Controlling Risks in Derivatives Markets

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ABSTRACT: The debate about risks and regulation in derivatives markets has failed to provide a clear analysis of what the risks are and whether regulation is a useful tool for their control. The debate is particularly confusing in the area of what has been termed “systemic” risk. This paper analyzes the risks associated with derivatives transactions. We argue that systemic risk is just the aggregation of individual default risks. And because default risk has been exaggerated, so has systemic risk. Furthermore, the debate seems to have ignored the most prominent risk evident in recent derivatives debacles: what we call “agency risk”. After analyzing the risks in derivative markets, we investigate the appropriate role for regulation in their control.

KEYWORDS: Agency risk, default, derivatives, futures, forwards, hedging, options, risk management, regulation, swaps.

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1 Introduction

The current debate about risks and regulation in derivative markets illustrates that there is little agreement on what the risks are or whether regulation is a useful tool for their control. One major source of confusion is the sheer profusion of names describing the risks arising from derivatives. Besides the “price risk” of potential losses on derivatives from changes in interest rates, foreign exchange rates, or commodity prices, there is “default risk” (sometimes referred to as “counterparty risk”), “liquidity (or funding) risk,” “legal risk,” “settlement risk” (or a variation thereof, “Herstatt risk”), and “operations risk.” Last, but not least, is the specter of “systemic risk” that has captured so much Congressional and regulatory attention.

In this paper, we analyze the risks associated with derivative transactions and the impact of regulation in limiting these risks. We proceed in five steps. First, in section 2, we begin with a brief review of price risk—that is, the potential for losses on derivative positions stemming from changes in the prices of the “underlying assets” such as interest rates, exchange rates, and commodity prices. In section 3, we examine the risk of default by either party to a derivatives contract—a risk that we believe has been largely misunderstood and exaggerated. Although the existence of price risk has been demonstrated by a handful of large, highly publicized derivatives losses, there are remarkably few examples of default in derivative markets—and we show why that trend can be expected to continue. In section 4, we argue that systemic risk is simply the aggregation of default risks faced by individual firms in using derivatives. In section 5, we suggest that recent, highly publicized losses can largely be attributed to improper compensation, control and supervision within firms. We define derivative risks stemming from these sources as “agency risks.” In section 6, we assess the efficacy of proposed regulations in controlling risks in derivative markets.

In brief, we argue that the possibility of widespread default throughout the financial system caused by derivatives has been exaggerated, principally due to

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1 The term “derivative” is not used consistently, since claims like common equity can be thought of as options but are never called derivatives. Nonetheless, we follow common usage and apply the term “derivative” to financial contracts that explicitly have the features of options, futures, forwards, or swaps.
the failure to appreciate the low default risk associated with individual derivative contracts. Partly for this reason, the current regulatory proposals should be viewed with some skepticism. In particular, none of the proposals recognize fundamental differences in default risk depending on how derivatives are used. Although the authors of such proposals invariably assure us that new regulations can be put into place with minimal costs, the “regulatory risk” arising from the proposals themselves may now pose the more serious threat to the workings of domestic and international capital markets. Moreover, we argue that important factors in the recent derivatives debacles have largely escaped public discussion. For instance, we believe that some traditional evaluation and compensation systems can be ill-suited for employees granted decision rights over derivatives transactions. Firms that pay large bonuses based on short-term performance can encourage excessive risk-taking by employees. Despite limited public discussion, it appears that firms are keenly aware of the issues and are working to control the problems.

2 Price Risk

The theory of option pricing, pioneered by Black and Scholes (1973) and Merton (1973), is one of the cornerstones of modern finance theory and practice. The central insight from option pricing is that the payoff from a stock option can be replicated by the payoff on a portfolio consisting of the underlying asset and risk-free bonds. Wall Street arbitrageurs ensure that these two equivalent cash-flow packages sell for the same price; hence, the prices of options rapidly move in response to changes in asset and T-bill markets.

To be sure, the proportions of the assets in the replicating portfolios can vary considerably over time; and maintaining these portfolios can involve extensive and costly trading. Even if such trading costs introduce a degree of imprecision into derivative pricing models, virtually all derivatives can be valued

\[2 \text{Note that the trading required to replicate the payoffs depends critically on the other outstanding positions managed by the firm. Required trading costs for a market maker with an extensive derivatives position book are generally dramatically less than the sum of the trades to replicate the individual contracts.}\]
using these arbitrage models. Moreover, this analysis has provided Wall Street with a set of practical tools that have resulted in more effective market-making in the emerging options markets, as well as the creation of new instruments, markets, and strategies.

The ability to use arbitrage pricing in valuing derivatives has profound implications for the current public debate on derivatives: Because derivatives are equivalent to combinations of existing securities, they cannot introduce any new, fundamentally different risks into the financial system. What derivatives can and do accomplish, however, is to isolate and concentrate existing risks, thereby permitting their efficient transfer. Indeed, it is precisely this ability to isolate quite specific risks at low transactions costs that makes derivatives such useful risk-management tools. Derivatives can be used to reduce the variation in net cash flows from areas that benefit from this reduction while introducing little additional, undesirable noise.

