Derivatives Regulation:

Implications for Central Banks

LUDGER HENTSCHEL and CLIFFORD W. SMITH, JR. *

William E. Simon Graduate School
of Business Administration
University of Rochester
Rochester, NY 14627

November 15, 1996

First Draft: June 1996

Comments Welcome

ABSTRACT: We review aspects of derivatives markets that affect central bank operations. We focus on how derivatives affect monetary policy and bank supervision. We argue that derivatives have no material adverse impact on the conduct of monetary policy. Our analysis suggests that both derivatives users and dealers face relatively small default risks from derivatives. Systemic risk, the risk of widespread default, has been largely exaggerated. Policy debates have neglected incentives of employees; the nature of this agency risk suggests that internal controls are more likely to reduce these problems than derivatives regulation.

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

JEL CLASSIFICATIONS: E58, G18

*We gratefully acknowledge helpful conversations with Thomas Cooley, John Long, Glenn MacDonald and Charles Plosser, as well as the comments of the participants at the the "Monetary Policy and Financial Markets" conference in Gerzensee, October 1996, especially those of the discussants, John Boyd and René Stulz. This research was generously supported by the John M. Olin Foundation and the Bradley Policy Research Center at the Simon School.

Contents

1 Introduction

Central banks generally have two primary policy roles: monetary policy and bank supervision. For most central banks, the primary objective in the formulation and implementation of monetary policy is domestic stability of the currency. Although somewhat less clear, the objectives of bank supervision normally involve a stable payments system and frequently a stable banking sector. In terms of constraints, most central banks are directly or indirectly charged with conducting their policies so that they do not unnecessarily impinge upon real economic growth.

During recent derivatives debacles, in which banks (like Barings and Sumitomo) and other firms (like Procter & Gamble and Gibson Greetings) lost billions of dollars in derivatives transactions, there were frequent calls for additional regulation of derivatives. Yet, these calls were rarely accompanied by carefully articulated arguments detailing the benefits of additional regulation. The usual implication, however, is that additional regulation of any activity that could lead to such large losses surely must be for the public good. But the limited scope of the regulatory proposals that actually have been implemented suggests a quite different valuation of the merits of more sweeping regulations.

In this paper, we offer an overview of the primary issues in derivatives markets and regulation as they might concern central banks. To this end, we investigate the interactions among derivatives, monetary policy, and the banking system, as well as the role of regulation in derivatives markets.

Conducting monetary policy and regulating the banking system are not entirely separate. The primary overlap between monetary policy and banking regulation involves monetary policy instruments that rely on the banking system. For example, most central banks regulate reserve requirements (a monetary policy tool as well as a banking regulation) and have emergency lending facilities (for instance, the Federal Reserve's discount window). Hence, changing the discount rate is a monetary policy tool yet operates in concert with bank regulation.

We organize our analysis by focusing on the effects of derivatives on central banks' ability to (i) conduct monetary policy and (ii) safeguard the banking system.[1] Overall, our assessment is that derivatives have no material adverse impact on the conduct of monetary policy. Furthermore, when used to manage risks, derivatives result in a more stable banking system. Nonetheless, we recognize that there are risks in derivatives markets, and that central banks in their role as bank supervisors are appropriately concerned with these risks. Our assessment, however, is that the recent, highly publicized losses can be attributed largely to inadequate controls and dysfunctional compensation packages within firms, including banks. We define derivative risks stemming from these sources as "agency risks", a reference to the principal–agent conflicts from which they arise. Despite limited public discussion, it appears that banks are aware of these issues and are working to control the problems. Moreover, given the internal nature of agency risks and the existing private incentives to control these problems, we believe that more aggressive regulation of derivatives markets is likely to do more harm than good.

We divide our analysis into three primary sections. First, we investigate the effects of derivatives on central banks' ability to conduct monetary policy. Next, we analyze the effect of derivatives on central banks' ability to safeguard the banking system. In section 4, we conclude by considering the role of regulation that central banks might impose on derivatives markets.

2 Monetary Policy and Derivatives

To begin our analysis, we assume perfect capital markets. Such idealized markets with complete information about current and past events have no contracting costs and offer access to complete state-contingent contracts. After establishing this benchmark, we investigate several important deviations.

In markets without transaction costs, securities with identical payoffs must trade at the same price. This law of one price—also known as the absence of arbitrage—is the primary pricing tool for derivatives. While arbitrage pricing of forward contracts has been understood at least since Keynes (1923) and Hicks (1939), the pricing of other derivatives took longer to formalize even

[1] Since most monetary policy is implemented through open market operations, not adjustments of reserve requirements or discount rates, this separation is of limited practical importance.

though the principle is fundamentally the same. Black and Scholes (1973) and Merton (1973) show that options also can be priced via arbitrage arguments. Black (1976), Margrabe (1976), and Cox, Ingersoll and Ross (1981) account for the marking to market common to futures contracts. Bicksler and Chen (1986) and Smith, Smithson and Wakeman (1986) summarize arbitrage pricing principles for swaps. In virtually all cases, these models provide prices that correspond closely to observed prices.

In this idealized setting, derivative contracts are redundant financial instruments; arbitrage pricing methods imply that payoffs identical to those of the derivative could be achieved by trading in a replicating portfolio. Moreover, all derivatives are financial contracts between two counterparties; each party takes one side of the contract; their positions in the derivative net to zero. Consequently, derivatives contracts do not introduce new resources into this idealized market.

This view of derivatives as redundant securities has profound implications for the risks that derivatives could introduce into the market: If derivatives are equivalent to portfolios of underlying securities, they cannot introduce fundamentally new payoffs or risks into the market. In such an idealized market, the presence or absence of derivatives is economically irrelevant.

2.1 Macro effects of derivatives

It is too simplistic to treat derivatives as merely redundant. In practice, incomplete markets, transaction costs, and information costs can justify the existence of derivatives. In such an environment, derivatives contracts provide efficient state-contingent transfers among agents.

Transaction costs. Providing traders with access to derivatives markets lowers transaction costs. A major cost of trading in financial markets is the bid-ask spread. Informational asymmetries and trading volume are important factors in determining the spread. As Treynor argues, traders can be divided into those who trade in attempts to take advantage of their private information, and those who trade for liquidity purposes (Bagehot, 1971). On average, market makers lose when they trade with better-informed counterparties. In order to mitigate these losses, market makers must quote higher spreads than they would offer to traders who trade purely for liquidity reasons. With larger information differences among traders, bid-ask spreads are higher.

Establishing derivatives markets differentially attracts information-motivated traders because of the higher effective leverage in derivatives. Thus, fewer of the traders who remain in the underlying securities market have private information. But, as trades take place in the derivatives market, traders' private information is transformed into publicly observable prices. Of course, arbitrage between the underlying and derivatives markets keeps prices in the two markets linked, thereby ensuring that the derivatives traders' information is reflected in the underlying asset prices. This migration of informed traders to derivatives markets reduces the spread in the underlying market; arbitrage increases the volume of trading. Both of these factors lower transaction costs. This reduction in bid-ask spreads has been documented for a variety of assets (for a survey, see Damodaran and Subrahmanyam, 1992).

Incomplete markets. Ross (1976) argues that options can complete markets in particularly efficient ways. In other words, derivatives whose payoffs are nonlinear functions of an underlying asset can generate a range of payoffs that may be more costly to construct from underlying assets in the presence of transactions costs. In the case of options, while the derivatives could be replicated from the underlying asset and riskless bonds, such replication would require continuous trading in the replicating portfolio.

Costly information. Black (1976) and Grossman (1988) argue that establishing derivatives markets can lower information costs. For example, agricultural futures and options provide information on the market's assessment of the payoffs to future production decisions. Even though the derivatives could be replicated through alternative trading strategies, these strategies would not reveal the same information. With derivatives, the market aggregates private information and makes it public through the prices of the derivatives. This process lowers information costs for producers, even if they never use the derivatives market for trading. Moreover, options markets reveal traders' expectations about the volatility of the underlying price. Such information is much more difficult to infer from simply observing prices in the underlying asset market.

By lowering the cost of transacting and by making prices more explicit, access to derivatives markets raises the returns to investments in information about factors relevant to the price-setting process. This should increase the production of such information and make financial markets more efficient.

As voluntary trades, financial contracts have to improve overall welfare, unless they impose negative externalities on third parties. While derivatives might impose externalities on other market participants, effects such as lower transaction costs, more complete markets, and better information are positive externalities. We now investigate the possibility that derivatives impose negative externalities through their effects on monetary policy.

2.2 Conducting monetary policy

With markets for derivatives such as forwards, futures and swaps, expectations of future prices are more explicit. With options markets, a central bank also has information about the market's expectations of future volatilities of interest rates, foreign exchange rates, and commodity prices. This is potentially useful information in setting monetary policy targets. (For a summary of methods to extract this information from derivatives prices see Svensson and Soederlind, 1997.)

Ultimately, all monetary policy has to operate through three channels: changes in the monetary base, changes in the money multiplier, or changes in the velocity of circulation. We now examine whether the presence of derivatives reduces central bank control over any of these three monetary policy channels.

The monetary base. A central bank's primary monetary policy tool is the monetary base. Implementing monetary policy generally involves management of the current level of the base and expectations about future levels of the base. In order to conduct monetary policy effectively, a central bank appropriately desires tight control over the monetary base. Indeed, Alesina and Summers (1993) provide evidence that central banks that can exercise this control unencumbered by other branches of their government are better able to control inflation.

In principle, a central bank has virtually complete control over the monetary base—currency plus bank reserves held in deposit at the central bank. Unless the central bank faces legal or political restrictions, it clearly can control the currency in circulation. Reserves held at the central bank consist of required reserves—also under central-bank control—and voluntary reserves. Thus, derivatives or other financial contracts can only affect the base through changes in voluntary reserves, a topic we now discuss in the context of the money multiplier.

THE MONEY MULTIPLIER. Two factors jointly determine the money multiplier: the statutory reserve requirements (generally set by the central bank) and the excess reserves held by commercial banks. While the central bank controls the minimum reserve requirements, commercial banks may voluntarily hold excess reserves. Such excess reserves are valuable buffers if there is an unexpected shock to a commercial bank's assets.

