RETHINKING RISK MANAGEMENT

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This article explores an apparent conflict between the theory and current practice of corporate risk management. Academic theory suggests that some companies facing large exposures to interest rates, exchange rates, or commodity prices can increase their market values by using derivative securities to reduce their exposures. The primary emphasis of the theory is on the role of derivatives in reducing the variability of corporate cash flows and, in so doing, reducing various costs associated with financial distress.

The actual corporate use of derivatives, however, does not seem to correspond closely to the theory. For one thing, large companies make far greater use of derivatives than small firms, even though small firms have more volatile cash flows, more restricted access to capital, and thus presumably more reason to buy protection against financial trouble. Perhaps more puzzling, however, is that many companies appear to be using risk management to pursue goals other than reducing variance.

Does this mean that the prevailing academic theory of risk management is wrong, and that "variance-minimization" is not a useful goal for companies using derivatives? Or, is the current corporate practice of risk management misguided and in urgent need of reform? In this paper, I answer "no" to both questions while at the same time suggesting there may be room for improvement in the theory as well as the practice of risk management.

The paper begins by reviewing some evidence that has accumulated about the current practice of corporate risk management. Part of this evidence takes the form of recent "anecdotes," or cases, involving large derivatives losses. Most of the evidence, however, consists of corporate responses to surveys. What the stories suggest, and the surveys seem to confirm, is the popularity of a practice known as "selective" as opposed to "full-cover" hedging. That is, while few companies regularly use derivatives to take a "naked" speculative position on FX rates or commodity prices, most corporate derivatives users appear to allow their views of future interest rates, exchange rates, and commodity prices to influence their hedge ratios.

Such a practice seems inconsistent with modern risk management theory, or at least the theory that has been presented thus far. But there is a plausible defense of selective hedging—one that would justify the practice without violating the efficient markets tenet at the center of modern financial theory. In this paper, I attempt to explain more of the corporate behavior we observe by pushing the theory of risk management beyond the variance-minimization model that prevails in most academic circles. Some companies, I argue below, may have a comparative advantage in bearing certain financial risks (while other companies mistakenly think and act as if they do). I accordingly propose a somewhat different goal for corporate risk management—namely, the *elimination of costly lower-tail outcomes*—that is designed to reduce the expected costs of financial trouble while preserving a company's ability to exploit any comparative advantage in risk-bearing it may have. (In the jargon of finance specialists, the fundamental aim of corporate risk management can be viewed as the purchase of "well-out-of-the-money put options" that eliminate the downside while preserving as much of the upside as can be justified by the principle of comparative advantage.)

*I am grateful for extensive editorial assistance from Don Chew, and for comments by Steve Figlewski, Andrew Karolyi, Robert Whaley, and participants at a seminar at McKinsey, at the Annual Meeting of the International Association of Financial Engineers, and at the French Finance Association.

Such a modified theory of risk management implies that some companies should hedge all financial risks, other firms should worry about only certain kinds of risks, and still others should not worry about risks at all. But, as I also argue below, when making decisions whether or not to hedge, management should keep in mind that risk management can be used to change both a company's capital structure and its ownership structure. By reducing the probability of financial trouble, risk management has the potential both to increase debt capacity and to facilitate larger equity stakes for management.

This paper also argues that common measures of risk such as variance and Value at Risk (VaR) are not useful for most risk management applications by non-financial companies, nor are they consistent with the objective of risk management presented here. In place of both VaR and the variance of cash flows, I suggest a method for measuring corporate exposures that, besides having a foundation in modern finance theory, should be relatively easy to use.

I conclude with a discussion of the internal "management" of risk management. If corporate risk management is focused not on minimizing variance, but rather on eliminating downside risk while extending the corporate quest for comparative advantage into financial markets, then much more attention must be devoted to the evaluation and control of corporate risk-management activities. The closing section of the paper offers some suggestions for evaluating the performance of risk managers whose "view-taking" is an accepted part of the firm's risk management strategy.

RISK MANAGEMENT IN PRACTICE

In one of their series of papers on Metallgesellschaft, Chris Culp and Merton Miller make an observation that may seem startling to students of modern finance: "We need hardly remind readers that most value-maximizing firms do not hedge."[1] But is this true? And, if so, how would we know?

Culp and Miller refer to survey evidence—in particular, to a Wharton-Chase study that sent questionnaires to 1,999 companies inquiring about their risk management practices.[2] Of the 530 firms that responded to the survey, only about a third answered "yes" when asked if they ever used futures, forwards, options, or swaps. One clear finding that emerges from this survey is that large companies make greater use of derivatives than smaller firms. Whereas 65% of companies with a market value greater than $250 million reported using derivatives, only 13% of the firms with market values of $50 million or less claimed to use them.

What are the derivatives used to accomplish? The only uses reported by more than half of the corporate users are to hedge contractual commitments and to hedge anticipated transactions expected to take place within 12 months. About two thirds of the companies responded that they never use derivatives to reduce funding costs (or earn "treasury profits") by arbitraging the markets or by taking a view. Roughly the same proportion of firms also said they never use derivatives to hedge their balance sheets, their foreign dividends, or their economic or competitive exposures.

The Wharton-Chase study was updated in 1995, and its results were published in 1996 as the Wharton-CIBC Wood Gundy study. The results of the 1995 survey confirm those of its predecessor, but with one striking new finding: Over a third of all derivative users said they sometimes "actively take positions" that reflect their market views of interest rate and exchange rates.

This finding was anticipated in a survey of Fortune 500 companies conducted by Walter Dolde in 1992, and published in this journal in the following year.[3] Of the 244 companies that responded to Dolde's survey, 85% reported having used swaps, forwards, futures, or options. As in the Wharton surveys, larger companies reported greater use of derivatives than smaller firms. And, as Dolde notes, such a finding confirms the experience of risk management practitioners that the corporate use of derivatives requires a considerable upfront investment in personnel, training, and computer hardware and software—an investment that could discourage small firms.

1. Christopher Culp and Merton Miller, "Hedging in the Theory of Corporate Finance: A Reply to Our Critics," *Journal of Applied Corporate Finance* 8 (Spring 1995), p. 122. For the central idea of this paper, I am indebted to Culp and Miller's discussion of Holbrook Working's "carrying-charge" theory of commodity hedging. It is essentially Workings' notion—and Culp and Miller's elaboration of it—that I attempt in this paper to generalize into a broader theory of risk management based on comparative advantage in risk-bearing.

2. The Wharton School and The Chase Manhattan Bank, N.A., Survey of Derivative Usage Among U.S. Non-Financial Firms (February 1994).

3. Walter Dolde, "The Trajectory of Corporate Financial Risk Management, *Journal of Applied Corporate Finance* 6 (Fall 1993), 33-41.

But, as we observed earlier, there are also reasons why the demand for risk management products should actually be greater for small firms than for large—notably the greater probability of default caused by unhedged exposures and the greater concentration of equity ownership in smaller companies. And Dolde's survey provides an interesting piece of evidence in support of this argument. When companies were asked to estimate what percentages of their exposures they chose to hedge, many respondents said that it depended on whether they had a view of future market movements. *Almost 90% of the derivatives users in Dolde's survey said they sometimes took a view.* And, when the companies employed such views in their hedging decisions, the smaller companies reported hedging significantly greater percentages of their FX and interest rate exposures than the larger companies.

Put another way, the larger companies were more inclined to "self-insure" their FX or interest rate risks. For example, if they expected FX rates to move in a way that would increase firm value, they might hedge only 10% to 20% (or maybe none) of their currency exposure. But if they expected rates to move in a way that would reduce value, they might hedge 100% of the exposure.

Like the Wharton surveys, the Dolde survey also found that the focus of risk management was mostly on transaction exposures and near-term exposures. Nevertheless, Dolde also reported "a distinct evolutionary pattern" in which many firms "progress from targeting individual transactions to more systematic measures of ongoing competitive exposures."[4]

The bottom line from the surveys, then, is that corporations do not systematically hedge their exposures, the extent to which they hedge depends on their views of future price movements, the focus of hedging is primarily on near-term transactions, and the use of derivatives is greater for large firms than small firms. Many of the widely-reported derivative problems of recent years are fully consistent with this survey evidence, and closer inspection of such cases provides additional insight into common risk management practices. We briefly recount two cases in which companies lost large amounts of money as a result of risk management programs.