MANAGING PRICE RISK WITH DERIVATIVES. To illustrate the use of derivatives in managing price risk, consider a mortgage lender, MTG, with significant interest rate exposures in its core business.

Panel A of figure 1 shows that MTG’s value declines with unexpected increases in the interest rate. At higher interest rates, MTG still receives the same interest payments on outstanding mortgages. Conversely, if the funding for the mortgages is obtained from short-term instruments like deposits, MTG now has to roll over these instruments at higher interest rates. In addition, fee income declines because the firm now originates fewer mortgages. This was exactly the predicament of many savings & loan associations in the early 1980s. MTG’s exposure can be represented by the downward-sloping risk profile in panel A of

\[3\]
\[4\]
figure 1: Higher interest rates (positive changes in $r$) imply lower firm value (negative changes in $V$).

In this example, if interest rates rise more than 200 basis points, the decline in MTG’s value will be sufficient to cause insolvency, which occurs in the shaded area below the dashed line marked I-I. In this region, the payments from outstanding mortgages would be insufficient to cover financing costs at the higher interest rates.

One way to control this problem is to carefully match the duration of assets and liabilities. MTG would have to issue long-term claims to match new mortgages or they would have to hold significant short-maturity assets to match deposits. This, however, would require MTG to alter its core business strategy.

Alternatively, MTG can buy an interest rate swap. Under the swap, MTG receives floating interest rate payments which can be used to pay depositors, while the fixed-rate payments from the mortgages can be used to satisfy the fixed-rate payments of the swap. As interest rates rise, the present value of the fixed-rate payments declines, while the value of the floating-rate payments increases. Hence, the value of MTG’s swap rises with interest rates.

Panel B of figure 1 shows the effects of this hedging strategy. The expos-

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5 “Buying” an interest rate swap customarily refers to taking the pay fixed/receive floating side of the exchange, while “selling” an interest rate swap refers to the opposite side of the transaction.
sure of the fixed for floating swap (shown as the upward-sloping dashed line in panel B) is opposite that of the core business exposure. The net exposure of MTG (shown as the dashed and dotted line in panel B) is the sum of the core and hedge exposures. The reduced slope indicates that the net exposure is less than the core exposure. Hence, engaging in the swap allows MTG to reduce its exposure to interest rate variations without changing its core activities. In particular, the likelihood of insolvency has been reduced, since interest rates now have to rise by 400 basis points to cause insolvency.

The swap reduces MTG’s exposure to interest rates by transferring it to the counterparty in the swap. If the counterparty has the opposite exposure of MTG, then both firms can reduce their exposures simultaneously by engaging in the swap. Although the cash flows of the derivative transactions sum to zero, both firms can benefit from these exposure reductions.

MTG clearly benefits by owning the swap if interest rates rise. What if interest rates fall? If rates decline, MTG is committed to making net payments instead of receiving them. In these circumstances, MTG’s net interest margins would widen. As the cost of MTG’s liabilities fell, origination and refinancing fees would rise; hence, the firm would be in a strong position to meet the payments required by the swap. Thus, the swap makes payments when MTG values them most, and demands payments when MTG can most afford to make them. Only if MTG has insufficient funds to meet its obligations under the swap would it default.

3 Default Risk

Default on any financial contract, including derivatives, occurs when two conditions are met simultaneously: a party to the contract owes a payment under the contract, and the counterparty cannot obtain timely payment.\(^6\)\(^7\)

\(^6\)Under U.S. law this means that the defaulting party either has insufficient assets to cover the required payments, or has successfully filed for protection under the bankruptcy code.

\(^7\)In our discussion of default, we generally ignore technical default since it has no direct cash flow consequences. However, many derivative contracts have cross-default clauses which can place a party into technical default. Should the counterparty try to unwind the contract under the default terms but fail, then default occurs. On the other hand, if the contract can be unwound at market value, then technical default has no valuation consequence.
As noted earlier, part of the confusion in the current debate about derivatives stems from the profusion of names associated with default risk. Terms such as “credit risk” and “counterparty risk” are essentially synonyms for default risk. “Legal risk” refers to the enforceability of the contract. Terms such as “settlement risk” and “Herstatt risk” refer to defaults that occur at a specific point in the life of the contract: the date of settlement. These terms do not represent independent risks; they just describe different occasions or causes of default.

3.1 Default Risk on a Swap

To begin our analysis of default risk, let us return to the example of MTG and its use of an interest rate swap. Note what happens if interest rates do rise to the point where they endanger the firm. A 400-basis-point increase, although less likely than a 200-basis-point increase, is still possible. Yet, if interest rates rise by 400 basis points and MTG becomes insolvent, the firm will not default on its swap. MTG’s swap will be “in the money”—the firm will be receiving net payments from the swap.

