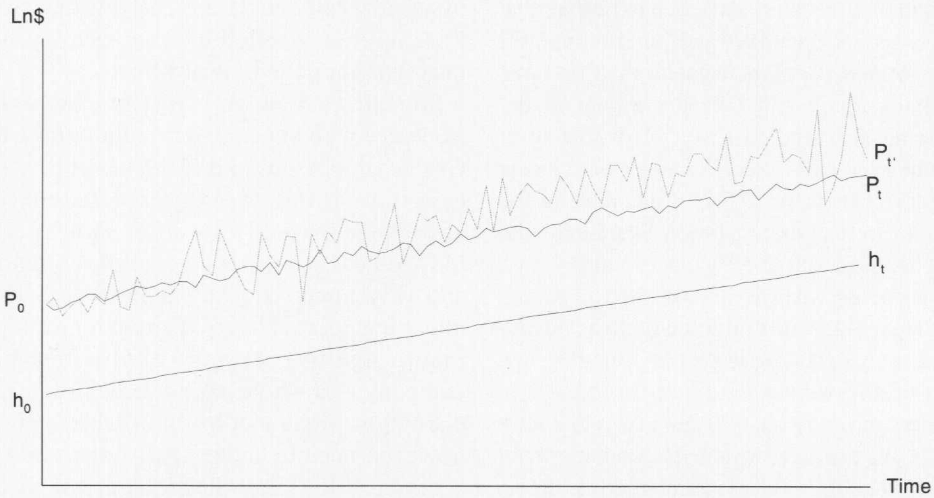
By integration, the expected time to business disruption (ruin) is

$$E(T) = \frac{b}{a} \tag{5}$$

[2]The assumption of this particular stochastic process makes the problem tractable and does not alter the insights.

Figure 1. Cash Flows and a Boundary over Time

The operating cash flow of a company is assumed to follow a Gauss-Wiener process, as illustrated by line $P_oP_{t'}$. The hedged cash flow also follows a Gauss-Wiener process, as represented by line P_oP_t, but with lower drift (due to the costs of hedging) and lower volatility. It the line representing hedged cash flows touches the boundary condition, line h_oh_t, the firm will suffer a business disruption cost.



where

$$a = \frac{\mu}{\sigma} - \frac{\sigma}{2} - \frac{r}{\sigma} \tag{6}$$

$$b = \frac{1}{\sigma}\ln\left[\frac{h_0}{P_0}\right] \tag{7}$$

This result may be simplified to

$$E(T) = -\frac{\ln(P_0/h_0)}{\mu - r - \frac{\sigma^2}{2}} \tag{8}$$

Note that in order to have a positive finite expected time to ruin, $\mu - r$, must be less than $\sigma^2/2$. When this condition is violated (e.g., when μ is much greater than r) the expected time to ruin is infinite. The denominator, $\mu - r - \sigma^2/2$, may be interpreted as the drift in $\ln(P_t/h_t)$. Note also that the expected time to ruin lengthens as the variance of hedged cashflows decreases. This is consistent with the usual hedging recommendation–reduce the volatility of operating cash flows with the hedge. However, other factors are important as well. One could interpret the ratio P_t/h_t as a "coverage ratio," given the FX hedge, because it is the ratio of cash flows from operations and the hedge, divided by the cash commitments of the company that make up its initial boundary. The expected time to ruin lengthens as P_o lies further above h_o. It also lengthens as the drift in hedged cash flows, μ, increases relative to the drift in the boundary condition, r. These results are intuitive and clearly indicate that variance reduction is not the only consideration for hedging. In fact, even if the hedge reduces σ, it may decrease μ enough to decrease the expected time to ruin. Therefore, variance reduction is not sufficient to increase E(T). It is not necessary either if the hedge increases μ.