Metallgesellschaft

Although the case of Metallgesellschaft continues to be surrounded by controversy, there is general agreement about the facts of the case. By the end of 1993, MGRM, the U.S. oil marketing subsidiary of Metallgesellschaft, contracted to sell 154 million barrels of oil through fixed-price contracts ranging over a period of ten years. These fixed-price contracts created a huge exposure to oil price increases that MGRM decided to hedge. However, it did not do so in a straightforward way. Rather than hedging its future outflows with offsetting positions of matching maturities, MGRM chose to take "stacked" positions in short-term contracts, both futures and swaps, and then roll the entire "stack" forward as the contracts expired.

MGRM's choice of short-term contracts can be explained in part by the lack of longer-term hedging vehicles. For example, liquid markets for oil futures do not go out much beyond 12 months. But it also appears that MGRM took a far larger position in oil futures than would have been consistent with a variance-minimizing strategy. For example, one study estimated that the minimum-variance hedge position for MGRM would have required the forward purchase of only 86 million barrels of oil, or about 55% of the 154 million barrels in short-maturity contracts that MGRM actually entered into.[5]

Does this mean that MGRM really took a position that was long some 58 million barrels of oil? Not necessarily. As Culp and Miller demonstrate, had MGRM adhered to its professed strategy and been able to obtain funding for whatever futures losses it incurred over the entire 10-year period, its position would have been largely hedged.[6]

But even if MGRM's net exposure to oil prices was effectively hedged over the long haul, it is also clear that MGRM's traders had not designed their hedge with the aim of minimizing the variance of their net position in oil during the life of the contracts. The traders presumably took the position they did because they thought they could benefit from their specialized information about supply and demand—and, more specifically, from a persistent feature of oil futures known as "backwardation," or the long-run

4. Dolde, p. 39.

5. Mello, A., and J.E. Parsons, "Maturity Structure of a Hedge Matters: Lessons from the Metallgesellschaft Debacle," *Journal of Applied Corporate Finance* Vol. 8 No. 1 (Spring 1995), 106-120.

6. More precisely, Culp and Miller's analysis shows that, ignoring any complications arising from basis risk and the daily mark-to-market requirement for futures, over the 10-year period each rolled-over futures contract would have eventually corresponded to an equivalent quantity of oil delivered to customers.

The lesson of market efficiency for corporate risk managers is that the attempt to earn higher returns in most financial markets generally means bearing large (and unfamiliar) risks.

tendency of spot prices to be higher than futures prices. So, although MGRM was effectively hedged against changes in spot oil prices, it nevertheless had what amounted to a long position in "the basis." Most of this long position in the basis represented a bet that the convenience yields on crude oil—that is, the premiums of near-term futures over long-dated futures—would remain positive as they had over most of the past decade.

When spot prices fell dramatically in 1993, MGRM lost on its futures positions and gained on its cash positions—that is, on the present value of its delivery contracts. But because the futures positions were marked to market while the delivery contracts were not, MGRM's financial statements showed large losses. Compounding this problem of large "paper losses," the backwardation of oil prices also disappeared, thus adding real losses to the paper ones. And, in response to the reports of mounting losses, MG's management chose to liquidate the hedge. This action, as Culp and Miller point out, had the unfortunate consequence of "turning paper losses into realized losses" and "leaving MGRM exposed to rising prices on its remaining fixed-price contracts."[7]

Daimler-Benz

In 1995, Daimler-Benz reported first-half losses of DM1.56 billion, the largest in the company's 109-year history. In its public statements, management attributed the losses to exchange rate losses due to the weakening dollar. One subsidiary of Daimler-Benz, Daimler-Benz Aerospace, had an order book of DM20 billion, of which 80% was fixed in dollars. Because the dollar fell by 14% during this period, Daimler-Benz had to take a provision for losses of DM1.2 billion to cover future losses.

Why did Daimler-Benz fail to hedge its expected dollar receivables? The company said that it chose not to hedge because the forecasts it received were too disperse, ranging as they did from DM1.2 to DM1.7 per dollar. Analysts, however, attributed Daimler-Benz's decision to remain unhedged to its view that the dollar would stay above DM1.55.[8]

These two brief case studies reinforce the conclusion drawn from the survey evidence. In both of these cases, management's view of future price movements was an important determinant of how (or whether) risk was managed. Risk management did not mean minimizing risk by putting on a minimum-variance hedge. Rather, it meant choosing to bear certain risks based on a number of different considerations, including the belief that a particular position would allow the firm to earn abnormal returns.

Is such a practice consistent with the modern theory of risk management? To answer that question, we first need to review the theory.

THE PERSPECTIVE OF MODERN FINANCE

The two pillars of modern finance theory are the concepts of efficient markets and diversification. Stated as briefly as possible, market efficiency means that markets don't leave money on the table. Information that is freely accessible is incorporated in prices with sufficient speed and accuracy that one cannot profit by trading on it.

Despite the spread of the doctrine of efficient markets, the world remains full of corporate executives who are convinced of their own ability to predict future interest rates, exchange rates, and commodity prices. As evidence of the strength and breadth of this conviction, many companies during the late '80s and early '90s set up their corporate treasuries as "profit centers" in their own right—a practice that, if the survey evidence can be trusted, has been largely abandoned in recent years by most industrial firms. And the practice has been abandoned with good reason: Behind most large derivative losses—in cases ranging from Orange County and Baring Brothers to Procter & Gamble and BancOne—there appear to have been more or less conscious decisions to bear significant exposures to market risks with the hope of earning abnormal returns.

The lesson of market efficiency for corporate risk managers is that the attempt to earn higher returns in most financial markets generally means bearing large (and unfamiliar) risks. In highly liquid markets such as those for interest rate and FX futures—and in the case of heavily traded commodities like oil and gold as well—industrial companies are unlikely to have a comparative advantage in bearing these risks. And so, for most industrial corporations, setting up the corporate treasury to

7. Culp and Miller, Vol. 7 No. 4 (Winter 1995), p. 63.
8. See *Risk Magazine*, October 1995, p. 11.

trade derivatives for profit is a value-destroying proposition. (As I will also argue later, however, market efficiency does not rule out the possibility that management's information may be better than the market's in special cases.)

But if the concept of market efficiency should discourage corporations from *creating* corporate exposures to financial market risks, the companion concept of diversification should also discourage some companies from *hedging* financial exposures incurred through their normal business operations. To explain why, however, requires a brief digression on the corporate cost of capital.

Finance theory says that the stock market, in setting the values of companies, effectively assigns minimum required rates of return on capital that vary directly with the companies' levels of risk. In general, the greater a company's risk, the higher the rate of return it must earn to produce superior returns for its shareholders. But a company's required rate of return, also known as its cost of capital, is said to depend only on its non-diversifiable (or "systematic") risk, not on its total risk. In slightly different words, a company's cost of capital depends on the strength of the firm's tendency to move with the broad market (in statistical terms, its "covariance") rather than its overall volatility (or "variance").

In general, most of a company's interest rate, currency, and commodity price exposures will not increase the risk of a well-diversified portfolio. Thus, most corporate financial exposures represent "non-systematic" or "diversifiable" risks that shareholders can eliminate by holding diversified portfolios. And because shareholders have such an inexpensive risk-management tool at their disposal, companies that reduce their earnings volatility by managing their financial risks will not be rewarded by investors with lower required rates of return (or, alternatively, with higher P/E ratios for given levels of cash flow or earnings). As one example, investors with portfolios that include stocks of oil companies are not likely to place higher multiples on the earnings of petrochemical firms just because the latter smooth their earnings by hedging against oil price increases.