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The term Herstatt risk derives from a German bank, I.D.Herstatt, that defaulted on contracts with foreign counterparties after receiving payments but before making them. The default exceeded the net payments due to differences in business hours.
This example illustrates the two conditions that must hold simultaneously for a party to default on a derivative contract. First, the party must owe money on the contract. For MTG, this occurs only to the left of the origin in figure 2. Only if rates fall and the swap finishes “out of the money” is MTG required to pay under the agreement. Second, the solvency (or at least the liquidity) of the party must be sufficiently impaired so that it is not able to meet its obligations. Figure 2 shows that MTG becomes insolvent when firm value falls into the shaded area below the I-I line. Therefore, MTG would default on its swap only if both interest rates and firm value fell at the same time. The range of interest rates and firm values that force MTG into default on the swap is indicated by the cross-hatched area in quadrant III of figure 2.

What is the probability that both of these conditions hold at the same time? The answer depends to a large extent on the correlation between changes in MTG’s value and changes in interest rates. For MTG, this correlation is strongly negative; that is, if interest rates increase and MTG must pay on the swap it has entered, its core business is likely to be robust. Thus, given this strong negative correlation, the probability of default on the swap is low—much lower than the default risk of, say, MTG’s outstanding debt. Because MTG always owes payments on its debt, it defaults on its debt whenever it is insolvent.

3.2 Interpreting Default Risk as an Option

The default risk of a derivative can be viewed as an option. However, the value of this “default option” depends on two uncertain values—the underlying financial price on which the derivative is based and the value of the firm that holds the derivative. Consequently, the option to default is a compound option. Because the mathematics of compound options can be daunting, we will focus on illustrating the problem graphically.\(^9\)

In general, both sides to a derivatives contract have the option to default during the life of the contract.\(^10\) In a swap, for example, either side has the option

\(^9\)See Johnson and Stulz (1987) for a more technical treatment of these issues.

\(^10\)Options form the notable exception to this rule. An option buyer cannot default after the purchase of the option since he does not have any further obligations to pay under the option contract. Hence, only the option writer poses default risk.
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Figure 3: Default as an Option.

to default on any of the settlement dates during the life of the swap. Since a given party cannot default more than once, there generally will be an optimal default policy which adds further complexity to the valuation of this default option. We abstract from these two complications and focus on the default risk posed by one side of the contract at a single payment date.

Figure 3 illustrates the relation between the underlying financial price and the value of the assets of the firm. For concreteness, we return to our example of MTG and interest rates. The ovals in figure 3 are contour lines like those on a topographical map; they represent constant probability associated with the joint distribution of the interest rates and the total value of MTG’s assets. (These ovals are “iso-probability contours.”) One can think of this joint probability distribution map as the topographical map of a hill with the hilltop centered over the point where the unexpected change in the value of the firm’s assets and the unexpected change in interest rates are both zero.

In figure 3, the inside oval contains the combinations of interest rates and MTG’s assets that will occur with a probability of 95%. Consequently, there is only a 5% probability that interest rates and the value of MTG’s assets will be outside the smallest oval. The probability that interest rates and the value of MTG’s assets will be outside the next largest oval drops to 1%; and the probability
that interest rates and MTG’s assets will be outside the largest oval is only $1/2\%$.

In figure 3, the likelihood of MTG’s default on the swap (the joint probability that MTG owes money under the swap and that the value of MTG’s assets are below the critical value) is less than $1/4\%$. The contour that touches the shaded region of quadrant III is the 1% confidence interval. Less than one quarter of the area outside this oval, however, coincides with the shaded region in quadrant III. More precisely, the probability of default is given by the volume above the shaded default area in quadrant III and underneath the probability density function. (This is equal to the bivariate integral of the probability density over the shaded area in quadrant III.) Although this probability is difficult to gauge precisely from the graph, it is straightforward to compute numerically for most probability distributions.

Figure 3 presumes that interest rates and the value of MTG’s assets are uncorrelated. While this may be the case, generally the two could have either positive or negative correlation. Figure 4 illustrates how the correlation affects the likelihood of default.

In both panels of figure 4, the distribution shows a strong correlation between the value of the firm and the value of the interest rate swap. This correlation is negative in panel A and positive in panel B. Since we have assumed linear exposures, the net exposure of the firm is the slope of the regression line of $\Delta V$ on $\Delta r$ (see Adler and Dumas, 1984). Furthermore, the net risk profile in figure 1 can be thought of as the ridge line of the distribution in panel A of figure 4.

Panel A of figure 4 illustrates the negative correlation between interest rates and MTG’s assets we assumed earlier. In this case, the swap is a hedge for MTG’s core exposure, and the likelihood of default on the swap is lower than if firm and swap value are uncorrelated. The 1% confidence region barely touches the shaded area of quadrant III. A considerable amount of the probability mass has been shifted from quadrant III to quadrant II—away from the default area.\footnote{The panel assumes that the negative net exposure does not stem from a large short position in interest rate swaps. If MTG were to sell interest rate swaps, then the default area would be the area of insolvency in quadrant II.} If we return to figure 2, and MTG’s negative correlation with interest rates were...
Figure 4: Default and the Correlation between Firm and Derivative Value.

perfect (the correlation coefficient would be \(-1\)) the probability of default on the swap would be zero.