If commercial banks regularly use derivatives markets to hedge their exposures to interest rates, foreign exchange rates, and commodity prices, then the desired level of excess reserves in the banking system would be lower than it might be without derivatives markets. Thus, as the use of derivatives increases, voluntary excess reserves would decline; this would increase the money multiplier. But, a central bank's ability to implement monetary policy is limited more by volatility of the multiplier than its level.[2] If access to derivatives reduces the demand for excess reserves by providing alternate risk-management opportunities, then access to derivatives should also reduce the volatility of the money multiplier. Such a reduction would increase effective control over the money supply by the central bank.

THE VELOCITY OF MONEY. There is little evidence that a central bank can affect velocity except through its influence on short-term interest rates. However, if firms and individuals hold precautionary money balances to deal with unexpected shocks, access to derivatives markets should reduce the level and volatility of these precautionary balances. Consequently, the volatility of velocity should decline as well. Again, derivatives markets offer an alternative method for managing shocks from changes in interest rates, foreign exchange rates, or commodity prices. Reducing the volatility of velocity would also increase central-bank control over the money supply.

[2] The money-supply effects of any increase in the multiplier due to declining excess reserves can be offset through adjustments in either reserve requirements or the base.

2.3 Effectiveness of monetary policy

So far, we have argued that derivatives do not reduce central-bank control over monetary aggregates. This unimpaired control over monetary aggregates does not imply, however, that monetary policy is unaffected by the introduction of derivatives. In particular, the effects of monetary policy depend on market structure and the interpretation of monetary shocks. The extent to which monetary shocks are anticipated rather than surprises largely determines the extent to which they have purely nominal rather than real effects.[3] Moreover, international market integration determines the extent to which a central bank can conduct sterilized exchange-rate intervention.

Real and nominal effects of monetary policy. From the outset, we have assumed that the primary responsibility of central banks is safeguarding the value of money without excessive restraints on real economic growth. Nonetheless, many economists and central bankers also regard economic stabilization as an important central-bank policy goal. This view presupposes that monetary policy has real effects—at least in the short run. Arguments over whether and how monetary policy has real effects have raged since Hume (1752). Without attempting to resolve this debate, we can offer several reasons why more active derivatives markets are likely to decrease any real effects of monetary policy without debating how large such real effects might be.

Once again, it is helpful to begin our analysis from the benchmark of perfect markets. In a frictionless economy with complete contingent contracts and no information costs, money would be purely a unit of account; changes in the money supply would simply change this unit of account.

An important deviation from this idealized economy stems from incomplete or costly information. Lucas (1972) shows that monetary shocks can have real effects when agents have insufficient information to accurately differentiate between nominal shocks from unanticipated changes in monetary policy and real shocks to the economy, such as productivity increases.

---

[3] The extent to which monetary policy has any effect, even nominal, largely depends on whether the central bank's currency is actually used in the economy. If another, alternate currency were developed, adjustments in the money supply would be irrelevant. Yet by all accounts, derivatives are sufficiently indivisible and frequently non-transferable, so that they are hardly an effective substitute for currency.

To the extent that the introduction of derivatives is a step toward more complete markets with lower information costs, their prices should provide more accurate information about the nature of monetary shocks. This information should help agents to differentiate between real and nominal disturbances, thereby reducing any real effects of monetary policy.

A reduction of the real effects of monetary policy liberates a central bank in its pursuit of stable prices; with fewer real effects, monetary policy is less constrained by considerations of impacts on real growth. Conversely, the powers of the central bank are reduced, providing a more limited role for using monetary policy to stabilize real output.

Sterilized exchange rate intervention. Another interesting deviation from our benchmark economy are frictions between the domestic and international money markets. Sterilized exchange-rate intervention can be effective only if domestic and international money markets are imperfectly integrated. If money moves freely between the domestic and foreign markets, then a central bank cannot intervene in the foreign market for its currency without affecting the domestic monetary base. By better integrating markets, derivatives reduce a central bank's ability to conduct sterilized exchange-rate intervention.

2.4 Summary

Our analysis of monetary policy and derivatives suggests that derivatives have no negative impact on central-bank control over monetary aggregates. Nonetheless, to the extent that derivatives act to complete markets and provide information through more explicit prices, they may make it more difficult for a central bank to surprise the public. Better forecasts and clearer understanding of monetary policy are likely to reduce any real policy effects. In a similar manner, market completion through derivatives makes sterilized exchange-rate intervention more difficult.[4]

Some central banks view this reduction of the real effects of their policies as an erosion of power and influence that should be stopped. We believe a more appropriate interpretation is that reduced real effects of monetary policy make

[4] For central banks' discussion of these effects, see the Bank for International Settlements (1994).

the primary central bank responsibility—stability of the value of money—an easier task. After all, perceived real effects of monetary policy are frequently cited as constraints in central bank attempts to control inflation.

3 Bank Supervision and Derivatives

As stated earlier, monetary policy and banking supervision are not entirely separate; for example central-bank control over reserve requirements and discount rates can be useful tools in implementing monetary policy. Now, however, we focus more on whether and how derivatives might affect the stability of the banking and payment systems. In their capacity as bank regulators, most central banks are interested in these issues—even in isolation from monetary policy.

3.1 Supervision of banks

Banks are among the most active participants in derivatives markets. They participate in two primary capacities: Many banks use derivatives to manage their own risks. Furthermore, many banks are market makers in derivatives. These banks act either as market makers directly, or, as is becoming increasingly common, through separately capitalized derivatives subsidiaries.

Banks are also among the most heavily regulated financial institutions. There are two primary motivations for the supervision and regulation of banks. The first is that banks play important roles in the operation of the payment system. Individual bank failures can have negative externalities on the functioning of the payment system—externalities that can justify regulatory oversight. The second motivation for the supervision and regulation of banks stems from deposit insurance.[5] In the United States, and in many other countries, the government operates deposit-insurance programs. With these insurance programs in place, depositors at a commercial bank have greatly reduced incentives to monitor risktaking by the bank, leaving the bank's owners with powerful incentives to undertake more risk with other people's money.

[5] For now, we ignore the motive that by restricting entry into banking, the government generates rents within the industry that can be taxed. We return to this aspect of regulation later.

Considering the large number risks commonly associated with derivatives, central banks—in their role as bank supervisors—worry about the influence of derivatives on the stability of the banking system. Besides the price risk of potential variations in the value of derivatives based on changes in interest or exchange rates, there is default risk, counterparty risk, settlement risk, Herstatt risk, liquidity risk, funding risk, legal risk, and operations risk—to mention only the most prominent from the list of identified derivatives risks.[6] We argue that, apart from price risk, this litany of risks in derivatives transactions describes different circumstances and causes of default, but ultimately this list details various facets of default risk.

In addition, there is the threat of systemic risk that has captured so much regulatory and legislative attention. The basic notion is that a single default could spread to other firms and markets through a kind of chain reaction. We define the systemic risk of derivatives as the risk that a default in a derivatives transaction leads to widespread default.

Changes in the value of a bank's derivatives holdings arise from two sources: changes in the price of derivatives held by the bank, and changes in the quantity of derivatives held by the bank. The first source of uncertainty is generally labeled price risk. The second source of uncertainty is frequently omitted from policy discussions about derivatives. We call this risk agency risk, since it arises from a principal-agent conflict between the bank's owners and their employees who actually establish the derivatives positions.

3.2 Price risk and derivatives

A widespread use for derivatives is risk management. Derivatives are well suited for risk management since they efficiently isolate and transfer specific risks. The standard use of derivatives is in managing price risks through hedging. Firms with an inherent business exposure to underlying factors such as commodity prices, interest or exchange rates, can reduce their net exposures to these factors by acquiring offsetting exposures using derivatives. Rational, value-maximizing

[6] The term Herstatt risk derives from a German bank 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.

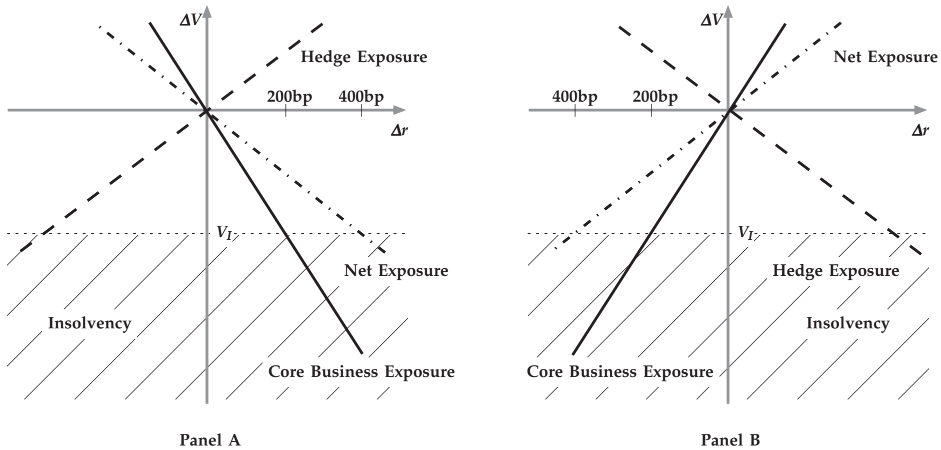

FIGURE 1: Exposures, Hedging, and Risk Sharing.

motivations for such corporate hedging activities are provided by Mayers and Smith (1982, 1987); Stulz (1984); Smith and Stulz (1985); and Froot, Scharfstein, and Stein (1993), among others.

Although risk aversion can provide powerful incentives to hedge for individuals, this generally is not the motive for large public companies whose owners can manage their risk exposures by adjusting the composition of their portfolios. Rather, current theory suggests that incentives to hedge stem from progressivity in the structure of taxes, contracting costs, or underinvestment problems. All of these issues involve internally generated, after-tax cash flows to the firm and cannot be replicated by external investors. For instance, a bank may be able to reduce its risk of bankruptcy and default on deposits by hedging its interest-rate exposures. If this risk reduction allows the bank to attract deposits at lower rates, for example, then hedging provides benefits that the bank's stockholders cannot obtain by hedging their investment returns.