For this reason, having the corporation devote resources to reducing FX or commodity price risks makes sense only if the cash flow variability arising from such risks has the potential to impose "real" costs on the corporation. The academic finance literature has identified three major costs associated with higher variability: (1) higher expected bankruptcy costs (and, more generally, costs of financial distress); (2) higher expected payments to corporate "stakeholders" (including higher rates of return required by owners of closely-held firms); and (3) higher expected tax payments. The potential gains from risk management come from its ability to reduce each of these three costs—and I review each in turn below.[9]

Risk Management Can Reduce Bankruptcy Costs

Although well-diversified shareholders may not be concerned about the cash flow variability caused by swings in FX rates or commodity prices, they will become concerned if such variability materially raises the probability of financial distress. In the extreme case, a company with significant amounts of debt could experience a sharp downturn in operating cash flow—caused in part by an unhedged exposure—and be forced to file for bankruptcy.

What are the costs of bankruptcy? Most obvious are the payments to lawyers and court costs. But, in addition to these "direct" costs of administration and reorganization, there are some potentially larger "indirect" costs. Companies that wind up in Chapter 11 face considerable interference from the bankruptcy court with their investment and operating decisions. And such interference has the potential to cause significant reductions in the ongoing operating value of the firm.

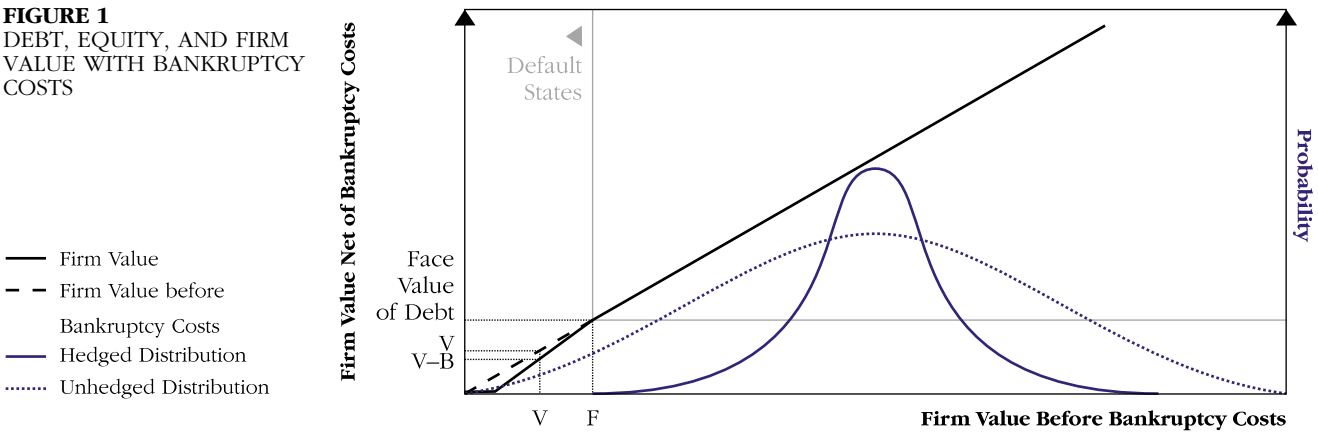
If a company's shareholders view bankruptcy as a real possibility—and to the extent the process of reorganization itself is expected to reduce the firm's operating value—the expected present value of these costs will be reflected in a company's *current* market value. A risk management program that costlessly eliminates the risk of bankruptcy effectively reduces these costs to zero and, in so doing, increases the value of the firm.

The effects of risk management on bankruptcy costs and firm value are illustrated in Figure 1. In the case shown in the figure, hedging is assumed to

9. For a discussion of the benefits of corporate hedging, see Clifford Smith and René Stulz, "The Determinants of Firms' Hedging Policies," *Journal of Financial and Quantitative Analysis* 20 (1985), pp. 391-405.

Because shareholders have such an inexpensive risk-management tool, companies that reduce their earnings volatility by managing financial risks will not be rewarded with a lower "cost of capital." But if shareholders are not concerned about the cash flow variability caused by swings in FX rates or commodity prices, they will become concerned if such variability materially raises the probability of financial distress.

FIGURE 1
DEBT, EQUITY, AND FIRM VALUE WITH BANKRUPTCY COSTS



reduce the variability of cash flow and firm value to the degree that default is no longer possible. By eliminating the possibility of bankruptcy, risk management increases the value of the firm's equity by an amount roughly equal to Bc (bankruptcy costs) multiplied by the probability of bankruptcy if the firm remains unhedged (pBU). For example, let's assume the market value of the firm's equity is $100 million, bankruptcy costs are expected to run $25 million (or 25% of current firm value), and the probability of bankruptcy in the absence of hedging is 10%. In this case, risk management can be seen as increasing the current value of the firm's equity by $2.5 million (10% x $25 million), or 2.5%. (Keep in mind that this is the contribution of risk management to firm value *when the company is healthy*; in the event that cash flow and value should decline sharply from current levels, the value added by risk management increases in absolute dollars, and even more on a percentage-of-value basis.)

This argument extends to distress costs in general. For instance, as a company becomes weaker financially, it becomes more difficult for it to raise funds. At some point, the cost of outside funding—if available at all—may become so great that management chooses to pass up profitable investments. This "underinvestment problem" experienced by companies when facing the prospect of default (or, in some cases, just a downturn in earnings[10]) represents an important cost of financial distress. And, to the extent that risk management succeeds in reducing the perceived *probability* of financial distress and the costs associated with underinvestment, it will increase the current market value of the firm.

Risk Management Can Reduce Payments to "Stakeholders" (and Required Returns to Owners of Closely Held Firms)[11]

Although the shareholders of large public companies can often manage most financial risks more efficiently than the companies themselves, the case may be different for the owners—or owner-managers—of private or closely-held companies. Because such owners tend to have a large proportion of their wealth tied up in the firm, their required rates of return are likely to reflect all important sources of risk, those that can be "diversified away" by outside investors as well as those that cannot. In such circumstances, hedging financial exposures can be thought of as adding value by reducing the owners' risks and hence their required rates of return on investment.

And it's not just the owners of closely held companies that value the protection from risk management. In public companies with dispersed ownership, non-investor groups such as managers, employees, customers, and suppliers with a large stake in the success of the firm typically cannot diversify away large financial exposures. If there is a chance that their "firm-specific" investments could be lost because of financial distress, they are likely to require added compensation for the greater risk.

10. This argument is made by Kenneth Froot, David Scharfstein, and Jeremy Stein in "Risk Management: Coordinating Corporate Investment and Financing Policies," *Journal of Finance* 48, (1993), 1629-1658.

11. The discussion in this section and the next draws heavily on Smith and Stulz (1985), cited in footnote 9.

Employees will demand higher wages (or reduce their loyalty or perhaps their work effort) at a company where the probability of layoff is greater. Managers with alternative opportunities will demand higher salaries (or maybe an equity stake in the company) to run firms where the risks of insolvency and financial embarrassment are significant. Suppliers will be more reluctant to enter into long-term contracts, and trade creditors will charge more and be less flexible, with companies whose prospects are more uncertain. And customers concerned about the company's ability to fulfil warranty obligations or service their products in the future may be reluctant to buy those products.

To the extent risk management can protect the investments of each of these corporate stakeholders, the company can improve the terms on which it contracts with them and so increase firm value. And, as I discuss later in more detail, hedging can also facilitate larger equity stakes for managers of public companies by limiting "uncontrollables" and thus the "scope" of their bets.

Risk Management Can Reduce Taxes

The potential tax benefits of risk management derive from the interaction of risk management's ability to reduce the volatility of reported income and the progressivity (or, more precisely, the "convexity") of most of the world's tax codes. In the U.S., as in most countries, a company's effective tax rate rises along with increases in pre-tax income. Increasing marginal tax rates, limits on the use of tax-loss carry forwards, and the alternative minimum tax all work together to impose higher effective rates of taxation on higher levels of reported income and to provide lower percentage tax rebates for ever larger losses.