Panel B of figure 4 illustrates the case of positive correlation between interest rates and MTG’s assets. MTG could achieve such an exposure by fundamentally changing its business, or by acquiring interest rate swaps with very large notional principal. In this case, the likelihood of distress-induced default on the swap increases. Now the 1% confidence region reaches well into the shaded area of quadrant III and probability mass has been shifted to the default area. Figure 4 shows that the likelihood of distress-induced default on derivatives increases with the correlation between the value of the firm and the value of the derivative.

3.3 The Magnitude of Default Risk

Default risk on derivatives is the risk that losses will be incurred due to default by the counterparty. Default risk has two components: the expected exposure, (the expected replacement cost of the derivative minus the expected recovery from the counterparty) and the probability that default will occur.

Expected exposure. The expected exposure measures how much capital is likely to be at risk should the counterparty default. The notional principal amounts of derivatives like swaps and options grossly overstate actual exposure.
For example, in interest rate swaps only net interest payments are exchanged; these are substantially smaller than the notional principal of the swap. In fact, the US General Accounting office (GAO) estimates that the net credit exposure on swaps is only about 1% of notional principal.

In addition to the expected value of the derivative at the time of default, the expected exposure also depends on the expected rate of recovery after default. (Current capital standards implicitly assume that the recovery rate is zero, which leads to a material overstatement of the expected loss.) Most swaps are unsecured claims in bankruptcy proceedings. For unsecured (senior) claims, recovery rates average about 50% (Franks and Torous, 1994)—for collateralized claims recovery rates are closer to 80%.

Finally, the expected exposure depends on whether the contract includes imbedded options. Specifically, if the swap stipulates a floor rate, the buyer’s obligations and the magnitude of the losses it could cause in a default are limited.

**Probability of Default.** To analyze the probability of default it is helpful to recall the necessary conditions for default: the firm must owe payments on the derivative and the firm must be insolvent.

One can decompose the probability of default, \( P(D) \), into the probability of insolvency, \( P(I) \), and the probability of default conditional on insolvency, \( P(D|I) \):\(^{12}\)

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P(D) = P(I) \times P(D|I).
\]

This decomposition is also presented graphically in figure 5.

As we discussed in the context of figure 2, the probability of insolvency and the probability of default conditional on insolvency both depend on the correlation between the value of the firm and the value of the derivative. This correlation changes as the firm varies its hedge ratio. When the firm does not hold any derivatives, the hedge ratio is zero. When the firm fully hedges its exposures, the hedge ratio is one, and the derivatives position minimizes variations in firm value due to the underlying risk factor. As the firm increases its hedge

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\(^{12}\) Since \( P(D|I) \) is a conditional probability between 0 and 1, this decomposition is another way to see that the probability of default on derivatives is never bigger than the probability of insolvency for the firm.
ratio past one, the firm is reversing its net exposure; eventually, firm volatility and the probability of insolvency surpass the magnitudes associated with the firm’s inherent exposure. When the hedge ratio is below zero, the firm is using derivatives to increase rather than reduce its exposures. This is shown in the top panel of figure 5. Nonetheless, as long as firm value has to fall to induce insolvency, the probability of insolvency will be less than $\frac{1}{2}$. This is due to the fact that, regardless of correlation, only half of the probability mass is below the horizontal axis in figure 4.

The middle panel of figure 5 shows how the probability of default conditional on insolvency depends on the hedge ratio. As the firm gradually increases its hedge ratio from zero, it also increases the correlation between the value of the firm and the value of the derivatives. This consequently increases the probability of default conditional on insolvency since more of the probability mass is shifted into the default region. At a hedge ratio of 1, firm and derivative value are uncorrelated, as in figure 3, and the probability of default given insolvency is $\frac{1}{2}$. (Here, we assume that unexpected changes are symmetric.) But, if the hedge ratio is negative, default risk jumps immediately. (MTG would have a negative
hedge ratio if they sold a swap instead of buying one.) In panel A of figure 4, this would have the effect of switching the default area into quadrant II; hence, the discontinuous increase in the default probability. In the extremes, if the firm acquires very large derivatives positions, the firm is sure to default on these positions in the event of insolvency.

Finally, the bottom panel of figure 5 shows the probability of default on the derivative, the product of the probabilities in the two panels above. The probability of default is always less than $\frac{1}{2}$, and much lower than that for reasonable derivative positions with hedge ratios between zero and one.

By buying or selling derivatives, a firm can exploit the negative correlation between its derivatives position and firm value to reduce its risk of insolvency. To the extent that derivatives are used to hedge, they have significantly lower default probabilities than debt issued by the same firm. And not only is the default risk of derivatives significantly lower than that of the firm’s debt, but their use of derivatives helps reduce the default risk of that debt by offsetting the firm’s core business exposures.