The drift in the hedged cash flows, μ, can be written as the drift in the firm's unhedged cash flows, μ_c, minus (or plus) the dollars of FX sold (or bought) per dollar of unhedged cash flows, w_x, multiplied by the ex ante drift in the value of the forward contracts, μ_x:

$$\mu = \mu_c - w_x\mu_x \tag{9}$$

Recall that μ_c is the nominal drift in unhedged cashflows expressed in the local currency, e.g., dollars. Therefore, it includes the ex ante drift in the foreign currency relative to the domestic currency. The drift term, μ_x, has two components. The first is the transaction costs per dollar of unhedged cash flows per unit time. These costs include the bid-ask spread, transaction fees, and price pressure effects of large trading positions (if any). The second component is the ex ante premium (or discount) of the foreign currency relative to the domestic currency. Furthermore, the variance of the hedged cash flows σ^2 depends on the variance of the unhedged cash flows, , the correlation between the unhedged cash flows and the FX contracts, ρ_{cx}, and the variance of the FX position, σ_x^2:

$$\sigma^2 = \sigma_c^2 - 2w_x\rho_{cx}\sigma_c\sigma_x + w_x^2\sigma_x^2 \tag{10}$$

Given these definitions, we can maximize the expected time to ruin, Equation (8), with respect to the choice variable, w_x. Note that the numerator of Equation (8) is a negative constant ($-\ln(P_0/h_0)$) because the initial boundary, h_o, is less than initial cash flow, P_o. Therefore, the denominator of the expected time to ruin must be negative, and maximizing it (i.e., bringing it close to zero) will maximize the expected time to ruin. The first derivative of the denominator of Equation (8) with respect to w_x is set equal to zero:

$$-2\mu_x + 2\rho_{cx}\sigma_c\sigma_x - 2w_x\sigma_x^2 = 0$$

Therefore, the optimal hedge ratio, w_x, interpreted as the dollars of FX sold (bought) per dollar of unhedged cash flow, is

$$w_x = \frac{\rho_{cx}\sigma_c\sigma_x - \mu_x}{\sigma_x^2} \tag{11}$$

If we define β_x as the slope of a linear regression between the FX contract returns and the unhedged cash flows, we can write the hedge ratio as

$$w_x = \beta_x - \frac{\mu_x}{\sigma_x^2} \tag{12}$$

Thus, the hedge ratio that maximizes the expected time to ruin is the variance-minimizing hedge ratio, β_x, minus the rate of drift per unit of variance in return on the FX contract. The intuition is that the drift in the FX position is a cost (or benefit) that decreases (increases) the hedge ratio. If the drift term, μ_x, is zero, then the result reduces to the conventional variance-minimizing hedge ratio, β_x.

The expected time to ruin is a sufficient statistic to describe the probability of business disruption. However, even if the expected time to ruin is infinite, it does not mean that the probability of business disruption is zero. Practitioners may wish to calculate a statistic, such as the probability of ruin within a specified time interval, in order to have a better intuitive feel for the numbers. For example, two companies, both with an infinite expected time to ruin, may have very different probabilities of ruin within the first year.

The probability of ruin within time T may be written as:[3]

$$\text{Prob}[\min_{0<t<T}\{P_t/h_t\} \le 1] = N(d_1) + \exp(d_2)N(d_3) \tag{13}$$

If we define

$$A = \frac{2(\mu - r) - \sigma^2}{2} \tag{14}$$

then the variables d_1, d_2, and d_3, are:

$$d_1 = \frac{\ln(h_0/P_0) - AT}{\sigma T^{1/2}} \tag{15}$$

$$d_2 = \frac{2\ln(h_0/P_0)A}{\sigma^2} \tag{16}$$

$$d_3 = \frac{\ln(h_0/P_0) + AT}{\sigma T^{1/2}} \tag{17}$$

and $N(d_1)$ and $N(d_3)$ are cumulative unit normal variables. To show how this formula reduces, take the extreme example that $h_o = P_o$. In this case $d_1 = -d_3$, and $d_2 = 0$. Therefore Prob = $N(-d_3) + N(d_3)$ and Prob = 1.0.

Given a stochastic boundary condition

$$\frac{dh_t}{h} = \mu_h dt + \sigma_h dz_t \tag{18}$$

with covariance σ_{hP} with the operating cash flows, the parameter A in Equation (13) changes to

$$A = \frac{2(\mu - \mu_h) - V^2}{2} \tag{19}$$

where μ_h is the drift in h_t (replacing r) and V^2 is the variance of the ratio of P_t/h_t, defined as

$$V^2 = \sigma^2 + \sigma_h^2 - 2\rho_{hp}\sigma\sigma_h \tag{20}$$

The major implication is that high positive correlation between the hedged cash flows and the boundary condition decreases the probability of ruin within time T. For example, a US corporation that is exposed to French francs can reduce that exposure either by shorting forward contracts in francs (hedging) or by borrowing in francs (affecting the correlatedness of the boundary condition).