Because of the convexity of the tax code, there are benefits to "managing" taxable income so that as much of it as possible falls within an optimal range—that is, neither too high nor too low. By reducing fluctuations in taxable income, risk management can lead to lower tax payments by ensuring that, over a complete business cycle, the largest possible proportion of corporate income falls within this optimal range of tax rates.

RISK MANAGEMENT AND COMPARATIVE ADVANTAGE IN RISK-TAKING

Up to this point, we have seen that companies should not expect to make money consistently by taking financial positions based on information that is publicly available. But what about information that is not publicly available? After all, many companies in the course of their normal operating activities acquire specialized information about certain financial markets. Could not such information give them a comparative advantage over their shareholders in taking some types of risks?

Let's look at a hypothetical example. Consider company X that produces consumer durables using large amounts of copper as a major input. In the process of ensuring that it has the appropriate amount of copper on hand, it gathers useful information about the copper market. It knows its own demand for copper, of course, but it also learns a lot about the supply. In such a case, the firm will almost certainly allow that specialized information to play some role in its risk management strategy.

For example, let's assume that company X's management has determined that, when it has no view about future copper prices, it will hedge 50% of the next year's expected copper purchases to protect itself against the possibility of financial distress. But, now let's say that the firm's purchasing agents persuade top management that the price of copper is far more likely to rise than fall in the coming year. In this case, the firm's risk manager might choose to take a long position in copper futures that would hedge as much as 100% of its anticipated purchases for the year instead of the customary 50%. Conversely, if management becomes convinced that copper prices are likely to drop sharply (with almost no possibility of a major increase), it might choose to hedge as little as 20% of its exposure.[12]

Should the management of company X refrain from exploiting its specialized knowledge in this fashion, and instead adhere to its 50% hedging target? Or should it, in certain circumstances, allow its market view to influence its hedge ratio?

Although there are clearly risks to selective hedging of this kind—in particular, the risk that the

12. For a good example of this kind of selective hedging policy, see the comments by John Van Roden, Chief Financial Officer of Lukens, Inc. in the "Bank of America Rroundtable on Corporate Risk Management," *Journal of Applied Corporate Finance*, Vol. 8 No. 3 (Fall 1995). As a stainless steel producer, one of the company's principal inputs is nickel; and Lukens' policy is to allow its view of nickel prices to influence how much of its nickel exposure it hedges. By contrast, although it may have views of interest rates or FX exposures, such views play no role in hedging those exposures.

How can management determine when it should take risks and when it should not? The best approach is to implement a *risk-taking audit*—a comprehensive review of the risks to which the company is exposed, both through its financial instruments and liability structure as well as its normal operations.

firm's information may not in fact be better than the market's—it seems quite plausible that companies could have such informational advantages. Companies that repurchase their own shares based on the belief that their current value fails to reflect the firm's prospects seem to be vindicated more often than not. And though it's true that management may be able to predict the firm's future earnings with more confidence than the price of one of its major inputs, the information companies acquire about certain financial markets may still prove a reasonably reliable source of gain in risk management decisions.

The Importance of Understanding Comparative Advantage

What this example fails to suggest, however, is that the same operating activity in one company may not necessarily provide a comparative advantage in risk-bearing for another firm. As suggested above, the major risk associated with "selective" hedging is that the firm's information may not in fact be better than the market's. For this reason, it is important for management to understand the source of its comparative advantages.

To illustrate this point, take the case of a foreign currency trading operation in a large commercial bank. A foreign currency trading room can make a lot of money from taking positions provided, of course, exchange rates move in the anticipated direction. But, in an efficient market, as we have seen, banks can reliably make money from position-taking of this sort only if they have access to information before most other firms. In the case of FX, this is likely to happen only if the bank's trading operation is very large—large enough so that its deal flow is likely to reflect general shifts in demand for foreign currencies.

Most FX dealers, however, have no comparative advantage in gathering information about changes in the value of foreign currencies. For such firms, management of currency risk means ensuring that their exposures are short-lived. The most reliable way to minimize exposures for most currency traders is to enlarge their customer base. With a sufficient number of large, highly active customers, a trading operation has the following advantage: If one of its traders agrees to buy yen from one customer, the firm can resell them quickly to another customer and pocket the bid-ask spread.

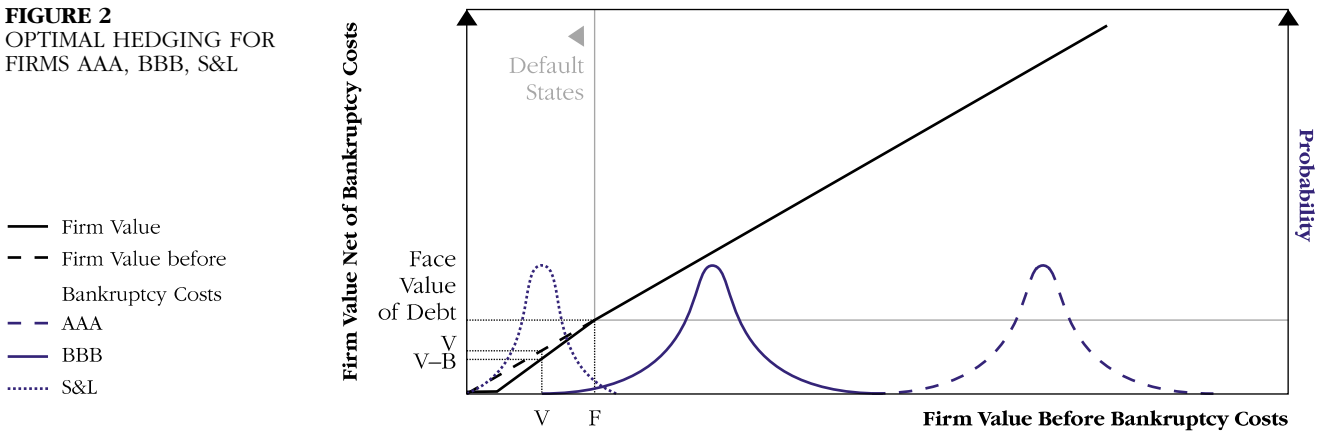
In an article entitled "An Analysis of Trading Profits: How Trading Rooms Really Make Money," Alberic Braas and Charles Bralver present evidence suggesting that most FX trading profits come from market-making, not position-taking.[13] Moreover, as the authors of this article point out, a trading operation that does not understand its comparative advantage in trading currencies is likely not only to fail to generate consistent profit, but to endanger its existing comparative advantage. If the source of the profits of the trading room is really the customer base of the bank, and not the predictive power of its traders, then the bank must invest in maintaining and building its customer base. A trading room that mistakenly believes that the source of its profits is position-taking will take large positions that, on average, will neither make money nor lose money. More troubling, though, is that the resulting variability of its trading income is likely to unsettle its customers and weaken its customer base. Making matters worse, it may choose a compensation system for its traders that rewards profitable position-taking instead of valuable coordination of trading and sales activities. A top management that fails to understand its comparative advantage may waste its time looking for star traders while neglecting the development of marketing strategies and services.

How can management determine when it should take risks and when it should not? The best approach is to implement a *risk-taking audit*. This would involve a comprehensive review of the risks to which the company is exposed, both through its financial instruments and liability structure as well as its normal operations. Such an audit should attempt to answer questions like the following: Which of its major risks has the firm proved capable of "self-insuring" over a complete business cycle? If the firm chooses to hedge "selectively," or leaves exposures completely unhedged, what is the source of the firm's comparative advantage in taking these positions? Which risk management activities have consistently added value without introducing another source of volatility?

Once a firm has decided that it has a comparative advantage in taking certain financial risks, it must then determine the role of risk management

13. See Alberic Braas and Charles Bralver, "How Trading Rooms Really Make Money?," *Journal of Applied Corporate Finance*, Vol. 2 No. 4 (Winter 1990).