At the same time, however, derivatives that are used in attempts to convert the treasury into a profit center generally succeed only in adding financial risk to business risk. As the size of the derivatives position becomes very large, firm value (including the derivatives) and the derivatives become more highly correlated.

To the extent that corporations in the aggregate are using derivatives to reduce and not to amplify exposures, we are justified in using general corporate default rates as a basis for assessing the default risk of derivatives. Altman (1989) examines corporate bond defaults. He reports that 0.93% of all A-rated bonds defaulted during the first 10 years after being issued. Thus, Altman’s evidence suggests an annual average default rate of 0.1%. For the special case of a firm negotiating an at-market swap that completely hedges the firm’s interest rate exposure, the default rate on the swap will be half the default rate on the debt. (This is because for an at-market swap, future interest rates are as likely to be above as below the swap rate. If the firm completely hedges its exposure

\[13\] If (unhedged) firm value and the derivative are uncorrelated, then the figure is symmetric about zero without the discontinuity.
to interest rates, firm value changes and interest rate changes are uncorrelated.) Consequently, a conservative estimate of the average annual default rate on swaps for an A-rated firm that completely hedges its exposure is $\frac{1}{20}$ of one percent (see Figure 5).

**Default Exposure.** In the special case of independence between interest rates and firm value, the default exposure is simply the product of the expected exposure and the probability of default. We have already estimated each of these two components. Our conservative estimate of the default probability is 0.0005. We have also argued that the expected loss on an unsecured swap is 0.5% of notional principal. Therefore, a conservative estimate of the annual expected default cost is 0.00025% of notional principal. This means that on a $10 million interest rate swap, the expected annual cost of default is no more than $25.

### 3.4 Corporate Use of Derivatives

At this point, the evidence on corporate derivative use is still somewhat preliminary. Yet, what evidence there is supports the claim that firms use derivatives to hedge, reducing rather than increasing exposures.

Dolde (1993) reports the results of a survey of the risk-management practices of 244 Fortune 500 firms. The overwhelming majority responded that their policy is to hedge their exposures. Roughly 20 percent responded that their policy is to hedge fully, even when they have a market view. Most firms with a view adjust the extent of their hedging—if their view of likely rate moves is positive, they hedge perhaps only 30 percent of their exposure, but if their view is negative, they hedge 100 percent. Only 2 of the 244 firms responded that they sometimes choose hedge ratios outside the 0–100% range. Thus, less than one percent of the firms responded that they would speculate in a way that might increase exposure.

Furthermore, a considerable body of theory (see Mayers and Smith 1982 and 1987; Stulz 1984; Smith and Stulz 1985; and Froot, Scharfstein, and Stein 1993) predicts what firm characteristics should be associated with higher demand for hedging and hence larger derivatives positions. Nance, Smith, and Smithson (1993); Booth, Smith, and Stolz (1984); Block and Gal-
lagher (1986); Houston and Mueller (1988); Wall and Pringle (1989); Hentschel and Kothari (1995); and Mian (1994) generally report empirical support for these predictions. Yet, if firms were using derivatives to simply speculate, one would not expect to observe this association between firm characteristics and derivatives use.

4 Systemic Risk from Derivatives

As previously mentioned, one of the greatest concerns voiced by regulators is “systemic risk” arising from derivatives. Although such risk is typically undefined and almost never assessed in quantitative terms, the systemic risk associated with derivatives is often envisioned as a potential domino effect in which default in one derivative contract spreads to other contracts and markets, ultimately threatening the entire financial system.

4.1 What Is Systemic Risk?

For the purposes of this paper, we define the systemic risk of derivatives as widespread default in any set of financial contracts that can be associated with default in derivatives. If derivative contracts are to cause widespread default in other markets, there first must be large defaults in derivative markets. In other words, significant derivative defaults are a necessary but not sufficient condition for systemic problems. While this interpretation of systemic risk is consistent with most others, we believe that focusing on default is useful because it has definite cash flow consequences and is more operational.\footnote{The Bank for International Settlements (1992), for example, defines systemic risk to include “widespread difficulties.” Although this definition agrees with ours in spirit, it is less observable.}

Even if systemic risk is simply the aggregation of the underlying risks, because the underlying risks are correlated, one cannot simply sum them to find the total. In the case of derivatives, the underlying risks are likely to be correlated through two channels.

First, default \textit{within} derivative contracts is negatively correlated—that is, at any point in time, only the side of a derivative contract that is in the money can lose due to default and that party’s losses represent an equal and offsetting
gain to the counterparty in the transaction. This negative correlation of the risks arises because the net supply of derivatives is zero. For every party to a derivatives transaction, there is a counterparty with an equal and offsetting position. For this reason, a simple summation of derivatives positions across the economy overstates total default risk.

The second channel is more complex. Some argue that widespread corporate risk management with derivatives increases the correlation of default among financial contracts. If risks are borne by more and different investors than before, the argument goes, more participants will be affected by the underlying shocks to the economy which occur from time to time.