Our model does not provide for the effect of buffer stocks of cash and marketable securities, except perhaps insofar as the initial boundary level, h_o, can be defined as net of buffer stocks.[4] Also, our analysis is "static" in nature because it establishes a hedge ratio given the current parameters of the problem, e.g., the expected drift in cash flows and in the FX rate. These can change over time (obviously), thereby requiring dynamic adjustment of the hedge.

III. A Numerical Example

We now apply these concepts to an example. The relative magnitudes of the parameters are realistic enough to provide useful insights. We assume that the firm is profitable with \$50 million of cash flow in the current quarter (P_o), a positive drift rate of 10% per quarter (μ_c), and a volatility of cash flows of 30% per

[3] See Ingersoll (1987).

[4] For a discussion of this problem see Mello and Parsons (1999).

quarter (σ_c). Also, business disruption occurs if cash flows drop to \$20 million in the current quarter (h_0).

The firm decides to hedge by taking a short position in yen futures because the firm is essentially long yen. (Its revenues are in yen, expenses in dollars.) Initially, we calculate the drift in the hedge position, μ_x, as only the transaction costs incurred for the hedge position. We assume that the bid-ask spread on 12-month yen forwards is a fair indication of transaction costs. Assuming one trade per quarter, the transaction cost, μ_x, is then 0.14%, the average bid-ask spread for 12-month yen forwards over the period from 1991 to 1995. The standard deviation of the hedge position cash flows (σ_x) is assumed to be the same as the standard deviation on 12-month yen forwards during 1991 to 1995, or 5.3% per quarter.

Finally, the correlation between the firm's cash flows and yen forwards, ρ_{cx}, is 0.45, and the drift rate in the boundary condition, r, is assumed to be 1.5% per quarter. Table 1 summarizes the assumptions and the outputs from the model. In particular, w_x, the optimal hedge ratio is 2.0, indicating an optimal hedge position of \$100 million of "sold 12-month yen forwards." Note that the traditional variance-reduction model would result in an optimal hedge ratio of 2.50, suggesting an optimal hedge position of \$125 million of "sold 12-month yen forwards." Therefore, transaction costs as small as 0.14% per quarter can substantially reduce the size of the optimal hedge position. The higher the transaction costs, the smaller the optimal hedge position.

The second interesting set of results relates to the time to ruin. The expected time to ruin is infinity with and without the hedge. But the probability of distress in one year (T=4 quarters) reduces to 0.05 with the optimal hedge versus 0.08 without the hedge. And the probability of distress in five years (T=20 quarters) reduces to 0.22 with the optimal hedge versus 0.31 without the hedge. Note that the probability of distress within one year declines by 37.5% (i.e., from 0.08 to 0.05). Thus, the elimination of lower-tail outcomes can be more dramatic than apparent variance reduction.[5]

Finally, a small change in our example leads to other interesting results. Assume that h_0, the cash flow needed to avoid financial distress, is \$45 million, not the \$20 million assumed in our base case. All else stays the same. Note that this situation might represent firms in the basic metals industry, which need most of their current cash flow to avoid distress. In this modified situation, the optimal hedge ratio remains the same as the base case, 2.0, suggesting the same \$100 million sold yen forwards. However, the probability of distress in one year now is much higher—0.78 with the hedge versus 0.82 without the hedge; and the probability of distress in five years increases only marginally to 0.85 with the hedge versus 0.89 without the hedge, mainly because the +10% positive drift in operating cash flows provides an increasing margin of safety over time.

IV. A Benefit-Cost Ratio

So far, we have not discussed the effect of the costs of business disruption on the hedging decision. If these costs are trivial, then there is no economic motive for avoiding them. However, some authors, e.g., Altman (1984), have suggested they may be as high as 15% of the enterprise value of the firm. Undoubtedly, disruption costs vary significantly from industry to industry and firm to firm.