FIGURE 2
OPTIMAL HEDGING FOR FIRMS AAA, BBB, S&L



in exploiting this advantage. As I argue below, risk management may paradoxically enable the firm to take *more* of these risks than it would in the absence of risk management. To illustrate this point, let's return to our example of company X and assume it has valuable information about the copper market that enables it to earn consistently superior profits trading copper. Even in this situation, such trading profits are by no means a sure thing; there is always the possibility that the firm will experience significant losses. Purchasing far-out-of-the-money calls on copper in such a case could actually serve to increase the firm's ability to take speculative positions in copper. But, as I argue in the next section, a company's ability to withstand large trading losses without endangering its operating activities depends not only on its risk management policy, but also on its capital structure and general financial health.

THE LINK BETWEEN RISK MANAGEMENT, RISK-TAKING, AND CAPITAL STRUCTURE

In discussing earlier the benefits of risk management, I suggested that companies should manage risk in a way that makes financial distress highly unlikely and, in so doing, preserves the financing flexibility necessary to carry out their investment strategies. Given this primary objective for risk management, one would not expect companies with little or no debt financing—and, hence, a low probability of financial trouble—to benefit from hedging.

In this sense, risk management can be viewed as a direct substitute for equity capital. That is, the more the firm hedges its financial exposures, the less equity it requires to support its business. Or, to put it another way, the use of risk management to reduce exposures effectively increases a company's debt capacity.

Moreover, to the extent one views risk management as a substitute for equity capital—or, alternatively, as a technique that allows management to substitute debt for equity—then it pays companies to practice risk management only to the extent that equity capital is more expensive than debt. As this formulation of the issue suggests, a company's decisions to hedge financial risks—or to bear part of such risks through selective hedging—should be made jointly with the corporate capital structure decision.

To illustrate this interdependence between risk management and capital structure, consider the three kinds of companies pictured in Figure 2. At the right-hand side of the figure is company AAA, so named because it has little debt and a very high debt rating. The probability of default is essentially zero; and thus the left or lower tail of AAA's distribution of potential outcomes never reaches the range where low value begins to impose financial distress costs on the firm. Based on the theory of risk management just presented, there is no reason for this company to hedge its financial exposures; the company's shareholders can do the same job more cost-effectively. And, should investment opportunities arise, AAA will likely be able to raise funds on an economic basis, even if its cash flows should decline temporarily.

Should such a company take bets on financial markets? The answer could be yes, provided management has specialized information that would give it a comparative advantage in a certain market. In

The question of what is the right corporate risk management decision for a company begs the question of not only its optimal capital structure, but optimal *ownership* structure as well.

AAA's case, a bet that turns out badly will not affect the company's ability to carry out its strategic plan.

But now let's consider the company in the middle of the picture, call it BBB. Like the company shown in Figure 1 earlier, this firm has a lower credit rating, and there is a significant probability that the firm could face distress. What should BBB do? As shown earlier in Figure 1, this firm should probably eliminate the probability of encountering financial distress through risk management. In this case, even if management feels that there are occasional opportunities to profit from market inefficiencies, hedging exposures is likely to be the best policy. In company BBB's case, the cost of having a bet turn sour can be substantial, since this would almost certainly imply default. Consequently, one would not expect the management of such a firm to let its views affect the hedge ratio.

Finally, let's consider a firm that is in distress—and let's call it "S&L." What should it do? Reducing risk once the firm is in distress is not in the interest of shareholders. If the firm stays in distress and eventually defaults, shareholders will end up with near-worthless shares. In these circumstances, a management intent on maximizing shareholder value will not only accept bets that present themselves, but will *seek out* new ones. Such managers will take bets even if they believe markets are efficient because introducing new sources of volatility raises the probability of the "upper-tail" outcomes that are capable of rescuing the firm from financial distress.

Back to the Capital Structure Decision. As we saw in the case of company AAA, firms that have a lot of equity capital can make bets without worrying about whether doing so will bring about financial distress. One would therefore not expect these firms to hedge aggressively, particularly if risk management is costly and shareholders are better off without it.

The major issue that such companies must address, however, is whether they have too much capital—or, too much equity capital. In other words, although risk management may not be useful to them *given their current leverage ratios*, they might be better off using risk management and increasing leverage. Debt financing, of course, has a tax advantage over equity financing. But, in addition to its ability to reduce corporate taxes, increasing leverage also has the potential to strengthen management incentives to improve efficiency and add value. For one thing, the substitution of debt for equity leads managers to pay out excess capital—an action that could be a major source of value added in industries with overcapacity and few promising investment opportunities. Perhaps even more important, however, is that the substitution of debt for equity also allows for greater concentration of equity ownership, including a significant ownership stake for managers.

In sum, the question of what is the right corporate risk management decision for a company begs the question of not only its optimal capital structure, but optimal *ownership* structure as well. As suggested above, hedging could help some companies to increase shareholder value by enabling them to raise leverage—say, by buying back their shares—and increase management's percentage ownership. For other companies, however, leaving exposures unhedged or hedging "selectively" while maintaining more equity may turn out to be the value-maximizing strategy.

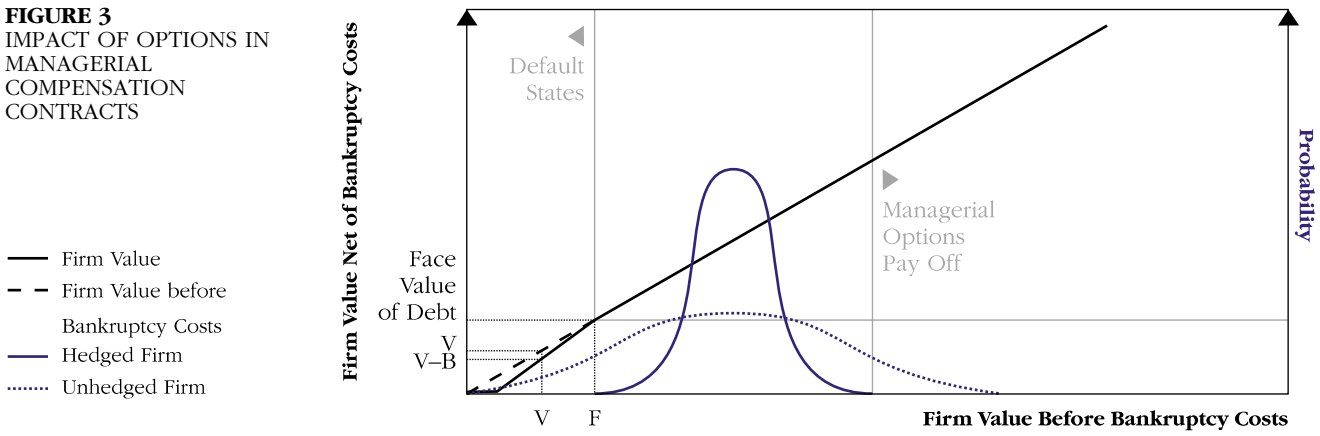
CORPORATE RISK-TAKING AND MANAGEMENT INCENTIVES

Management incentives may have a lot to do with why some firms take bets and others do not. As suggested, some companies that leave exposures unhedged or take bets on financial markets may have a comparative advantage in so doing; and, for those companies, such risk-taking may be a value-increasing strategy. Other companies, however, may choose to take financial risks without having a comparative advantage, particularly if such risk-taking somehow serves the interests of those managers who choose to expose their firms to the risks.

We have little convincing empirical evidence on the extent of risk-taking by companies, whether public or private. But there is one notable exception—a study by Peter Tufano of the hedging behavior of 48 publicly traded North American gold mining companies that was published in the September 1996 issue of the *Journal of Finance*.[14] The gold mining industry is ideal for studying hedging behav-

14. Peter Tufano, "Who Manages Risk? An Empirical Examination of the Risk Management Practices of the Gold Mining Industry, *Journal of Finance* (September, 1996).

FIGURE 3
IMPACT OF OPTIONS IN MANAGERIAL COMPENSATION CONTRACTS



ior in the sense that gold mining companies tend to be single-industry firms with one very large price exposure and a wide range of hedging vehicles, from forward sales, to exchange-traded gold futures and options, to gold swaps and bullion loans.