What this argument fails to recognize, however, is that the adverse effects of such shocks on individual firms should be smaller precisely because the same shocks are spread more widely. More important, to the extent firms use derivatives to hedge their existing exposures, much of the impact of shocks is being transferred from corporations and investors less able to bear them to counterparties better able to absorb them. For this reason defaults in the economy as a whole, and hence systemic risk, are unambiguously reduced through the operation of derivatives markets.

4.2 How Bad Is It Likely to Be?

It is certainly conceivable that financial markets could be hit by a very large disturbance. The effects of such a disturbance on derivative markets and participants in these markets depends, in particular, on the duration of the disturbances and whether firms suffer common or independent shocks.

Temporary disturbances. If the disturbance were large but temporary—the liquidity effects of the stock market crash of 1987 are perhaps a good example—many outstanding derivatives would be essentially unaffected. Over-the-counter forwards, options, and swaps specify relatively infrequent payments: forwards and European options only make payments at maturity; swaps make periodic payments, but for standard swaps these payments only occur every six months. Therefore, a temporary disturbance would primarily affect contracts with required settlements during this period. Even if payments were impossible for
some time, a temporary liquidity impairment still would imply that only a fraction of the total payments on swaps would be delayed.

That is not to say that large disturbances, even if they are only temporary, are without effects. During such uncertain times, market makers are likely to substantially increase the spreads they quote to compensate for the risk they assume. Such behavior was evident during the 1992 upheavals in the European Monetary System when, for several hours, many market makers reportedly ceased quoting forward prices for some European currencies. Such an increase in trading costs makes the arbitrage between underlying instruments and derivatives more costly, which in turn would slow the origination of new derivative contracts.

LONGER-TERM PROBLEMS. If the shock were permanent, it would affect derivatives in much the same manner that it affects other instruments. If the underlying price increases, long positions gain while short positions lose. Since derivative contracts are in zero net supply, the gains exactly equal the losses. Nevertheless, for sufficiently large disturbances, there will be—and probably should be—defaults. If it is expensive to reduce the probability of default, the optimal number of defaults in the market will not be zero. The option to default on a contract is an important feature that does not negate the usefulness of the contract. Regulators and other economic policy makers should only try to reduce default probabilities if the benefits of fewer defaults exceed the costs of preventing them.

INDEPENDENT AND CORRELATED DISTURBANCES. A critical question in evaluating systemic risk, however, concerns the extent to which defaults across derivatives markets, and financial markets in general, are likely to be correlated.

We believe that there are strong reasons to expect that defaults on derivatives contracts are approximately independent across dealers and over time. Dealers have powerful incentives to assess the default risks of their customers. In practice, a strong credit rating is required of derivatives customers. This may be all the assurance a derivatives dealer needs to take the other side of a transaction. If the dealer receives a call from a AAA credit expressing an interest in
a swap, the dealer is unlikely to care whether such a firm is hedging or speculating with the swap—it has such a strong balance sheet relative to the size of the transaction that default is extremely unlikely in either circumstance. But if a Baa-rated firm were to ask about the same swap, the dealer would be much more likely to investigate the firm’s exposure to ensure that the swap is being used to offset, not magnify, that exposure.

Second, as we have discussed in detail, firms using derivatives to hedge their exposures are most likely to become insolvent precisely when their derivatives are in the money. Price shocks in the underlying derivative do not cause these firms to default on the derivative.

In this sense, derivative defaults are significantly more idiosyncratic than defaults on loans. For example, a large increase in interest rates is much more likely to lead to a rash of defaults on floating-rate bank loans than on interest rate swaps. Because the correlation among derivative defaults is likely to be lower than the correlation among loan defaults, diversification is a more effective tool for managing the credit risk of derivatives than loans. This is why derivatives dealers carefully monitor and ultimately limit their exposures to individual counterparties, industries, and geographical areas.

Finally, dealers with a carefully balanced book and substantial capital reserves can absorb individual defaults by their counterparties without defaulting on their other outstanding contracts. Dealers function somewhat like a clearing house at futures and options exchanges. For a dealer to default, customer defaults would have to impair dealer capital. Since many financial institutions have set up highly capitalized, highly rated, special-purpose subsidiaries to conduct their derivatives business, such defaults would have to be large to jeopardize the dealer. In addition, these separate subsidiaries protect the remaining business of the financial institution from derivative defaults.

Given these risk-reducing arrangements, highly correlated derivative defaults are not as likely as discussions of systemic risk generally suggest. If the defaults that trigger systemic problems are independent across market participants, then available data on corporate default rates can be used to obtain crude estimates of the likelihood of large-scale disturbances.

Based on the bond default rates in Altman (1989), we have argued that $1/20$
of one percent is a conservative estimate of the annual default rate on derivatives. The default rates from Altman are for industrial firms; they are likely to be much too high for the market makers in these instruments, since they make extensive efforts to run market-neutral books.