We define the dollar business disruption costs as k(t,V(t)). This expression allows disruption costs to have a fixed cost component that may grow through time and a variable cost component that changes with the market value of the firm. Given an expression of business disruption costs, then we can define a benefit-cost ratio, E(B), which will result in hedging activity at the optimal hedge ratio, w_x, if the benefit-cost ratio is greater than one. Otherwise, the optimal decision is not to hedge. Let $\phi(t)$ be the probability of ruin at time t:[6]

$$\phi(t) = \frac{1}{\sigma} \ln \frac{P_0}{h_0} t^{-3/2}\, n\left[\frac{\ln(P_0/h_0) + At}{\sigma\sqrt{t}}\right] \quad (21)$$

Note that n is the normal density function, not the cumulative density. Next, the benefit-cost ratio may be written as:

$$E(B) = \frac{\int_0^{E(T_u)} \phi(t_u)K(t, V(t))e^{-rt}\,dt - \int_0^{E(T_h)} \phi(t_h)K(t, V(t))e^{-rt}\,dt}{\int_0^{E(T_h)} \mu_x (w_x P_t)e^{-rt}\,dt} > 1 \quad (22)$$

where $\phi(t_u)$ and $\phi(t_h)$ refer to the unhedged and hedged densities, respectively. In this way the benefit of hedging, namely the expected savings of business disruption costs, is made explicit. The expected cost of hedging, found in the denominator of the benefit-cost ratio, is the expected cumulative hedging cost from the inception of the hedge up to the expected time to ruin, given that the hedge is in place. The result allows value-maximizing behavior for the firm. The firm first estimates the optimal hedge ratio (Equation 12), then computes the benefit-cost ratio (Equation 22) to decide whether or not to hedge.

V. Empirical Implications

Unfortunately, the empirical company-level data on

[5]At the minimum-variance hedge ratio, β_x, the variance in this case was only 10% lower than the variance with no hedge at all.

[6]See Ingersoll (1987).

Table 1. ABC Company's Probability of Distress

This numerical example illustrates the calculation of an optimal hedge ratio and the probability of business distress in a predetermined interval (one year or five years).

Operating cash flow parameters

- P_o = \$50 million in current quarter
- h_o = \$20 million in current quarter
- μ_c = 10.0% drift per quarter
- σ_c = 30.0% per quarter

Hedge position parameters

- μ_x = 0.14% drift per quarter
- σ_x = 5.30% per quarter

Other parameters

- ρ_{cx} = 0.45
- r = 1.5% per quarter

Results

- $w_x = 2.5 - 0.5 = 2.0$
- $E(T_h) = -20.0$, i.e., infinity
- $E(T_u) = -22.9$, i.e., infinity
- Probability of distress in 1 year (T=4 quarters):
  - with optimal hedge = 0.05
  - without hedge = 0.08
- Probability of distress in 5 years (T=20 quarters):
  - with optimal hedge = 0.22
  - without hedge = 0.31

hedging is not good. There is nothing on the size of the hedge for US companies. Therefore, most empirical attempts have been relegated to explanations of whether a company hedges or not. The benefit-cost ratio of Equation (22) predicts that a company is less likely to hedge if the ex ante (negative) drift term, μ_x, is large (either because transaction costs are high or because there is an ex ante premium in the foreign relative to the domestic currency), if the cost of business disruption is low, if the optimal hedge does not significantly reduce the probability of business disruption. As we demonstrated earlier, the reduction of the probability of business disruption, at the optimal hedge ratio, is a decreasing function of the coverage ratio, P_0/h_0. Therefore, companies are less likely to hedge if coverage or liquidity surrogates (e.g., operating earnings to interest expense or current assets to current liabilities) are high. Finally, companies that have a high positive drift (growth rate) in operating cash flows are less likely to hedge, ceteris paribus. However, if high growth (in revenues) is accompanied by high capital expenditure requirements, the company will be more likely to hedge because the investment requirements place it closer to the business disruption boundary condition.