Panel A of figure 1 illustrates the interest exposure of a bank. In the figure, the inherent exposures of the bank indicates that the bank's value would decline with rising short-term interest rates. This situation can arise if the bank makes long-term loans but obtains its funds through short-term deposits. With this inherent exposure, the bank becomes insolvent if interest rates rise 200 basis points. If, however, the bank offsets its inherent exposure with an interest-rate swap, then its net exposure to short-term interest rates is reduced. In panel A, the hedged bank can sustain short-term interest rate increases up to 400 basis points.

Clearly, this hedging by the bank transfers interest-rate risk to the counterparty of the swap. This does not imply, however, that the counterparty must speculate on interest rates, or increase its net exposure to interest rates. As illustrated in panel B of figure 1, the counterparty could have the opposite inherent exposure. Such a situation arises, for example, if the counterparty is an insurance company that has short-term assets (to provide liquidity) but has underwritten long-term policies. This swap allows both counterparties to reduce their net exposures to interest rates.

Consequently, risk management transfers risks from one party to another, but in the process it can reduce the riskiness of all derivatives participants by pooling the risks among counterparties with offsetting exposures. Even if all firms faced a negative inherent interest rate exposure, they would not all find this exposure equally costly. In this case, some parties would take on additional risks; pooling risks by shifting them from parties that find them onerous to parties that are more willing to accept them improves aggregate welfare. The derivatives market establishes a market-wide opportunity cost and risks are shifted to those with a comparative advantage in bearing them.

3.3 Default risk, market making, and organizational architecture

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

The misalignment between owners' objectives and employees' actions makes this a standard 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). Given the nature of the problem, we refer to the associated risks as agency risks. In principle, such agency problems exist whenever an agent in charge of establishing a derivatives position has private incentives to deviate from the position that maximizes the value of the firm.

Problems of this type are not special to derivatives; they arise in many different settings where principals and agents have divergent interests.[7] 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. Brickley, Smith and Zimmerman (1997) focus on three critical facets of organizational architecture: assignment of decision rights, reward systems, and control systems.

Decision rights. For most firms, an optimal derivatives position, although not static, changes relatively slowly. Most firms' exposures change little from day to day. In such cases, it is less important that individual employees have decision rights over derivatives positions. In such cases, allocating these decision rights to a team of treasury employees can improve internal controls at low cost.

In contrast, derivatives traders and dealers typically have—and normally should have—substantial decision rights over the positions they assume in derivatives. In a trading environment, relevant information frequently must be acted upon quickly, or its value is lost.

Reward systems. Typical employment in the derivatives trading area also suggests that an optimal compensation package should have strong incentive components (see Holmstrom, 1979). In particular, improved performance can generate large additional profits and normal trading activities are readily observable. There is also no reason to believe that employees in the derivatives area are more risk averse or less responsive to incentives than other employees.

[7] A prominent example involving trades in U.S. Treasury securities produced a billion dollar loss for Daiwa Bank in 1995, when one of its senior traders in New York was discovered to have falsified trading records over the previous 11 years.

In corporate hedging operations, even if the actual derivatives activity is costly to observe, compensation based on the outcome of firm value in certain circumstances will still induce the desired behavior. By tying compensation to the objective, senior management can induce employees in the derivatives area to adhere to the hedging program so long as the firm's inherent exposures are observable. In tandem with periodic observations of derivatives positions, senior management can draw some inferences from the time series of cash flows and incentive compensation can be useful in implementing hedging activities by employees.

Indeed, if the objective is to stabilize some combination of firm value, reported earnings, and taxable income, incentive compensation for treasury employees might be cheaper to implement than for other employees. A basic cost of incentive compensation is the increased income risk for the employee; risk-averse employees demand higher average compensation to bear this risk. Yet, employees charged with reducing risk face less risk when they are successful.

For derivatives employees in trading or market-making functions, the situation is somewhat different. Here, the objective is not to stabilize firm value but to generate profits. For any high-leverage financial contract, strong incentive compensation based on the payoff to the contract can have undesirable side effects.

A fundamental problem in linking pay to derivative profits is the limited liability of employees. Although employees can participate in the upside, they usually have insufficient resources to share large negative outcomes. This asymmetry induces option-like features in compensation plans based on trading profits. 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, payouts increase as 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. Compensating employees on the basis of long-term performance reduces the option-like features that would otherwise encourage traders to take riskier positions than is optimal from the owners' perspective.[8]

Control systems. The agency problem would be simple to control if both the inherent exposure and the actual derivatives position were perfectly observable. In this case, owners would simply force their employees to implement optimal hedging policies by rewarding compliance with and punishing deviations from these policies.

The recent derivatives scandals point out, however, that monitoring can be difficult even within the firm. Managers at firms like Barings Bank and Procter & Gamble claim they were unaware of the extent of the derivatives activities of their subordinates. In a less dramatic incident, an internal reorganization at American International Group apparently was prompted by lapses that occurred because a single individual had both run and evaluated the firm's main derivatives activities.

Careful control and supervision is critically important for derivatives activities. Setting position limits for derivatives traders constrains the size of the positions that they are permitted to assume without additional authorization. Separating trading and settlement responsibilities (something that apparently was not done in the case of Barings Bank) allows firms to monitor derivatives activity. This separation also facilitates compliance with position limits.

Although leverage is one of the features that makes derivatives attractive hedging instruments, this leverage also makes it harder to monitor derivatives activity by reducing the cash flows at initiation of the contracts. This problem is more difficult today because of the steady increase in available maturities over the past decade, which has extended the time required to determine the ultimate net gain or loss from derivatives contracts.

Even insiders find information about derivatives activities at their firm expensive to obtain in a timely manner. Fortunately, extremely detailed information may not be necessary. Our analysis in the appendix suggests that potential derivatives losses are quite sensitive to whether the firm hedges or

---

[8] While such long-term compensation is less risky, it is also less valuable. Other components of the compensation system may have to be adjusted to assure that the firm offers the appropriate level of compensation to retain employees with the desired skills.

speculates. But the potential losses are less sensitive to precisely establishing and maintaining the optimal hedge ratio.

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

3.4 Default risk and derivatives

As supervisors of the banking and payment system, central banks are frequently concerned that commercial banks' participation in derivatives markets could lead to a large bank default, or worse, widespread disruption of financial markets.

Default on any financial contract involves a failure by one party to the contract to make a payment required under the contract.[9] For derivatives, default 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.[10]

Legal risk. One condition under which the counterparty cannot obtain timely payment is when the courts rule that the contract is void. This is precisely what happened in the case of Hazell v. Hammersmith & Fulham. Hammersmith & Fulham is a local British authority that entered into a series of swap transactions. Upon losing substantial sums, they argued in British courts that they lacked the legal authority to enter into the transactions and thus the contracts should be voided. This argument was accepted by the courts and the associated defaults represent a substantial fraction of all realized defaults in the history of the swap market.

[9] 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.

[10] 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 that 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 consequences.

Nonetheless, care should be exercised in extrapolating from that experience in forecasting future default rates. As experience with derivatives accumulates and more contracts are tested in the courts, precedents cumulate in common-law countries and statues are clarified in code-law countries. In both environments, given a stable legal system, contracts and practices are modified based on the prior judgements. In both environments, legal risk declines over time.

Credit risk. The restriction that default can only occur when a payment is owed indicates that the default probability on derivatives is no higher than that on ordinary debt. Subsequent to issuing debt, the debtor only owes payments under the contract, never receives them. In contrast, most derivatives make or require payments depending on the value of an underlying asset.[11]

Moreover, the probability of defaulting on a derivative depends on whether the derivative is used to reduce or increase an existing exposure. Figure 1 shows that by using derivatives to hedge, this bank can sustain larger adverse changes in interest rates before it becomes insolvent. This means that the bank's probability of insolvency is lower, which translates into a lower probability of default on all its obligations—regardless of whether these obligations are deposits, long-term debts, or derivatives contracts. Conversely, a bank that uses derivatives to exacerbate its inherent exposures increases its probability of insolvency and default (see Hentschel and Smith, 1995; this analysis is summarized in the appendix).

The default risk on derivatives has three primary implications for commercial banks. First, under a derivatives contract, a bank faces lower default risk if its counterparty is using the derivative to hedge than when the counterparty is using the derivative to speculate. Second, when using derivatives to reduce the bank's exposures, the bank reduces the probability of default on all of its obligations, including deposits. Third, even if a bank uses derivatives to speculate and increase bank risk (for example, because of the asymmetric payoffs it receives given deposit insurance), the default on the derivative is always less than the probability on a fixed liability like an uninsured CD.

[11] Options form a notable extreme, since the owner of the option is never required to make any payments after purchase of the option. Hence, owners of options cannot default on the options.

3.5 Bank supervision, monetary policy, and systemic risk

As previously mentioned, one of the greatest concerns expressed by regulators is systemic risk arising from derivatives. Although such risk is rarely defined precisely 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 derivatives contract spreads to other contracts and markets, ultimately threatening the entire financial system.

We define the systemic risk of derivatives as widespread default in any set of financial contracts that can be traced to defaults in derivatives. If derivative contracts are to cause widespread default in other markets, there first must be large-scale defaults in derivative markets. In other words, significant derivative defaults are a necessary but not sufficient condition for systemic problems. While this definition 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.[12]

Even if systemic risk were simply the aggregation of the underlying risks, because the underlying risks are correlated, we cannot simply sum them to obtain the total. In the case of derivatives, the underlying risks are correlated through at least two channels.

First, default *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 from default and that party's losses represent equal and offsetting gains to the counterparty in the transaction. This negative correlation of the risks is due to the zero net supply of derivatives. For this reason, a simple summation of derivatives positions across the economy overstates total default risk.

The second channel of correlation 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 are affected by the underlying shocks to the economy that occur from time to time.

[12] 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 more difficult to apply in practice.

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 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.

A frequently voiced concern about banks' use of derivatives is that banks are likely to accumulate similar derivatives positions. This similarity in derivatives positions within the industry, the argument goes, exposes the industry to common shocks and therefore raises the specter of systemic risk. For example, if banks are typically short-funded (the duration of their liabilities tends to be shorter than that of their assets), then in hedging their exposures, banks will tend to enter swaps under which they receive floating and make fixed payments. Nonetheless, these swaps unambiguously reduce the probability of default for each bank and thus for the banking industry as whole.