If default were literally independent across firms and time, then it could be thought of as tossing a heavily loaded coin. Based on our estimate of the default probability, we load the coin to come up “default” only 5 times in ten thousand throws (we assume that default has a binomial distribution with a default probability of 0.0005 or 1/20 of one percent). We then compute the probability that at least a certain number of firms default. Just how quickly the numbers become incomprehensibly small can be illustrated with the following examples. Table 1 shows that if there are 50 major dealers, the odds of five or more defaults during the same year—not the same quarter or month—are one in 650 billion. These odds rise slowly with the size of the pool, but drop rapidly as the number of defaults is increased. Table 1 shows several example probabilities.

These default rates are not intended to be precise estimates. The fact that they are so small makes it unlikely that we could ever obtain very precise estimates of these phenomena, simply because we don’t observe many of them. Furthermore, assuming that the outcomes are independent across dealers is too strong. But with the capital that dealers devote to the support of their operations, we believe that defaults among dealers are not too far from independent. Even if we have understated the likelihood of systemic problems by a factor of a million, these default rates illustrate just how small these risks are likely to be.

<table>
<thead>
<tr>
<th>Number of firms</th>
<th>Minimum number of defaults</th>
<th>Odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>5</td>
<td>1 : 900 × 10^{12}</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>1 : 2 × 10^{12}</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
<td>1 : 650 × 10^{9}</td>
</tr>
<tr>
<td>50</td>
<td>10</td>
<td>1 : 100 × 10^{24}</td>
</tr>
<tr>
<td>100</td>
<td>5</td>
<td>1 : 2 × 10^{9}</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>1 : 200 × 10^{12}</td>
</tr>
<tr>
<td>100</td>
<td>20</td>
<td>1 : 50 × 10^{45}</td>
</tr>
</tbody>
</table>
5 Agency Risk

The derivatives losses incurred by firms like Procter & Gamble, Gibson Greetings, and Barings Bank gained notoriety because of their size, not because there was serious concern that the companies would default on the contracts. Nevertheless, these losses share a disturbing pattern of inappropriate incentives and controls within the firms. In many instances, the magnitudes of the derivative losses and hence the underlying derivative positions came as surprises to senior management and shareholders. This suggests that employees with the authority to take such derivatives positions were not acting in the best interests of the firm’s owners.

This is a prototypical agency problem. Employees in the derivatives area (the agents) are not working toward the general corporate objectives set by senior management and shareholders (the principals). Since the problem is an agency problem, we will refer to the associated risks as “agency risks.”

Problems of this type are not special to derivatives; they arise in many different settings where principals and agents have divergent interests. Since the agent’s incentives are affected by the structure of the organization, the design of the organization can either exacerbate or control these incentive problems. There are three critical facets of organizational structure: assignments of decision rights, evaluation and control systems, and compensation and reward systems (see Brickley, Smith, and Zimmerman 1995). No single organizational structure is appropriate for all firms. Nonetheless, there are several general features that should help control agency risk in derivatives.

Setting position limits for traders contains the size of the bets that they could take. Separating trading and settlement responsibilities (something that apparently was not done in the case of Barings) allows firms to monitor derivatives activity. This separation is also necessary to ensure compliance with position limits. Compensating traders on the basis of long-term performance reduces the option-like features in some bonus plans that can encourage traders to take riskier positions than the firm would like.

One way to reward traders for good performance without forgiving all losses is to base more of the compensation on long-term performance. For example, in a
good year, a trader might have part of a bonus paid into a deferred compensation account. If subsequent performance is also good, the account continues to grow. On the other hand, if the trader is simply taking large bets, half of which lose, then the bonus account is reduced during years with poor performance. In this way, derivatives traders share responsibility for their losses as well as gains.

Careful control and supervision is critically important for derivatives that offer high leverage. Although leverage is one of the features that makes derivatives attractive hedging instruments, leverage also makes it easier for traders to exceed position limits. For example, forward contracts do not require any payments until maturity, and thus are more easily hidden until maturity.

Many firms are changing the ways in which they manage their derivatives operations to account for these issues. As we gather more experience with these compensation and control systems, control of these problems is likely to improve. Nevertheless, the recent losses demonstrate that agency risk is currently a material problem for many firms.

6 Regulation

Derivatives markets continue to attract a great deal of attention from regulatory bodies around the world. In press accounts and in the popular debate, the aforementioned large losses have been cited as evidence that these markets are very risky. Proponents of greater regulation of derivatives usually argue that regulations can reduce these risks with minimal costs.

Establishing effective public policy, however, requires accurate assessment of not only the risks associated with derivatives, but also of the benefits offered by the instruments and the potential costs of regulatory interference. We believe the benefits are substantial. As we have attempted to demonstrate in this paper, derivatives have provided corporations with a powerful and flexible set of financial tools to manage their exposures to financial prices.

