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Thoughts on Financial Derivatives, Systematic Risk, and Central Banking: A Review of Some Recent Developments *

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Abstract

This paper critically reviews the literature examining the role of central banks in addressing systemic risk. We focus on how the growth in derivatives markets might affect that role. Analysis of systemic risk policy is hampered by the lack of a consensus theory of systemic risk. We propose a set of criteria that theories of systemic risk should satisfy, and we critically discuss a number of theories proposed in the literature. We argue that concerns about systemic effects of derivatives appear somewhat overstated. In particular, derivative markets do not appear unduly prone to systemic disturbances. Furthermore, derivative trading may increase informational efficiency of financial markets and provide instruments for more effective risk management. Both of these effects tend to reduce the danger of systemic crises. However, the complexity of derivative contracts (in particular, their high implicit leverage and nonlinear payoffs) do complicate the process of regulatory oversight. In addition, derivatives may make the conduct of monetary policy more difficult. Most theories of systemic risk imply a critical role for central banks as the ultimate provider of liquidity. However, the countervailing danger of moral hazard must be recognized and addressed through vigilant supervision.

I. Introduction

Innovation is the hallmark of financial markets around the world. This characteristic of modern financial markets is epitomized by the rapid evolution of financial derivatives. Indeed, the growth in exchange-traded and over-the-counter (OTC) financial derivatives since the early 1980s has been one of the most profound structural developments in U.S. financial markets since the 1920s. These new instruments have proven to be important tools for businesses, financial institutions, and individual investors, who use them for risk management and as investment vehicles. The importance of financial derivatives as flexible and cost effective instruments for managing risks is evidenced by their explosive growth. For example, in the area of exchange traded interest rate derivatives alone, the total volume of trades in these instruments in their initial years approximated less than 10,000 trades per month on the Chicago Board of Trade. Today, monthly trading activity in these instruments has increased by a factor of more than 800. The volume of OTC swap transactions (interest rate swaps, currency swaps, and options on interest rates) reported to the International Swaps and Derivatives Association (ISDA) has also increased substantially over the past decade, from about $866 billion of debt being hedged using these instruments in 1987 to more than $15 trillion of hedges in place in 1998.

This dramatic growth has raised concerns in some quarters about the complexity of these instruments and the ability of managers, regulators, and market participants in general to understand the risks associated with their use. This concern is justified in that these new instruments and products present a significant challenge to existing regulatory, supervisory, accounting, and legal frameworks. These frameworks were designed for a world of on-balance sheet finance, and are not well suited to deal with rapid and frequent transformations of a firm's financial claims and obligations.

In particular, the traditional supervisory and regulatory structures for wholesale banks, whose focus is on periodic examinations of on-balance sheet transactions, are ill-equipped to deal with an environment where the intra-day on-and-off balance sheet positions change so rapidly that end-of-day positions are no longer sufficient statistics for projecting the evolving risk profile of an institution.

In addition to these concerns, there is also a growing perception that, as a result of rapid innovation, these markets have become less transparent and more interconnected; that the derivatives business is unduly concentrated in a small group of dealer banks; and that these markets are prone to systemic disturbances which threaten the real economy complicating (or at least fundamentally changing) the conduct of monetary policy and central banking. In this paper, we focus on the last of these issues. We ask how the growth of derivatives markets changes the role of the central bank in guarding against systemic risk and in implementing monetary policy. To do so, we must confront a troublesome fact: there is no generally-accepted theory of systemic risk. This presents a problem for our purposes because the appropriate policy towards systemic risk depends critically on the mechanism underlying these risks.

Rather than positing a specific theory of systemic risk, we first propose a general definition of systemic risk (section II, below), and we suggest certain characteristics that any theory of systemic risk ought to have (section III). We then critically review a number of specific theories of systemic risk that have been proposed in the literature (section IV). Having mapped out these alternative frameworks for analyzing systemic risk, we turn to issues raised by the growth of derivative markets. We first consider whether derivative markets are special. Do they differ, from a policy perspective, from markets in traditional financial instruments (section V)? We then look at how the growth in derivatives trading affects the policy implications of various theories of systemic risk (section VI).