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, both on whether firms suffer common or independent shocks and the duration of the disturbances.

Independent and correlated disturbances. A critical question in evaluating systemic risk 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 default risks of their customers. In practice, a strong credit rating is required of over-the-counter derivatives customers. This may be all the assurance a derivatives dealer needs to take the other side of a transaction. If a 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—with a strong balance sheet relative to the size of the transaction, 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 discuss in detail in the appendix, firms using derivatives to hedge their exposures are most likely to become insolvent precisely when their derivatives are in the money. Shocks to the price of the asset underlying the 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 generally limit their exposures to individual counterparties, industries, and geographical areas.

Finally, dealers with carefully balanced books 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 (see Bartman, Milich and Voldstad, 1994). In addition, these separate subsidiaries shield the remaining business of the financial institution from derivative defaults.

Temporary disturbances. If a disturbance were large but temporary—the liquidity effects of the stock market crash of 1987 are perhaps a good example—few outstanding derivatives would be affected. Over-the-counter forwards, options, and swaps require 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 only temporary, are without effects. During such uncertain times, market makers are likely to increase quoted spreads substantially to compensate for the additional risk they assume. Such behavior was evident during the 1987 stock market crash as well as the 1992 upheavals in the European Monetary System. Such an increase in trading costs makes arbitrage between underlying instruments and derivatives more costly, which in turn slows the origination of new derivative contracts—including transactions to unwind existing positions.

Moreover, higher trading costs and delays in execution makes dynamic replication of derivatives more expensive or even impossible. These difficulties occur exactly at times when risk, and consequently the demand for risk management, is high. Hence, the actual derivatives contracts are particularly valuable during such episodes—both, because they are cheaper to trade and because they make the market's risk assessments more explicit through prices.

Longer-term problems. If a 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. So long as 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. Optimal regulation implies that regulators and other economic policy makers would only try to reduce default probabilities if the benefits of fewer defaults exceed the costs of preventing them.

3.6 Summary

The possibility of widespread default throughout the financial system stemming from the use of derivatives has been exaggerated, principally because of the failure to recognize the low default risk associated with derivatives. While most now recognize that traditional measures of derivatives exposure—notional principal—

overstate the amount of capital at risk, even net exposures (estimated to be about 1% of notional principal) is misleading. It fails to recognize both the expected recoveries in the event of default and the low probability that the firm will be insolvent and simultaneously owe payments on its derivatives. For a firm that is hedging, or a dealer with a balanced book, this probability is quite low.[13]

Nonetheless, we recognize that derivatives are not without problems. In particular, the high leverage and infrequent payments associated with some derivatives make more careful internal controls especially important in the management of agency risk, the misuse of derivatives by employees.

4 Regulation and Derivatives

Positive economics leaves a clear but limited role for regulation. To improve social welfare, regulation must correct market failures. A market failure arises when property rights are not clearly defined, are difficult to enforce, or expensive to transfer. In such cases, market mechanisms can not set appropriate prices or make proper allocations. Classic examples of such market failures include the pollution externalities of resources with ill-defined property rights like water and air.

Coase's (1960) seminal work on social cost shows that market failures are necessary but not sufficient to justify regulatory interference on economic grounds. In many cases, making clear assignments of property rights and allowing for their transfer can solve market failures. When this solution is performed by a regulatory agency, then the regulator tries to correct the market failure by creating a market where none existed before (for instance, by creating a transferable right to pollute.) Traditionally, however, regulatory agencies have performed some of the allocational roles of the market. This can be done by directly allocating resources, for example by prohibiting activities like pollution. Almost equivalently, a regulatory agency can make adjustments to market prices. This is typically accomplished through taxes.

Given the complexity of the allocation mechanism, creating markets and letting agents make their preferred allocations is generally more successful than

[13] See the appendix for a rough estimate of the magnitude of default risk.

the construction of an ever more elaborate regulatory framework that directs resources.

As Stigler (1971) points out, there are economic forces that distort observed or proposed regulation away from the ideal of correcting market failures. In many situations, a subset of market participants benefits from regulation at the expense of others and overall welfare. The beneficiaries clearly have an interest in proposing and supporting such regulation; frequently they succeed in its institution. For example, banks have an active interest in setting high barriers to entry for the banking industry. The presence of such barriers reduces competition among banks and creates quasi-rents for existing banks, which in turn can be shared with regulators.[14]

To analyze the appropriate role for regulation of derivatives use by banks, we first examine potential market failures involving derivatives; we then analyze the role of derivatives regulation in controlling these failures.

4.1 Potential market failures

In order to assess the efficacy of derivatives regulation we must assess two factors: First, we examine the importance of potential market failures associated with derivatives. Second, once we have identified a market failure, we have to weigh the costs and benefits of regulations that reduce the problem.

Since all derivatives contracts are voluntary agreements between the counterparties, there is relatively little room for market failures between derivatives counterparties. Much of the notional principal in derivatives contracts stems from over-the-counter contracts. In these customized contracts, counterparties take great care to leave as little uncertainty about the nature and enforceability of obligations as they deem cost-effective. Market failures associated with derivatives therefore primarily involve third parties—those not participating in the derivatives transaction.

We cannot provide an exhaustive survey of economic activities on which derivatives have an impact. Rather, we focus on what we think are the two most

[14] An example of such restrictive regulation is the fixed commission schedule for stock trades on the New York Stock Exchange that was enforced by the U.S. Securities and Exchange Commission until 1975 (see Phillips and Zecher, 1981).

important potential market failures where the banking system and derivatives interact. In turn, we address the interactions between government-supplied deposit insurance and derivatives, and between the safe operation of the payment system and derivatives.

Deposit insurance and derivatives. Government-supplied deposit insurance can lead to excessive risktaking by banks. This is the moral-hazard problem associated with most insurance. Without deposit insurance, depositors have private incentives to limit a bank's risktaking by requiring higher interest rates on their deposits at riskier banks. With complete deposit insurance, depositors do not increase the interest rates they demand from risky banks since the deposits are insured by the government.

If the insurance premia do not fully charge banks for additional risks, then banks are likely to react to the lower costs of risktaking by undertaking higher levels of risk. In the United States, the Federal Deposit Insurance Corporation (FDIC) insures deposits up to $100,000 against loss (*de facto* insurance arguably extends to larger deposits). This insurance is not priced explicitly on the basis of bank risk, since the premium is fixed per dollar of insured deposits.[15] Absent additional constraints, banks can achieve higher risk either by pursuing higher profits through higher leverage in traditional banking activities, or by entering other markets, for instance by speculating using derivatives.

The social costs of these insurance programs comes from the misallocation of resources they produce. With insurance, neither banks nor depositors bear the full costs of the risks they assume. As a result, they assume too much risk from a social standpoint. Banks fund risky projects at rates that are too low relative to their true cost to society: more than the optimal amount of risk is undertaken in the economy as a whole.

Deposit insurance can be viewed as a put option on the bank's assets with a strike price equal to the face value of the bank's deposits (see Merton, 1977). As the writer of the put option, the insurer has an immediate incentive to limit the riskiness of the bank's assets. If such limitations are not imposed through

[15] In principle, deposit insurance premia could be structured to increase with the default risk of the bank, thereby limiting the increased risktaking. This is not done in practice, presumably because of the difficulty in establishing and enforcing the appropriate premia in the absence of a market mechanism.

explicit insurance premia, the deposit insurance agency has incentives to impose limits through implicit premia. Because U.S. deposit insurance premia are not risk adjusted, the FDIC establishes implicit premia through regulations (see Buser, Chen and Kane, 1981). Banks, however, will submit to regulation as a requirement for deposit insurance only if they are at least as well off with insurance (inclusive of the indirect costs of regulation) as they would be without insurance and the associated regulatory burden. Thus, subsidized insurance serves to induce banks to submit to the regulation.

It should be noted that there are other factors that also limit banks' incentives to assume additional risks. If a bank uses derivatives to take risks, the bank jeopardizes its franchise value. This means that incentives to undertake additional risk are most pronounced when the probability of insolvency is high. For instance, in the United States, during the savings and loan crisis of the late 1980s, these incentives were particularly strong. Much of the equity in the savings and loan industry had been wiped out. Many S&Ls dramatically increased the risk they bore through means like higher leverage and changes in their asset portfolios.

THE PAYMENT SYSTEM AND DERIVATIVES. Potential market failures associated with the payments system arise in at least three dimensions: the risk of default on demand deposits by a bank creates incentives for sellers of goods to verify both that the buyer has funds in his acount and that the bank is solvent (see Merton and Bodie, 1993); access to the payment system is mispriced (see Humphrey and Berger, 1990); and the risk that a failure by an individual institution to meet its commitments in funds transfer generates a chain of failures among other institutions (see Faulhaber, Phillips, and Santomero, 1990).

In the first case, the probability of a check being honored depends on both the solvency of the check writer and the solvency of the writer's bank. Thus, if the payment system is secure, individuals and businesses are concerned only about the credit risk of the writer—they do not need to invest in information about the risk of the writer's bank. Banks' risks in derivatives markets have no direct implications for the mispricing of payment-system services. Moreover, our previous analysis suggests that derivatives are unlikely to be a major cause for bank failures, let alone widespread bank failures. In neither their end-user nor their market-maker capacities do banks face risks in derivatives markets that are fundamentally different from the types of risks they manage in their loan and security portfolios. Moreover, as we have outlined earlier and explain in detail in the appendix, a bank that uses derivatives to hedge its exposures is less likely to default on any of its obligations.

Although market making is likely to expose banks to some additional default risk, this risk is likely to be smaller than the risks associated with more traditional banking activities like lending. As we have already noted, because default on derivatives is more idiosyncratic than default on loans, diversification is a more effective tool in managing default risk in derivatives than in loans. Furthermore, to the extent that a bank's derivatives subsidiary can shield its parent from losses at the subsidiary, the current movement toward conducting most market making in derivatives through such subsidiaries reduces banks' default risk and further isolates the payments system from problems arising from derivatives market making.