Of course, the misuse of derivatives can be costly. Nevertheless, a growing body of academic evidence suggests that these tools are typically used by firms to hedge their exposures, thereby increasing their competitiveness in global markets. Largely for this reason, we believe the risks and hence potential costs
of these markets have been materially overstated. To the extent that derivatives are being used primarily to hedge rather than to speculate, the default risk associated with derivatives has been significantly overstated. Far from increasing systemic risk, we argue that derivatives markets act to reduce systemic risk by spreading the impact of underlying economic shocks among a larger set of investors in a better position to absorb them.

Overstatement of risk has led to regulatory proposals that significantly raise the costs of—and thereby restrict access to—derivative instruments. By providing a clearer analysis of the risks and potential costs, we hope to encourage more productive regulatory initiatives—those better designed to limit risks while preserving the efficiency of domestic and international capital markets.

We are also concerned about the misidentification of the nature of the risk which regulation might address. Although regulatory proposals focus on default and systemic risk, the problem cases appear to involve agency risk. Little in current or proposed regulation is likely to be effective in controlling agency risk. And given the internal nature of these problems, they are unlikely to be solved by any regulatory decree.

**PROPOSED REGULATION OF END USERS.** In the U.S., the principal regulatory initiatives that would affect the users of derivatives involve disclosure requirements. The proposals now on the table—particularly those calling for periodic reporting of the market value of derivatives positions—have two obvious shortcomings.

First, they are based upon GAAP accounting. Marking derivatives to market can cause problems for corporations that are hedging exposures. If the derivatives used to hedge an exposure are required to be marked to market, but the underlying assets or liabilities being hedged must be carried at historical cost, then reported earnings will become more volatile—even when variability in the firm’s value has been reduced through hedging. For this reason, the accounting system may have to be fixed to make the disclosures more useful to investors.

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15 See Beatty (1995) for an example of how such accounting changes can have repercussions for firm behavior.
The second problem with disclosure requirements is that they effectively ignore the private incentives of companies to provide sufficient information to enable investors to value their shares accurately. Because investors discount shares for uncertainty, companies can be counted on (eventually, if not immediately) to provide additional information about their derivatives activities as long as the benefits of the new information outweigh the costs.

However, the capacity of mandated disclosure to impose additional costs is limited. Disclosure requirements are inefficient only to the extent that they require companies to disclose more than investors are willing to “pay for” in the form of a higher stock price for reduced uncertainty. Yet disclosure requirements, even if modest at first, have a tendency to proliferate.

**Proposed Regulation of Dealers.** Potentially more troubling than disclosure requirements, however, are the current risk-based capital requirements that affect derivatives dealing at banks and other regulated financial institutions, and the proposals to extend such requirements to unregulated market makers in derivatives. Without getting into the details of the calculations, the capital guidelines for banks apply a risk weighting to derivatives (as well as other on- and off-balance-sheet assets), and then compare the institution’s risk-adjusted assets to qualifying capital.

In our analysis, we argued that the credit risk of derivatives depends primarily on two factors: the credit standing of the counterparty and whether the derivative is being used to hedge or speculate. The capital guidelines, however, make no attempt to distinguish between a 10-year swap to a single-B credit that is using the swap to speculate on interest rates and a 3-year swap to a AAA credit that is hedging. In the first case, the guidelines might be too low; in the second, they are almost certainly too high.

Because these capital guidelines are such a blunt tool, their effectiveness in limiting the risk of a dealer default is questionable. Derivatives dealers have strong incentives to back their operations with appropriate levels of capital; in fact, a AA credit rating is almost a requirement to compete in the business. To the extent that regulations specifying minimum capital requirements are set too high, they impose additional costs on dealers. The requirement for excess capital
amounts to a tax; and, like all taxes, it raises costs and prices, thereby limiting access to the market.

In the process of raising costs, moreover, excessive capital requirements also have the potential to create precisely the opposite kind of incentives as those presumably intended by regulators. By burdening safer-than-average derivatives transactions with excessive capital charges, capital requirements that are too high encourage dealers to book riskier deals in order to justify the capital employed. To offer just one example, the current capital guidelines effectively create an incentive for banks and other dealers to structure the kind of leveraged derivatives that Bankers Trust sold Procter & Gamble (since the guidelines are keyed to notional principal, highly leveraged derivatives allow the dealer to support a larger effective exposure with the same amount of capital.)

If one accepts our basic contention—that the risks of derivatives have been exaggerated—then the regulatory history of derivatives certainly can be explained as cautious responses by well-meaning regulators to rapidly growing markets in complex and unfamiliar products. But there may be problems in effecting constructive policy changes. Just as derivatives dealers and users face important private incentives to manage risks in their operations, politicians have private incentives that influence legislative proposals to regulate this market. To the extent that politicians are able to convince the public that the derivatives markets are fundamentally dangerous and that all that keeps the threat at bay is regulatory vigilance, they gain public and political support and so fortify their own positions.

As long as the resulting regulation is relatively inexpensive, such political maneuvering will be fairly harmless. But if the regulation that emerges from the political process becomes too burdensome—which represents a very real risk to the derivatives markets—we will end up reducing the efficiency of the entire financial system.

References


References