The purpose of Tufano's study was to examine the ability of various corporate risk management theories to explain any significant pattern of differences in the percentage of their gold price exposures that the companies choose to hedge. Somewhat surprisingly, there was considerable variation in the hedging behavior of these 48 firms. One company, Homestake Mining, chose not only to hedge none of its exposure, but to publicize its policy while condemning what it called "gold price management." At the other extreme were companies like American Barrick that hedged as much as 85% of their anticipated production over the next three years. And whereas about one in six of these firms chose to hedge none of its exposure and sold *all* of its output at spot prices, another one in six firms hedged 40% or more of its gold price exposure.

The bottom line of Tufano's study was that the only important systematic determinant of the 48 corporate hedging decisions was managerial ownership of shares and, more generally, the nature of the managerial compensation contract. In general, the greater management's direct percentage share ownership, the larger the percentage of its gold price exposure a firm hedged. By contrast, little hedging took place in gold mining firms where management owns a small stake. Moreover, managerial compensation contracts that emphasize options or option-like features were also associated with significantly less hedging.

As Tufano acknowledged in his study, this pattern of findings could have been predicted from arguments that Clifford Smith and I presented in a theoretical paper in 1985.[15] Our argument was essentially as follows: As we saw in the case of closely held companies, managers with a significant fraction of their own wealth tied up in their own firms are likely to consider all sources of risk when setting their required rates of return. And this could help explain the tendency of firms with heavy managerial equity ownership to hedge more of their gold price exposures. In such cases, the volatility of gold prices translates fairly directly into volatility of managers' wealth, and manager-owners concerned about such volatility may rationally choose to manage their exposures. (How, or whether, such hedging serves the interests of the companies' outside shareholders is another issue, one that I return to shortly.)

The propensity of managers with lots of stock options but little equity ownership to leave their gold price exposures unhedged is also easy to understand. As shown in Figure 3, the one-sided payoff from stock options effectively rewards management for taking bets and so increasing volatility. In this example, the reduction in volatility from hedging makes management's options worthless (that is, the example assumes these are well out-of-the-money options). But if the firm does not hedge, there is some

15. Clifford Smith and René Stulz, "The Determinants of Firms' Hedging Policies," *Journal of Financial and Quantitative Analysis* 20 (1985), pp. 391-405.

***Given that the firm has chosen to concentrate equity ownership*, hedging may well be a value-adding strategy. If significant equity ownership for managers is expected to strengthen incentives to improve operating performance, hedging can make these incentives even stronger by removing the "noise" introduced by a major performance variable that is beyond management's control.**

probability that a large increase in gold prices will cause the options to pay off.

What if we make the more realistic assumption that the options are *at the money* instead of far out of the money? In this case, options would still have the power to influence hedging behavior because management gains more from increases in firm value than it loses from reductions in firm value. As we saw in the case of the S&L presented earlier, this "asymmetric" payoff structure of options increases management's willingness to take bets.[16]

But if these differences in hedging behavior reflect differences in managerial incentives, what do they tell us about the effect of risk management on shareholder value? Without directly addressing the issue, Tufano implies that neither of the two polar risk management strategies—hedging none of their gold exposure vs. hedging 40% or more—seems designed to increase shareholder value while both appear to serve managers' interests. But can we therefore conclude from this study that neither of these approaches benefits shareholders?

Let's start with the case of the companies that, like Homestake Mining, choose to hedge none of their gold price exposure. As we saw earlier, companies for which financial distress is unlikely have no good reason to hedge (assuming they see no value in changing their current capital structure.) At the same time, in a market as heavily traded as gold, management is also not likely to possess a comparative advantage in predicting gold prices. And, lacking either a motive for hedging or superior information about future gold prices, management has no reason to alter the company's natural exposure to gold prices. In further defense of such a policy, one could also argue that such a gold price exposure will have diversification benefits for investors seeking protection against inflation and political risks.

On the other hand, as Smith and I pointed out, because stock options have considerably more upside than downside risk, such incentive packages could result in a misalignment of managers' and shareholders' interests. That is, stock options could be giving managers a one-sided preference for risk-taking that is not fully shared by the companies' stockholders; and, if so, a better policy would be to balance managers' upside potential by giving them a share of the downside risk.

But what about the opposite decision to hedge a significant portion of gold price exposures? Was that likely to have increased shareholder value? As Tufano's study suggests, the managers of the hedging firms tend to hold larger equity stakes. And, as we saw earlier, if such managers have a large fraction of their wealth tied up in their firms, they will demand higher levels of compensation to work in firms with such price exposures. *Given that the firm has chosen to concentrate equity ownership*, hedging may well be a value-adding strategy. That is, if significant equity ownership for managers is expected to add value by strengthening incentives to improve operating performance, the role of hedging is to make these incentives even stronger by removing the "noise" introduced by a major performance variable—the gold price—that is beyond management's control. For this reason, the combination of concentrated ownership, the less "noisy" performance measure produced by hedging, and the possibility of higher financial leverage[17] has the potential to add significant value. As this reasoning suggests, risk management can be used to facilitate an organizational structure that resembles that of an LBO![18]

To put the same thought another way, it is the risk management policy that allows companies with large financial exposures to have significant managerial stock ownership. For, without the hedging policy, a major price exposure would cause the scope of management's bet to be too diffuse, and "uncontrollables" would dilute the desired incentive benefits of more concentrated ownership.

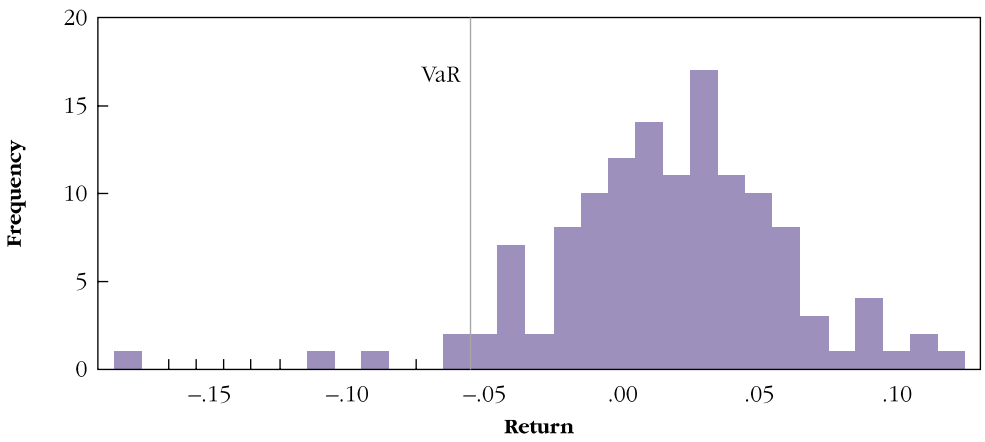
Although Tufano's study is finally incapable of answering the question, "Did risk management add value for shareholders?," the study nevertheless has an important message for corporate policy. It says

16. Additional empirical support for the importance of the relation between the option component of managerial compensation contracts and corporate risk-taking was provided in a recent study of S&Ls that changed their organizational form from mutual ownership to stock ownership. The study finds that those "converted" S&Ls where management has options choose to increase their one-year gaps and, hence, their exposure to interest rates. The study also shows that the greater the percentage of their interest rate exposure an S&L hedges, the larger the credit risk it takes on. The authors of the study interpret this finding to argue, as I do here, that risk management allows firms to increase their exposures to some risks by reducing other risks and thus limiting total firm risk. See C.M. Schrandt and H. Unal, "Coordinated Risk Management: On and Off-balance Sheet Hedging and Thrift Conversion," 1996, unpublished working paper, The Wharton School, University of Pennsylvania, Philadelphia, PA.

17. Although Tufano's study does not find that firms that hedge have systematically higher leverage ratios, it does find that companies that hedge less have higher cash balances.

18. For a discussion of the role of hedging in creating an LBO-like structure, see my study, "Managerial Discretion and Optimal Financing Policies," *Journal of Financial Economics* (1990), pp. 3-26.