Even the largest and most prominent recent bank failure, the collapse of Barings Bank, did not result in problems that can be characterized as systemic. Barings' failure also did not result in material difficulties for the payment system. The operations of Barings Bank were simply wound down in an orderly fashion or absorbed by ING.

The security of transaction balances, however, saves large information costs. Deposit insurance or alternative ways of guaranteeing demand deposits provide secure transaction balances. In addition to such safeguards, many governments and their central banks act as lenders of last resort for troubled banks. Many central banks lend to banks at subsidized rates long before bank failure is imminent. In the United States, this lending takes place through the Federal Reserve's discount window. Even in the absence of derivatives, lending at subsidized rates has to be constrained through practices that impose implicit costs, or it would become a primary source of borrowing for banks with access to the discount window. Currently, the Federal Reserve imposes these implicit costs through restrictions on who can borrow, the maturities of the loans, and the additional scrutiny imposed on institutions that use the discount window. The introduction of derivatives alters neither the basic operation of the discount window, nor the effectiveness of the rules limiting access to the discount window.

4.2 Regulatory solutions

There is a relatively simple market-based reform that simultaneously solves the externalities associated with an insecure payment system and deposit insurance. If demand deposits at banks are fully backed by default-free securities, then derivatives pose problems for the safety of neither deposits nor the payment system. We discuss this benchmark before proceeding to other regulatory solutions.

Secure demand deposits. Merton and Bodie (1993) describe a system in which transaction deposits at banks are fully backed by short-term government securities like U.S. Treasury bills.[16] In this benchmark case, demand deposits are fully insured and contribute to the safe and efficient operation of the payment system. If transactions deposits are not safe, third parties bear costs since they either have to accept risky payments, or monitor the safety of many different banks with whom they have no direct dealings. With demand deposits fully backed by government securities, a secure payments system can be achieved without additional deposit insurance.

Note that this system is not the same as "narrow banking." Only demand deposits provide direct access to the payment system. Consequently, only demand deposits would be secured by 100% reserves. Banks could continue to intermediate in all other instruments using a system of fractional reserves, which presumably would emerge as a market outcome.

In a system with 100% reserves for demand deposits, the government would continue to serve as the ultimate guarantor of the demand deposits, since the government securities held in reserve are only valuable when the government meets its obligations. Nonetheless, the full reserves relieve the government from its role in monitoring the portfolios of insured banks and assessing insurance premia, seizing banks when their values fall below some threshold, or restricting banks' portfolio choices.[17]

[16] Similar proposals have been made by Friedman (1960), as well as others cited in Merton and Bodie (1993).

[17] Although we focus on 100% reserve requirements on demand deposits as the main alternative to deposit insurance, Merton and Bodie (1993) reference several other reforms that offer similar benefits in principle, but appear to be more costly to implement.

For example, Merrill Lynch effectively offers fully collateralized deposits in its Cash Management Accounts. The accounts allow customers to issue drafts on their accounts, but Merrill Lynch maintains 100% reserves. There is little criticism of the role that the firm plays in the derivatives market, even though Merrill Lynch has very large Cash Management Account balances. Because of this effective segregation of funds, Cash Management Account customers are little concerned about the Merrill Lynch's other business—derivatives included. Yet, most central banks historically have chosen to retain fractional reserve banking and to protect the payment system by regulation and deposit insurance.

Finally, it is important to recognize that the benefits of a change from government-supplied deposit insurance to a 100% reserve system are partially defeated, unless the government can credibly commit to letting banks fail. If the government has difficulty making this commitment, then the implicit insurance still leads banks to undertake excessive risks.[18]

No major banking system operates with 100% reserves for demand deposits. Banks' lack of support for this standard is understandable. Fractional reserves benefit banks through lower expenses, which are only partly offset by the private costs they face from a less secure payment system. That governments do not impose such systems might be more surprising. Less efficient alternative regulations can be understood, however, if regulators are not just acting in the public's best interest but also are concerned with their own welfare. Such regulators have private incentives to impose less efficient and more cumbersome regulations that increase the regulators' ability to extract rents from the banking system.

If a system of 100% reserves for demand deposits is not implemented, either of the two aforementioned externalities can be used to justify a wide range of regulations under the theory of the second-best. We do not attempt to review all possible, or even all actual derivatives regulation. Instead, we focus on the main regulations that have been implemented and their shortcomings. Finally, we

[18] Presumably, one of the reasons why governments find it difficult to look the other way in cases of difficulty is that the private gains to the beneficiaries are much more concentrated than the losses to the rest of society (see Stigler, 1971 and Stiglitz, 1993). This provides the beneficiaries with large private incentives to lobby for aid and the *de facto* benefactors with small private incentives to lobby against aid.

suggest that self-reported risk levels or risk-based deposit insurance have more merit than most current regulations.

Currently, derivatives are regulated in many different ways by many different agencies. In most cases, however, the rules rely on a few primary devices. Firms and banks using derivatives generally are required to disclose their activity to the public or to bank supervisors. In addition, most banks are required to hold reserves against derivatives. While these rules typically are imposed by a regulatory agency, self-government of derivatives participants has also produced some "voluntary" rules. Such codification of procedures can be beneficial, but it is not always entirely voluntary.

Capital adequacy rules. In many countries, minimum capital standards are one of the primary regulations that constrain bank risktaking and derivatives activity. Capital standards generally set limits on the use of deposits and debt financing as a percentage of the banks' assets. Under risk-based capital standards, the limits are set as a percentage of risk-adjusted bank assets. These capital standards interact with deposit insurance and the bank-examination process to influence asset choice and risktaking (see Flannery, 1989). A substantial part of the examination process is focused on assessing the credit quality of a bank's asset portfolio. Bank examiners seek to identify assets whose timely repayment is unlikely. A portion of such assets is deducted from the regulator's assessment of bank capital.

Few of these capital standards were developed explicitly for derivatives. Rather, most countries have adapted their capital requirements to encompass derivatives. In many countries, these rules follow a model developed by the Bank for International Settlements (BIS). In this approach, banks are required to hold capital in proportion to the *credit-equivalent exposure* of their derivatives. This has two parts, the *potential credit exposure* plus *current replacement cost.*

The potential credit exposure is the product of the notional principal of the derivative and a *credit conversion factor* (which depends on the maturity of the transaction and whether it is an interest rate or foreign exchange rate contract). Current replacement cost is the mark-to-market value of the derivative if positive, or zero if the value is negative.

There are several aspects of these rules that make them fairly crude regulatory instruments. First, the credit-equivalent exposure does not depend on whether the counterparty is hedging or exacerbating their inherent exposure. Yet, as we show in the appendix, the default risk of the contract is materially different in these two cases. Second, this exposure method does not reflect the effective leverage in the transaction. For example, the transaction between Bankers Trust and Procter & Gamble was a leveraged swap—the swap's value changed with changes in interest rates multiplied by about 15 times the notional principal.[19] Third, given our arguments that default risks on a swap portfolio are quite idiosyncratic, then doubling the number of swaps does not double default risk because of diversification.

Dimson and Marsh (1995) show that diversification greatly reduces the risk in a securities dealer's portfolio. They show that the SEC's comprehensive capital requirements for securities dealers are virtually uncorrelated with the risk of dealers' portfolios.[20] Finally, they show that the building-block approach advocated by the Basle Committee on Banking Supervision also ignores correlations among assets and makes inefficient use of capital compared to reserve requirements that accurately measure portfolio risk. Kupiec and White (1996) confirm these results for derivatives portfolios. They also show that portfolio margining systems like the Statistical Portfolio Analysis of Risk (SPAN), used by the CFTC to set margins for futures clearing house members, are more efficient because they incorporate correlations among assets.

Disclosure requirements. Over the last several years, many regulatory bodies have increased the level of public disclosure they require for derivatives. The requirements by the Financial Accounting Standards Board in the United States may be the most publicized, but they are far from unique.

Public disclosure requirements can be interpreted as attempts to make firms' derivatives positions better observable and thereby reduce monitoring costs to control agency problems better. Unfortunately, financial accounting standards can play only a limited role in the solution of these internal control problems.

[19] The swap set the floating rate to 17.0415 times the 5-year Treasury yield, minus the price of the 30-year Treasury bond with a coupon of 8 percent, minus 0.75 percentage points, plus the commercial paper rate (see Norris, 1994).

[20] The SEC requires 15% reserves for all long positions and all short positions whose value exceeds one quarter of the value of the long positions.

After all, firms' managers and auditors can disclose only information of which they are aware. While disclosure requirements may provide incentives to produce additional information and increase internal controls, these incentives are likely to be small compared to the owners' underlying incentives to monitor employee activity.

Banks disclosures to regulatory agencies are typically designed to monitor the banks' adherence to capital adequacy rules. This monitoring of compliance is designed to mitigate the moral hazard problem facing insured banks.

If it is costly to gather or report information about derivatives, or if the information has private value, full public disclosure is generally suboptimal. Nonetheless, net, inherent, and derivatives exposures are surely among the most important pieces of summary information in evaluating the performance of a firm's derivatives activity. Moreover, readers of financial statements can achieve economies of scale through standardization of how financial information is disclosed. Consequently, one would expect new standards to evolve as new financial instruments are more widely used. Many of these standards would evolve on their own, even in the absence of regulation, since firms find it to their advantage to voluntarily disclose certain financial information. Indeed, Phillips and Zecher (1981) argue that SEC disclosure requirements produce little information over and above that which firms disclose voluntarily.

Obviously, neither current nor proposed disclosure standards approach perfect observability. Most firms are only required to report the notional size or market value of their derivative positions; they do not have to provide information about the exposures ("deltas" in options parlance) of these positions. Furthermore, the positions are reported only infrequently, yet positions and exposures can change over time. To make matters worse, the inherent exposures of the firm can be difficult to estimate for outsiders, making it hard to ascertain whether the firm is engaged in the kind of optimal hedging program we describe in section 3 and the appendix.

PRIORITY OF DERIVATIVES. Regulators can play an important role in clarifying the property rights among derivatives counterparties during the insolvency process for banks. For example, the U.S. regulatory body charged with oversight of the S&L industry, the Federal Home Loan Bank Board (FHLBB), circulated a policy statement on interest rate swaps. The statement announced that if an S&L became insolvent, interest rate swaps would be treated as senior financial claims only if the swap hedged the institution's inherent interest rate exposure.[21] This effectively restricted most S&Ls to interest rate swaps where they received floating and paid fixed.