The empirical evidence, scant as it is, is consistent with the predictions of our model. Nance, Smith, and Smithson (1993), using survey results, find that companies are less likely to hedge if they have high research and development expense, or if their ratio of earnings before interest and taxes to interest expense is high. Surprisingly, they find no relationship between financial leverage and the propensity to hedge, but they have no data on the national origin of debt (foreign or domestic). Bodnar, Hayt, and Marston (1998) sent surveys on derivatives usage to 1,928 firms with a response rate of 20.7% (399 firms). FX derivatives were the most commonly used with 83% of the derivatives-using firms employing them. Half of the responding firms did not use derivatives–mostly because they considered their exposure to be low or managable by other means. However, after these, the next most-reported reason was that the costs of hedging exceeded the benefits–evidence that companies clearly use a benefit-cost framework to ponder their derivative-usage decisions.

Mian (1996) searches through the footnotes of 3,022 firms and classifies them as hedgers or not. He finds little relationship between hedging and leverage, but finds that companies with greater liquidity (measured by the ratio of current assets to current liabilities) are less likely to hedge. He also finds that firms with higher market-to-book ratios, a proxy for growth, are less likely to hedge. This result is consistent with our model because the drift in unhedged cash flows is higher for high-growth firms and therefore, they should have a lower propensity to hedge.

Howton and Perfect (1998) report the use of currency derivatives in 1994 by a sample of 451 *Fortune* and S&P 500 firms and 461 randomly selected firms. Using a Tobit model they find that companies are less likely to use forward and futures contracts for FX hedging if they have high liquidity, if their ratio of R&D to sales (a measure of the need for external financing) is low, if financial distress is not a threat, if they do not have exposure to currency risk, and if hedging substitutes are available.

Using New Zealand data in which firms report the contract and fair values of on- and off-balance-sheet financial instruments, Berkman and Bradbury (1996) construct a dependent variable that is the value of the derivative position as a percentage of the market value of the firm. Consistent with our theory, they find that the ratio of earnings before interest and taxes over interest expense, a coverage ratio, is strongly negatively related to derivative usage.

Tufano (1986) also finds a strong negative relationship between the extent of hedging and liquidity for a sample of gold mining companies. His dependent variable is a firm's portfolio gold delta divided by the amount of gold production anticipated over the next three years. Geczy, Minton, and Schrank (1997) find that firms with a combination of high growth and low accessibility to internal and external finance are more likely to hedge. This is consistent with our model if capital expenditure requirements are thought of as part of the minimum cash requirement boundary condition. Along the same line of reasoning, Gay and Nam (1998) study a sample of 325 derivative-using firms and 161 non-users observed at the end of 1995. They find that firms with enhanced investment opportunities, lower liquidity, and low correlation between investment expenditures and internally generated cash flows tend to be more likely users of derivatives.

VI. Summary and Conclusions

Many companies face significant foreign-exchange risk. This paper discusses a new way of evaluating the use of derivatives to reduce that risk. Variance reduction is neither a necessary nor a sufficient condition for reducing the probability of business disruption, which is the central focus of our work.

We develop a new approach for evaluating FX management programs that directly estimates the probability of business disruption within a predetermined period of time, e.g., one year. The solution for the expected time to disruption shows that in addition to the variance of hedged cash flows, two other (common-sense) variables are important. First is the ratio of operating cash flows to cash outflow levels that represents the business disruption boundary–a "coverage" ratio. Large firms with a high coverage ratio have probabilities of business disruption so low that they don't need to hedge. Second, is the reduction in the drift of operating cash flows caused by FX hedging costs (transaction costs and the ex ante change in the FX rate). Furthermore, the optimal hedge ratio is the variance-reducing hedge β_x, adjusted by the cost of hedging, μ_x, per unit of variance in the FX contract. For a case example, we found that transaction costs of only 14 basis points per quarter reduce the optimal hedge ratio by 20%.

This paper should be viewed as an intermediate step forward in the evaluation of FX hedging programs. Although it is an improvement over variance-reduction approaches, we have assumed that the hedge does not affect the firm's unhedged cash flows. They might be. If a hedging program simultaneously enables greater business growth with acceptable risk, then even costly hedges may be positive-net-present-value activities. Additionally, we have not taken into our benefit-cost ratio the expected benefit of the tax shield if the hedge provides greater debt capacity. Nevertheless, our theory is consistent with much of the emerging empirical evidence on the hedging activity of companies. ■

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