FIGURE 4
WORLD MARKET PORTFOLIO RETURN SEPTEMBER 1985-DECEMBER 1995



that, to the extent that risk-taking within the corporation is decentralized, it is important to understand the incentives of those who make the decisions to take or lay off risks.

Organizations have lots of people doing a good job, and so simply doing a good job may not be enough to get promoted. And, if one views corporate promotions as the outcome of "tournaments" (as does one strand of the academic literature), there are tremendous incentives to stand out. One way to stand out is by volunteering to take big risks. In most areas of a corporation, it is generally impossible to take risks where the payoffs are large enough to be noticeable if things go well. But the treasury area may still be an exception. When organized as a profit center, the corporate treasury was certainly a place where an enterprising executive could take such risks and succeed. To the extent such possibilities for risk-taking still exist within some corporate treasuries, top management must be very careful in establishing the appropriate incentives for their risk managers. I return to this subject in the final section of the paper.

MEASURING RISK (OR, IMPROVING ON VaR)

As I mentioned at the outset, the academic literature has focused on volatility reduction as the primary objective of risk management, and on variance as the principal measure of risk. But such a focus on variance, as we have seen, is inconsistent with both most corporate practice and with the theory of risk management presented in this paper. Rather than aiming to reduce variance, most corporate risk management programs appear designed just to avoid "lower-tail outcomes" while preserving upside potential. Indeed, as I suggested earlier, some companies will hedge certain downside risks precisely in order to be able to increase their leverage ratios or to enlarge other financial exposures in ways designed to exploit their comparative advantage in risk-taking.

Many commercial banks and other financial institutions now attempt to quantify the probability of lower-tail outcomes by using a measure known as Value at Risk, or VaR. To illustrate the general principle underlying VaR, let's assume you are an investor who holds a stock portfolio that is fully diversified across all the major world markets. To calculate your Value at Risk, you will need the kind of information that is presented graphically in Figure 4, which is a histogram showing the distribution of monthly returns on the Morgan Stanley Capital International world market portfolio from September 1985 through December 1995.

How risky is that portfolio? One measure is the standard deviation of the portfolio's monthly returns. Over that roughly 10-year period, the average monthly return was 1.23%, with a standard deviation of 4.3%. This tells you that, about two thirds of the time, your actual return would have fallen within a range extending from a loss of 3.1% to a gain of 5.5%.

But what if one of your major concerns is the size of your monthly losses if things turn out badly, and you thus want to know more about the bottom third of the distribution of outcomes? Let's say, for example, that you want to know the maximum extent of your losses in 95 cases out of 100—that is, within a 95% "confidence interval." In that case, you would calculate the VaR evaluated at the 5% level,

The question management would like to be able to answer is this: If we define financial distress as a situation where we cannot raise funds with a rating of BBB, or where our cash flows fall below some target, what is the probability of distress over, say, the next three years? VaR by itself cannot answer this question—nor can traditional measures of volatility.

which turns out to be a loss of 5.9%. This VaR, represented by the vertical line in the middle of Figure 4, is obtained by taking the monthly average return of 1.23% and subtracting from it 1.65 times the standard deviation of 4.3%. And, if you wanted to know the dollar value of your maximum expected losses, you would simply multiply 5.9% times the dollar value of your holdings. That number is your monthly VaR at the 95% confidence level.

Athough the VaR is now used by some industrial firms to evaluate the risks of their derivatives portfolios, the measure was originally designed by J.P. Morgan to help financial institutions monitor the exposures created by their trading activities. In fact, for financial institutions that trade in liquid markets, a *daily* VaR is likely to be even more useful for monitoring trading operations than the monthly VaR illustrated above. Use of a daily VaR would tell an institution that it could expect, in 95 cases out of 100, to lose no more than X% of its value before unwinding its positions.

The special appeal of VaR is its ability to compress the expected distribution of bad outcomes into a single number. But how does one apply such a measure to the corporate risk management we have been discussing? Despite its advantages for certain uses, VaR cannot really be used to execute the risk management goal presented in this paper—namely, the elimination of lower-tail outcomes to avoid financial distress. The fact that there is a 95% probability that a company's loss on a given day, or in a given month, will not exceed a certain amount called VaR is not useful information when management's concern is whether firm value will fall below some critical value *over an extended period of time*. The question management would like to be able to answer is this: If we define financial distress as a situation where we cannot raise funds with a rating of BBB, or where our cash flows or the value of equity fall below some target, what is the probability of distress over, say, the next three years? VaR by itself cannot answer this question—nor can traditional measures of volatility.

It is relatively simple to calculate VaR for a financial institution's portfolio over a horizon of a day or a week. It is much less clear how one would compute the VaR associated with, say, an airline's ongoing operating exposure to oil prices. In evaluating their major risks, most non-financial companies will want to know how much volatility in their cash flows or firm value an exposure can be expected to cause over periods of at least a year, and often considerably longer. Unfortunately, there are at least two major difficulties in extending the VaR over longer time horizons that may not be surmountable.

First, remember that a daily VaR at the 99th percentile is one that is expected to occur on one day out of 100. The relative precision of such a prediction makes it possible to conduct empirical checks of the validity of the model. With the large number of daily observations, one can readily observe the frequency with which the loss is equal or greater than VaR *using reasonably current data*. But, if we attempt to move from a daily to, say, a one-year VaR at the same 99th percentile, it becomes very difficult to calculate such a model, much less subject it to empirical testing. Since an annual VaR at the 99th percentile means that the loss can be expected to take place in only one year in every 100, one presumably requires numerous 100-year periods to establish the validity of such a model.

The second problem in extending the time horizon of VaR is its reliance on the normal distribution. When one is especially concerned about "tail" probabilities—the probabilities of the worst and best outcomes—the assumption made about the statistical distribution of the gains and losses is important. Research on stock prices and on default probabilities across different classes of debt suggests that the tail probabilities are generally larger than implied by the normal distribution. A simple way to understand this is as follows. If stock returns were really normally distributed, as many pricing models assume, market declines in excess of 10% in a day would be extremely rare—say, once in a million years. The fact that such declines happen more often than this is proof that the normal distribution does not describe the probability of lower-tail events correctly.

Although this is not an important failing for most applications in corporate finance, including the valuation of most securities, it can be critical in the context of risk management. For example, if changes in the value of derivatives portfolios or default probabilities have "fatter tails" than those implied by a normal distribution, management could end up significantly understating the probability of distress.

An Alternative to VaR: Using Cash Flow Simulations to Estimate Default Probabilities. Moreover, even if we could calculate a one-year VaR for the value of the firm and be reasonably confident that the distribution was normal, the relevant risk measure for hedging purposes would not be the VaR com-

puted at the one-year horizon. A VaR computed at the one-year horizon at the 99th percentile answers the question: What is the maximum loss in firm value that I can expect in 99 years out of 100? But when a company hedges an exposure, its primary concern is the likelihood of distress *during the year*, which depends on the value of the cumulative loss throughout the year. Thus, it must be concerned about the path of firm value during a period of time rather than the distribution of firm value at the end of the period.

Given this focus on cumulative changes in firm value during a period of time, perhaps the most practical approach to assessing a company's probability of financial distress is to conduct sensitivity analysis on the expected distribution of cash flows. Using Monte Carlo simulation techniques, for example, one could project the company's cash flows over a ten-year horizon in a way that is designed to reflect the combined effect of (and any interactions among) all the firm's major risk exposures on its default probability. The probability of distress over that period would be measured by the fraction of simulated distributions that falls below a certain threshold level of cumulative cash flow. Such a technique could also be used to estimate the expected effect of various hedging strategies on the probability of distress.[19]

One of the advantages of using simulation techniques in this context is their ability to incorporate any special properties (or "non-normalities") of the cash flows. As we saw earlier, the VaR approach assumes that the gains and losses from risky positions are "serially independent," which means that if your firm experiences a loss today, the chance of experiencing another loss tomorrow is unaffected. But this assumption is likely to be wrong when applied to the operating cash flow of a nonfinancial firm: If cash flow is poor today, it is more likely to be poor tomorrow. Simulation has the ability to build this "serial dependence" of cash flows into an analysis of the probability of financial distress.