The costs imposed on counterparties by the failure of participant or a dealer depend in part on market expectations of how the derivatives will be handled through the insolvency process. At a minimum, the regulatory and judicial system should articulate a policy that details the priority of these contracts and the policy with respect to unwinding these instruments (see Wall, Tallman, and Abken, 1996).[22] A policy that requires immediate marking-to-market and unwinding of the derivatives portfolio can impose costs on counterparties. A policy that provides counterparties a longer period of time to find replacement hedges can mitigate some of these costs.

Protection of end users. In the wake of several large and highly publicized derivatives losses, there were repeated calls for derivatives regulations that would protect end users from derivatives dealers. Texas actually passed a law that required dealers to read the investment policies of any public agency with whom they do business and to certify that the dealer has procedures in place to "preclude imprudent investment activity" between the dealer and the agency.

Full disclosure of the nature of the derivatives contract not only is important, it is also virtually inevitable in over-the-counter transactions. Cash flows that are not explicitly specified in the contract are difficult or impossible to enforce later. Clearly, some derivatives call for rather complicated cash flows. In the OTC market for derivatives, however, these cash flows are specified explicitly in the contracts and essentially all market participants are financial professionals. Consequently, claims by treasurers that they were duped into derivatives losses are neither credible nor appropriate. If either party willfully misrepresents

[21] S&Ls are excluded under the U.S. bankruptcy code; if they become insolvent, the process is administered by the FHLBB, not the bankruptcy courts.

[22] In the United States, claims against insolvent banks are typically administered by the FDIC, not the Federal Reserve or bankruptcy courts. For a description of this process see Gooch and Klein (1993).

the contract, existing fraud statutes generally cover such deception.[23]

VOLUNTARY STANDARDS VERSUS LEGAL RESTRICTIONS. A recent proposal by a group of U.S. investment banks has tried to avert intrusive regulation by adopting a standard of voluntary disclosures to the Securities and Exchange Commission (SEC).[24] The members of the Derivatives Policy Group agreed to disclose their value at risk—the value of losses over a two-week period that will not be exceeded with 99 percent confidence. How this value is computed, however, is largely left to the individual banks.

One benefit of such an approach is that banks can use many of the same valuation methods they already have in place for internal controls to provide this external information. In addition, the banks can account more fully for the correlations among the assets in their total portfolio in order to compute the risk of their overall position. This portfolio approach is the appropriate way to assess the riskiness of banks (as we discussed earlier, most current capital adequacy rules neglect this aspect of the problem).[25]

The main drawback to letting banks report their own risk measures is that banks may be tempted to misrepresent their actual levels of risk. Such misrepresentations can subvert capital adequacy rules unless the banks' capital reserves can be monitored. If regulators can verify the level of reserves, they can verify whether the disclosed level of risk matches the size and frequency of reserve drawdowns. Moreover, regulators can penalize banks for inaccurate representations detected this way. An example of how the lack of such verification can lead to severe difficulties is provided by the collapse of Baring's Bank. Here, customer and bank capital were co-mingled in margin accounts at derivatives exchanges (see Stoll, 1996). As a result, the clearing house could not separate the bank's capital from that of its customers, allowing Barings to use its customers' capital as margin for its own trading.[26]

---

[23] Bankers Trust has settled with several counterparties who alleged that Bankers Trust intentionally and repeatedly misrepresented the accrued losses on outstanding derivatives contracts.

[24] It would be unrealistic to characterize these particular disclosures as truly voluntary.

[25] In the United States, the Federal Reserve is slowly moving away from rigid capital regulations and toward a more flexible assessment of overall risk (see Yellen, 1996).

[26] Note that if a bank segregates its derivatives business in a subsidiary, this also segregates capital to support the derivatives trading and makes monitoring easier.

Alternatives to secure demand deposits. Although requiring 100% reserves for demand deposits to safeguard the payment system provides a market-based solution to the two primary externalities associated with derivatives, this is a significant departure from current policy. If government-supplied deposit insurance is retained as a safeguard of the payment system, then risk levels at banks have to be controlled in order to reduce the associated moral hazard problem. One solution to excessive risktaking by an insured bank is to enforce additional regulations that limit the bank's ability to engage in this activity. The other solution is to reduce the bank's incentives to take excessive risks.

Capital standards are an example of limits on banks' overall risk. Unfortunately, most current capital requirements do not accurately measure the banks' overall portfolio risks. If risk is limited by regulation, permitting banks to compute their own risk levels is likely to provide more effective and less costly constraints. Combined with active monitoring of reported risk levels, such a program is a better complement to deposit insurance than current capital requirements.

Risk-based deposit insurance is the primary example of reduced bank incentives to take risks. If deposit insurance rates reflect the true cost of a bank's risk, then the insurance premia would act as the appropriate deterrent to excessive risktaking. The main practical difficulty with such a program is that the correct price of risk is difficult to discover without a market for this insurance. At the same time, a private market is unlikely to correctly value the negative externalities on the payment system. If governments continue to provide this insurance, they are unlikely to set accurate prices, which would defeat risk-based deposit insurance premia as an efficient deterrent to excessive risktaking by insured banks.

In addition to appropriate insurance premia, risk-based deposit insurance also requires accurate risk measures. Here too, the overall risks of banks' portfolios are relevant. Hence, it is likely that internal risk measures combined with monitoring are more accurate and cheaper to implement than externally imposed, standardized risk statistics or capital requirements.

Effectiveness of local regulation. Finally, it is important to realize the limits of national regulations. While national regulations can prevent local firms from participating in local derivatives markets, their impact is limited by opportunities to relocate derivatives activities to other countries.

For example, the Reserve Bank of India (RBI) prohibited domestic derivatives transactions until August 1996. Multinational companies headquartered outside India, like Coca-Cola, were largely unaffected by this prohibition, since they could readily engage in derivatives transactions through offices in the United States or the United Kingdom. Similarly, large Indian multinational firms, like Reliance, also have access to foreign financial markets and thus have greater opportunities to circumvent the constraints of the RBI rules. Thus, the companies that were most constrained were precisely the companies that attract most attention in discussions of creating level playing fields in markets—mid-sized and smaller domestic companies.

It is unlikely that small and mid-size, non-financial firms compare local derivatives regulations before they decide where to locate. For financial institutions with large derivatives activity, however, favorable local regulation may well justify a move. Highly restrictive derivatives regulation can prompt U.S. financial institutions to relocate their derivatives activities. More effective competition among these firms in an increasingly global market place raises the importance of a regulatory focus on maintaining a competitive environment.

In the United States, for example, a ruling by the Commodity Futures Trading Commission (CFTC, the futures markets equivalent of the Securities and Exchange Commission) on commodity swaps reflects these concerns. Commodity swaps employ the basic contract structure developed for other swaps: counterparties exchange regular payments based on changes in the underlying commodity price. An oil swap, for instance, allows an airline to hedge its exposure to jet fuel price changes. Although U.S. firms represented the majority of the user firms for commodity swaps and U.S. multinational banks were leaders in creating this market, virtually all the business was booked in London. This choice of location was primarily dictated by the legislation that established the CFTC. The law requires that all commodity futures are traded on a CFTC-regulated exchange and the basic commodity-swap structure fell within the CFTC's general definition of a futures contract. To remove this regulatory impediment to the development of an OTC commodity-swap market in the United States, the CFTC announced that it would exempt OTC commodity swaps from Commission oversight so long as the swaps were arranged by a U.S. financial institution regulated by another major government regulatory agency.

These examples illustrate that national derivatives regulation is likely to have distortionary effects since the regulation affects local firms to different degrees depending on their access to foreign capital markets. Furthermore, the examples also illustrate that purely national derivatives regulation can be largely circumvented by booking transactions in foreign markets. Binding financial regulation for large firms—who are the major participants in derivatives markets—almost always requires careful international coordination of the regulations.

4.3 Summary

We have argued that default risk in derivatives strongly depends on how they are used, but that it is always lower than default risk on fixed claims issued by the same firm. When combined with the standard practices of limiting exposure to individual counterparties, individual default in derivatives is unlikely. Widespread default, or systemic risk, caused by derivatives is an even smaller problem due to the improved sharing of existing risks.

Nonetheless, there are important internal control problems that arise with the use of derivatives just as with most other financial contracts. Many firms are aware of these agency risks, and external controls have limited scope to alleviate these problems. While additional disclosure requirements are unlikely to solve these agency problems, one would expect new disclosure standards to evolve with new financial instruments. Many of these standards are likely to evolve on their own since they produce economies of scale in interpreting financial statements.

Regulation that is purported to protect end users of derivatives by making dealers responsible for customers' investment polices has little social merit. Although end-users at the losing end of derivatives transactions have incentives to lobby for such protection after the fact, this option to sue dealers places unreasonable burdens on dealers. Dealers understand that such regulations have a distinct "heads I win, tails you loose" flavor and have responded to the local passage of such regulations by greatly reducing their activity in these jurisdictions or even refusing to initiate new contracts under these rules.

An economic rationale for regulation of derivatives markets exists conditional on deposit insurance schemes like the one currently used in the United States. The continued operation of this insurance plan is likely to require an ever more intricate regulatory environment in order to limit banks from taking on additional risks. By revising deposit insurance to require transactions deposits to be fully backed by Treasury securities, the payment system can be safeguarded without providing banks incentives to take additional risks.

Appendix A: Default Risk of Swaps

In this appendix we provide a more detailed analysis of the default risks associated with swaps and forwards. A similar analysis can be applied to futures contracts.[27]

A.1 Default risk on a swap

To begin our analysis of default risk, we return to the example of a bank using a swap to hedge its interest rate exposure. 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 the bank becomes insolvent, the bank will not default on its swap. The bank's swap will be "in the money", that is to say the bank will receive net payments from the swap.

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 the bank in our example, 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 the bank 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 the bank becomes insolvent when firm value falls into the shaded area below the V_I line. Therefore, the bank would default on its swap only if both interest rates and firm value fell at the same

[27] This analysis is based on Hentschel and Smith (1995).