MANAGING RISK-TAKING

As we have seen, a hedging strategy that focuses on the probability of distress can be consistent with an increase in risk-taking. With such a strategy, the primary goal of risk management is to eliminate lower-tail outcomes. Using risk management in this way, it is possible for a company to increase its volatility while also limiting the probability of a bad outcome that would create financial distress. One example of such a strategy would be to lever up the firm while at the same time buying way out-of-the-money put options that pay off if the firm does poorly. Focusing on lower-tail outcomes is also fully consistent with managing longer-term economic or competitive exposures, as opposed to the near-term transaction exposures that most corporate risk management seems designed to hedge.

But how would the firm decide whether the expected payoff from taking certain financial bets is adequate compensation for not only the risk of losses, but also the expected costs of financial distress? And, once management decides that it is a value-increasing proposition to undertake certain bets, how would the firm evaluate the success of its risk-taking efforts?

To evaluate if the bet is worth taking, let's start by supposing that we are willing to put an explicit cost on the increase in the probability of distress resulting from betting on certain markets. In that case, the trade-off for evaluating a bet for the company becomes fairly simple: The expected profit from the bet must exceed the increase in the probability of distress multiplied by the expected cost of distress.[20] Thus, a bet that has a positive expected value and no effect on the probability of distress is one that the firm should take. But a bet with positive expected profit that significantly increases the probability of financial distress may not appear profitable if the costs of a bad outcome are too large. In such cases, it makes sense for the firm to think

19. For an illustration of the use of Monte Carlo analysis in risk management, see René Stulz and Rohan Williamson, "Identifying and Quantifying Exposures," in ed., Robert Jameson, *Treasury Risk Management* (London, Risk Publications), forthcoming.

20. One possible approach to quantifying the *expected* costs of financial distress involves the concept of American "binary options" and the associated option pricing models. An example of a binary option is one that would pay a fixed amount, say, $10, if the stock price of IBM falls below $40. Unlike standard American put options, which when exercised pay an amount equal to (the strike price of) $40 minus the actual price, the holder of a binary option receives either $10 or nothing, and exercises when the stock price crosses the $40 barrier. Such options can be priced using modified option pricing models.

The connection between binary options and risk management is this: The present value of a binary option is a function of two major variables: the probability that firm value will fall below a certain level (in this case, $40) and the payoff in the event of such a drop in value ($10). By substituting for the $10 payoff its own estimate of how much *additional* value the firm is likely to lose *once its value falls to a certain level and gets into financial trouble*, management can then estimate the expected present value of such costs using a binary option pricing model. This is the number that could be set against the expected profit from the firm's bet in order to evaluate whether to go ahead with the bet.

To the extent that view-taking becomes an accepted part of a company's risk management program, it is important to evaluate managers' bets on a risk-adjusted basis and relative to the market. If managers want to behave like money managers, they should be evaluated like money managers.

about using risk management to reduce the probability of distress. By hedging, management may be able to achieve a reduction in cash flow variability that is large enough that an adverse outcome of the bet will not create financial distress.

Given that management has decided the bet is worth taking, how does it evaluate the outcome of the strategy? Consider first the case of our firm AAA discussed earlier. Recall that this firm is not concerned about lower-tail outcomes and thus has no reason to hedge. When evaluating the outcome of the bet in this case, the appropriate benchmark is the expected gain *adjusted for risk*. It is not enough that the bet ends up earning more than the risk-free rate or even more than the firm's cost of capital. To add value for the company's shareholders, the bet must earn a return that is higher than investors' expected return on other investments of comparable risk.

For example, there is considerable evidence that holding currencies of high-interest rate countries earns returns that, on average, exceed the risk-free rate. This excess return most likely represents "normal" compensation for bearing some kind of risk—say, the higher inflation and interest rate volatility associated with high-interest-rate countries. And because such a strategy is thus *expected* to earn excess returns, it would not make sense to reward a corporate treasury for earning excess returns in this way. The treasury takes risks when it pursues that strategy, and the firm's shareholders expect to be compensated for these risks. Thus, it is only the amount by which the treasury exceeds the expected return—or the "abnormal return"—that represents *economic profit* for the corporation.

So, the abnormal or excess return should be the measure for evaluating bets by company AAA. But now let's turn to the case of company BBB, where the expected increase in volatility from the bet is also expected to raise the probability of costly lower-tail outcomes. In such a case, as we saw earlier, management should probably hedge to reduce the probability of financial trouble to acceptable levels. At the same time, however, top management should also consider subjecting its bets to an even higher standard of profitability to compensate shareholders for any associated increase in expected financial distress costs.

How much higher should it be? One method would be to assume that, instead of hedging, the firm raises additional equity capital to support the expected increase in volatility associated with the bet. In that case, the bet would be expected to produce the same risk-adjusted return on capital as the bet taken by company AAA, but on a larger amount of imputed "risk" capital.[21]

In sum, when devising a compensation scheme for those managers entrusted with making the firm's bets, it is critical to structure their incentive payments so that they are encouraged to take only those bets that are expected to increase shareholder wealth. Managers should not be compensated for earning average returns when taking larger-than-average risks. They should be compensated only for earning more than what their shareholders could earn on their own when bearing the same amount of risk.

This approach does not completely eliminate the problem discussed earlier caused by incentives for individuals to stand out in large organizations by taking risks. But traditional compensation schemes only reinforce this problem. If a risk-taker simply receives a bonus for making gains, he has incentives to take random bets because he gets a fraction of his gains while the firm bears the losses. Evaluating managers' performance against a risk-adjusted benchmark can help discourage risk-taking that is not justified by comparative advantage by making it more difficult for the risk-taker to make money by taking random bets.

CONCLUSION

This paper presents a theory of risk management that attempts to go beyond the "variance-minimization" model that dominates most academic discussions of corporate risk management. I argue that the primary goal of risk management is to eliminate the probability of costly lower-tail outcomes—those that would cause financial distress or

21. The amount of implicit "risk capital" (as opposed to the actual cash capital) backing an activity can be calculated as a function of the expected volatility (as measured by the standard deviation) of the activity's cash flow returns. For the distinction between risk capital and cash capital, and a method for calculating risk capital, see Robert Merton and André Perold, "Theory of Risk Capital for Financial Firms," *Journal of Applied Corporate Finance*, Vol. 6 No. 3 (Fall 1993). For one company's application of a similar method for calculating risk capital, see Edward Zaik et al., "RAROC at Bank of America: From Theory to Practice," *Journal of Applied Corporate Finance*, Vol. 9 No. 2 (Summer 1996). For a theoretical model of capital budgeting that takes into account firm-specific risks, see Kenneth Froot and Jeremy Stein, "Risk Management, Capital Budgeting, and Capital Structure Policy for Financial Institutions: An Integrated Approach," Working Paper 96-030, Harvard Business School Division of Research.

make a company unable to carry out its investment strategy. (In this sense, risk management can be viewed as the purchase of well-out-of-the-money put options designed to limit downside risk.) Moreover, by eliminating downside risk and reducing the expected costs of financial trouble, risk management can also help move companies toward their optimal capital and ownership structure. For, besides increasing corporate debt capacity, the reduction of downside risk could also encourage larger equity stakes for managers by shielding their investments from "uncontrollables."

This paper also departs from standard finance theory in suggesting that some companies may have a comparative advantage in bearing certain financial market risks—an advantage that derives from information it acquires through its normal business activities. Although such specialized information may occasionally lead some companies to take speculative positions in commodities or currencies, it is more likely to encourage selective hedging, a practice in which the risk manager's view of future price movements influences the percentage of the exposure that is hedged. This kind of hedging, while certainly containing potential for abuse, may also represent a value-adding form of risk-taking for many companies.

But, to the extent that such view-taking becomes an accepted part of a company's risk management program, it is important to evaluate managers' bets on a risk-adjusted basis and relative to the market. If managers want to behave like money managers, they should be evaluated like money managers.

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