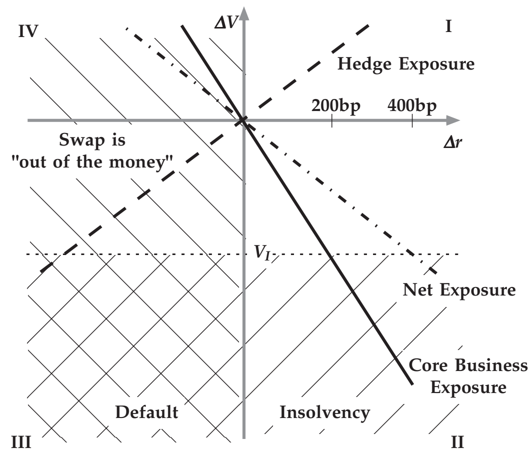

FIGURE 2: Insolvency and Default.

time. The range of interest rates and firm values that force the bank into default on the swap is indicated by the cross-hatched area in quadrant III of figure 2.

To a large extent, the probability that both of these conditions hold at the same time depends on the correlation between changes in the bank's value and changes in interest rates. For the bank in our example, this correlation is strongly negative; that is, if interest rates increase and the bank must pay on its swap, its core business is likely to be healthy. Given this strong negative correlation, the probability of default on the swap is low—much lower than the default risk of then bank's outstanding debt. Because the bank always owes payments on its debt, it defaults on its debt whenever it is insolvent.

A.2 The option to default

A financial contract with limited liability is equivalent to the same contract with unlimited liability plus a put option on the contract. When liability is limited by default, however, the value of the put option depends on two underlying prices: the value of the financial contract and the value of the counterparty's total assets. Johnson and Stulz (1987) value these multivariate options in order to price options with default risk. Here, we only evaluate the probability of default. While computing the probability of default is easier than pricing the default

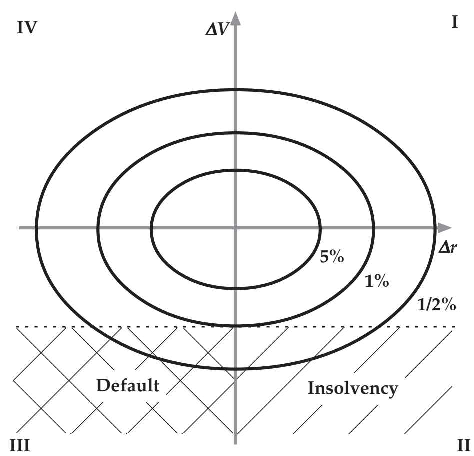

FIGURE 3: The Joint Distribution of Firm Value and Interest Rates.

option, the solution to both problems involves similar methods. Nonetheless, much of analysis of the probability of default is amenable to a graphical analysis, which we perform in this appendix.[28]

In general, both sides to a derivatives contract have the option to default during the life of the contract. In a swap, for example, either side has the 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 interest rates and the value of the bank in our example. The contour lines in figure 3 represent constant probability associated with the joint distribution of the interest rate and the total value of the bank's assets.[29] In figure 3, the inside contour contains the combinations of interest rates and bank assets that will occur with a probability of 95%.

[28] For more complete, mathematical analyses see Johnson and Stulz (1987) or Hentschel and Smith (1997).

[29] 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.

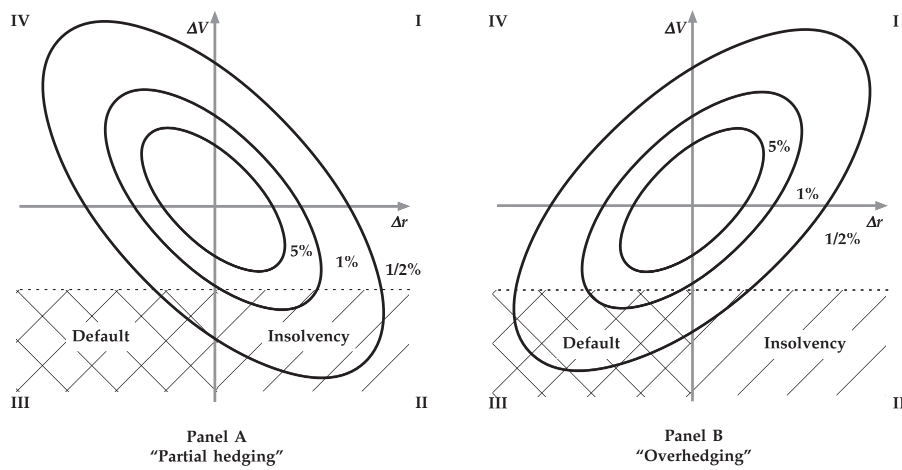

FIGURE 4: Default and the Correlation between Firm and Derivative Value.

Conversely, there is only a 5% probability that interest rates and the value of bank assets will be outside the smallest contour. Similarly, the probability that interest rates and the value of bank assets will be outside the other contours is 1% and 1/2%, respectively.

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 default area in quadrant III.) Although this probability is difficult to gauge precisely from figure 3, it is straightforward to compute numerically for most probability distributions. In figure 3, the probability that the bank defaults on the swap (the joint probability that the bank owes money under the swap and that the value of bank assets is below the critical value) is less than 1/4%. The contour that touches the default region in quadrant III is the 1% confidence interval. Less than one quarter of the area outside this contour, however, coincides with the shaded region in quadrant III.

Note that figure 3 implies that interest rates and the value of bank assets are uncorrelated—the bank has fully hedged its interest rate exposures. While this may be the case, generally the two can have either positive or negative correlation. 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. In both panels of figure 4, the distribution shows a strong correlation between the value of the bank and the value of the interest rate swap. The correlation is negative in panel A (the firm engages in partial hedging) and positive in panel B (the firm overhedges). The net exposure of the firm is the slope of the regression line of ΔV on Δr (see Adler and Dumas, 1984 or Flannery and James, 1984). Furthermore, the net risk profile in panel A of figure 1 can be thought of as the ridge line of the distributions in panel A of figure 4.[30]

Panel A of figure 4 illustrates the negative correlation between interest rates and bank assets that we assumed earlier. In this case, the swap is a hedge for the bank's core exposure, and the likelihood of default on the swap is lower than if firm and swap value are uncorrelated. A considerable amount of the probability mass has been shifted from quadrant III to quadrant II—away from the default area.[31]

Panel B of figure 4 illustrates the case of positive correlation between interest rates and firm assets. The bank 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 is higher since probability mass has been shifted to the default area.

A.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.

A.3.1 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

[30] Panel B of figure 1 does not directly map to panel B of figure 4, however. The swap shown in panel B of figure 1 would cause default in the shaded area in quadrant II of figure 4.

[31] The panel assumes that the negative net exposure does not stem from a large short position in interest rate swaps. If the bank were to sell interest rate swaps, then the default area would be the area of insolvency in quadrant II.

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.

A.3.2 Probability of default

Based on the bivariate nature of 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, $P(D|I)$:[32]

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

This decomposition is 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 variation in firm value is as low as it can be made using the derivatives. As the firm increases its hedge ratio past one, the firm

[32] Since $P(D|I)$ is a conditional probability between 0 and 1, this decomposition is another way to show that the probability of default on derivatives, $P(D)$, never exceeds the probability of insolvency for the firm, $P(I)$.

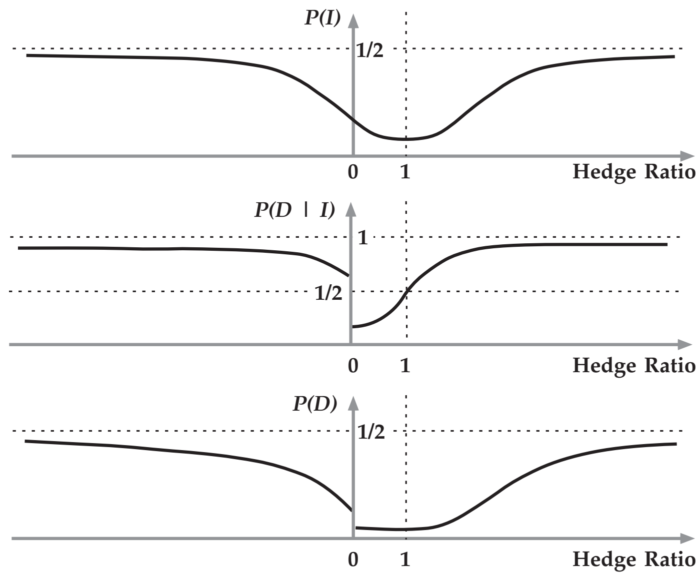

FIGURE 5: Hedging, Speculation, and the Probability of Default.

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 $^1/_2$. 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 $^1/_2$. (Here, we assume that unexpected changes are symmetric.) But, if the hedge ratio is negative, default risk jumps immediately. 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.[33] 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 $1/2$, 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.

A.3.3 An estimate of default risk

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.[34] Altman (1989) reports that just under 1% of A-rated bonds default during the first 10 years after issue. These default rates translate annual average bond default rates of 0.1% and annual swap default rates of 0.05% for firms striking at-market

[33] If (unhedged) firm value and the derivative are uncorrelated, then the figure is symmetric about zero without the discontinuity.

[34] Based on theories of why firms hedge (see Mayers and Smith, 1982 and 1987; Stulz, 1984; Smith and Stulz, 1985; and Froot, Scharfstein, and Stein, 1993; among others) the empirical evidence (see Dolde, 1993; Nance, Smith, and Smithson, 1993; Booth, Smith, and Stolz, 1984; Block and Gallagher, 1986; Houston and Mueller, 1988; Wall and Pringle, 1989; Geczy, Minton, and Schrand, 1997; Gorton and Rosen, 1995; Mian, 1996; Tufano, 1995; and Hentschel and Kothari, 1997; among others) generally supports the assumption that firms typically use derivatives to hedge rather than speculate.

swaps that completely hedge the firms' interest rate exposures. If the expected annual loss on an unsecured swap is 0.5% of notional principal, these default rates translate to an expected annual cost of default of no more than $25 on a $10 million interest rate swap.[35] Since these estimates are for A-rated non-financial corporations, the default rates for banks are likely to be considerably lower.

References

Adler, Michael and Bernard Dumas, 1984, Exposure to currency risk: Definition and measurement, *Financial Management* Summer, 41–50.

Alesina, Alberto and Lawrence H. Summers, 1993, Central bank independence and macroeconomic performance: Some comparative evidence, *Journal of Money, Credit, and Banking* 25, 151-162.

Altman, Edward I., 1989, Measuring corporate bond mortality and performance, *Journal of Finance* 44, 909–922.

Bagehot, Walter, 1971, The only game in town, *Financial Analysts Journal* 27, 12–22.

Bank for International Settlements, 1992, *Recent developments in international interbank relations,* Bank for International Settlements, Basle.

———, 1994, *Macroeconomic and monetary policy issues raised by the growth of derivatives markets,* Bank for International Settlements, Basle.

Bartman, Flavio C., David A. Milich, and Conrad P. Voldstad, 1994, Separating credit and market risks: The special purpose derivatives vehicle, *The Financier: ACMT* 1, 15–19.

Bicksler, J. and A.H. Chen, 1986, An economic analysis of interest rate swaps, *Journal of Finance* 41.

Black, Fischer, 1976, The pricing of commodity contracts, *Journal of Financial Economics* 3, 167–179.

Black, Fischer and Myron S. Scholes, 1973, The pricing of options and corporate liabilities, *Journal of Political Economy* 81, 637–54.

Block, S.B. and T.J. Gallagher, 1986, The use of interest rate futures and options by corporate financial managers, *Financial Management* 15, 73–78.

Booth, James R., Richard L. Smith, and Richard W. Stolz, 1984, Use of interest rate futures by financial institutions, *Journal of Bank Research* 15, 15–20.

[35] The estimated exposure of 0.5% of principal is based on the GAO's estimate that net credit exposures on swaps are 1% of principal and Franks and Torous's (1994) estimated recovery rates of about 50%.

Brickley, James A., Clifford W. Smith, Jr., and Jerold L. Zimmerman, 1997, *Organizational architecture: A managerial economics approach,* Irwin, Burr Ridge, IL.

Buser, Steven, Andrew Chen, and Edward Kane, 1981, Federal deposit insurance regulatory policy and optimal bank capital, *Journal of Finance* 36, 51–60.

Coase, Ronald H., 1960, The problem of social cost, *Journal of Law and Economics* 3, 1–44.

Cox, John C., Jonathan E. Ingersoll, Jr., and Stephen A. Ross, 1981, The relation between forward prices and futures prices, *Journal of Financial Economics* 9, 321–346.

Damodaran, Aswath and Marti G. Subrahmanyam, 1992, The effects of derivative securities on the markets for the underlying assets in the United States: A survey, *Financial Markets, Institutions and Instruments* 1, 1–21.

Dimson, Elroy and Paul Marsh, 1995, Capital requirements for securities firms, *Journal of Finance* 50, 821–851.

Dolde, Walter, 1993, The trajectory of corporate financial risk management, *Journal of Applied Corporate Finance* 6, 33–41.

Faulhaber, Gerald R., Almarin Phillips, and Anthony M. Santomero, 1990, Payment risk, network risk, and the role of the Fed, in: David B. Humphrey, ed., *The US payment system: Efficiency, risk and the role of the Federal Reserve* (Kluwer Academic Publishers, Boston, MA), 197–213.

Flannery, Mark J., 1989, Capital regulation and insured banks' choice of individual loan default risks, *Journal of Monetary Economics*.

Flannery, Mark J. and Christopher M. James, 1984, The effect of interest rate changes on the common stock returns of financial institutions, *Journal of Finance* 39, 1141–1153.

Franks, Julian R. and Walter N. Torous, 1994, A comparison of financial recontracting in distressed exchanges and chapter 11 reorganizations, *Journal of Financial Economics* 35, 349–370.

Friedman, Milton, 1960, *A program for monetary stability,* Fordham University Press, New York, NY.

Froot, Kenneth, A., David S. Scharfstein, and Jeremy, C. Stein, 1993, Risk management: Coordinating corporate investment and financing policies, *Journal of Finance* 48, 415–427.

Geczy, Christopher, Bernadette A. Minton, and Catherine M. Schrand, 1997, Why firms hedge: Distinguishing among existing theories, forthcoming *Journal of Finance*.

Gooch, Anthony C. and Linda B. Klein, 1993, A review of international and U.S. case law affecting swaps and related derivative products, in: Robert J. Schwartz and Clifford W. Smith, Jr., eds., *Advanced strategies in* *financial risk management* (New York Institute of Finance, Englewood Cliffs, NJ), 387–438.

Gorton, Gary and Richard J. Rosen, 1995, Banks and derivatives, unpublished paper, Rodney L. White Center for Financial Research, The Wharton School of the University of Pennsylvania.

Grossman, Sanford J., 1988, An analysis of the implications for stock and futures price volatility of program trading and dynamic hedging strategies, *Journal of Business* 61, 275–298.

Hentschel, Ludger and S.P. Kothari, 1997, Are corporations reducing or taking risks with derivatives?, unpublished paper, William E. Simon Graduate School of Business Administration, University of Rochester.

Hentschel, Ludger and Clifford W. Smith, Jr., 1995, Controlling risks in derivatives markets, *Journal of Financial Engineering* 4, 101–125.

———, 1997, Risks in derivatives markets: Implications for the insurance industry, forthcoming, *Journal of Risk and Insurance*.

Hicks, John R., 1939, *Value and capital,* Oxford University Press, Oxford.

Holmstrom, Bengt, 1979, Moral hazard and observability, *Bell Journal of Economics* 10, 74–91.

Houston, C.O. and G.G. Mueller, 1988, Foreign exchange rate hedging and SFAS no. 52—relatives or strangers?, *Accounting Horizons* 2, 50–57.

Hume, David, 1752, Of interest, in: Eugene Rotwein, ed., 1955, *David Hume: Writings on economics* (University of Wisconsin Press, Madison, WI), 47–59.

Humphrey, David B. and Alan N. Berger, 1990, Market failure and resource use: Economic incentives to use different payment instruments, in: David B. Humphrey, ed., *The US payment system: Efficiency, risk and the role of the Federal Reserve* (Kluwer Academic Publishers, Boston, MA), 45–86.

Johnson, Herbert, E. and René Stulz, 1987, The pricing of options with default risk, *Journal of Finance* 42, 267–280.

Keynes, John M., 1923, *A tract on monetary reform,* Macmillan, London; St. Martin's Press, 1971, New York.

Kupiec, Paul H. and A. Patricia White, 1996, Regulatory competition and the efficiency of alternative derivatives product margining systems, unpublished paper, Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System.

Lucas, Robert E., Jr., 1972, Expectations and the neutrality of money, *Journal of Economic Theory* 4, 103–124.

Margrabe, William, 1976, A theory of forward and futures prices, unpublished paper, The Wharton School of University of Pennsylvania.

Mayers, David and Clifford W. Smith, Jr., 1982, On the corporate demand for insurance, *Journal of Business* 55, 281–296.

————, 1987, Corporate insurance and the underinvestment problem, *Journal of Risk and Insurance*, 45–54.

Merton, Robert C., 1973, Theory of rational option pricing, *Bell Journal of Economics and Management Science* 1, 141–183.

————, 1977, An analytic derivation of the cost of deposit insurance and loan guarantees: An application of modern option pricing theory, *Journal of Banking and Finance* 1, 3–11.

Merton, Robert C. and Zvi Bodie, 1993, Deposit insurance reform: A functional approach, *Carnegie Rochester Conference Series on Public Policy* 38, 1–34.

Mian, Shehzad L., 1996, Evidence on the determinants of corporate hedging policy, *Journal of Financial and Quantitative Analysis* 31, 419–439.

Nance, Deana R., Clifford W. Smith, Jr., and Charles W. Smithson, 1993, On the determinants of corporate hedging, *Journal of Finance* 48, 267–284.

Norris, Floyd, 1994, Procter's tale: Gambling in ignorance, *New York Times* October 30, 1994, Sec. 3, p. 1.

Phillips, Susan M. and J. Richard Zecher, 1981, *The* SEC *and the public interest,* MIT Press, Cambridge, MA.

Ross, Stephen A., 1976, Options and efficiency, *Quarterly Journal of Economics* 90, 75–89.

Smith, Clifford, W., Jr. and René M. Stulz, 1985, The determinants of firms' hedging policies, *Journal of Financial and Quantitative Analysis* 20, 391–405.

Smith, Clifford W., Jr., Charles W. Smithson, and Lee M. Wakeman, 1986, The evolving market for swaps, *Midland Corporate Finance Journal* Winter, 20–32.

Stigler, George J., 1971, The theory of economic regulation, *Bell Journal of Economics and Management Science* 2, 1–21.

Stiglitz, Joseph E., 1993, Perspectives on the role of government risk-bearing within the financial sector, in: Mark S. Sniderman, ed., *Government risk-bearing* (Kluwer Academic Publishers, Boston, MA), 109–130.

Stoll, Hans R., 1995, Lost Barings: A tale in three parts concluding with a lesson, *Journal of Derivatives* 3, 109–115.

Stulz, René M., 1984, Optimal hedging policies, *Journal of Financial and Quantitative Analysis* 19, 127–140.

Svensson, Lars E.O. and Paul Soederlind, 1997, New techniques to extract market expectations from financial instruments, *Journal of Monetary Economics,* this issue.

Tufano, Peter, 1995, Who manages risk? An empirical examination of risk management practices in the gold mining industry, *Journal of Finance* 51, 1097–1139.

Wall, Larry D. and John J. Pringle, 1989, Alternative explanations of interest rate swaps: An empirical investigation, *Financial Management* 18, 59–73.

Wall, Larry D., Ellis W. Tallman, and Peter A. Abken, 1996, The impact of a dealer's failure on OTC derivatives market liquidity during volatile periods, unpublished paper, Federal Reserve Bank of Atlanta Working Paper Series.

Yellen, Janet L., 1996, The "new" science of credit risk mangement at financial institutions, in: The Jerome Levy Economics Institute of Bard College, *Recent developments in the financial structure*, 11–16.