Finally, we consider the implications of derivatives for the conduct of monetary policy (section VII). Section VIII concludes the paper.

II. Characterizing Systemic Risk

In broad terms, systemic risk can be defined as the risk that a shock to the financial system significantly impairs crucial functions, such as asset valuation, credit allocation, and payments and settlements, and imposes significant costs to the real economy. This characterization, while quite general, captures the spirit of many of the formal definitions of systemic risk published in the literature.[1] Kaufman (1994) and the Bank for International Settlements (BIS) offer typical definitions. Kaufman defines systemic risk as the possibility that an event ignites a series of successive losses along a chain of institutions or markets comprising a system. In its Promisel Report (BIS 1992) the Bank for International Settlements (BIS) defines a systemic crisis as a disturbance that severely impairs the working of the financial system and, at the extreme, causes a complete breakdown in the system. It defines systemic risks as those risks that have the potential to cause such a crisis. More specifically, the BIS characterizes systemic risk as the risk that the failure of a participant to meet its contractual obligations may in turn cause other participants to default, with a chain reaction leading to broader financial difficulties.

The U.S. General Accounting Office (GAO, 1994) offers a definition of systemic risk tied to the notion that the abrupt failure of a large derivatives dealer could undermine stability in several markets, simultaneously, leading to a chain of market withdrawals, firm failures, and a systemic crisis. Other definitions offered by policymakers also center on the notion that the risk of a bank's default may cause a chain reaction of failures and even threaten the solvency of nonfinancial institutions.[2]

Discussions of systemic risk often focus on banking system crises even when the event precipitating the crisis originates outside of the banking sector. Following Kaufman (1988), the reason for this is two-fold. First, banks are thought to be special in the sense that their failure is more costly to society that is the failure of nonbank firms. Second, banks are more fragile in the sense that they are more highly leveraged than are nonbank firms: They operate with low cash-to-asset ratios (as a result of the fractional reserve banking system); and they operate with high ratios of short-term debt to total debt, with many of their short term liabilities payable on demand (implying a high potential for bank runs). These characteristics are thought to make banks more susceptible to systemic crises than other firms. While it is probably true that banks inherently are more fragile than other nonbank firms, this does not mean that banks have higher failure rates that other firms. As argued by Kaufman (1995), if banks are more fragile they should be handled with more care. That is, regulation of banks should be designed in a manner that is consistent with bank fragility and that promotes proper risk-taking and adequate market discipline.

III. Modeling Systemic Risk

Thus far, we have used the terms "systemic risk" and "systemic crisis" without being precise about the causes of these phenomena. This omission reflects the state of knowledge about the theory of systemic risk. In our view, a satisfactory equilibrium model of systemic risk has not yet been articulated. This gap in the literature is troubling for policy makers. Under some models, the growth in derivatives increases the probability of a systemic crisis, while other models imply that derivatives *decrease* this probability. More generally, the optimal policy response to the problem of systemic risk depends on the fundamental cause of the problem.

Before reviewing proposed theories of systemic risk, let us consider what general characteristics such a theory should have. A reasonable model of systemic risk and systemic crisis should incorporate the following elements.

1. A systemic crisis originates in, or is substantially magnified by financial markets. More precisely, systemic risk must originate in the *process of financing*. That is, that the capital needed by a firm is provided by investors outside the firm. According to this property, systemic risk would not be present if all firms were purely financed internally.

2. A systemic crisis involves contagion. That is, problems in one institution (firm, country) cause (or at least, appear to cause) insolvency (distress, bankruptcy) in other, *otherwise healthy*, institutions.

3. A systemic crisis involves a "loss of confidence" by investors. Typically, this means that investors or financial institutions cut back the amount of liquidity they are willing to provide to firms or other financial institutions.

4. A systemic crisis involves substantial real costs, in terms of losses to economic output and/or reductions in economic efficiency. For example, a stock market crash is not necessarily a systemic crisis. If the crash simply re-distributes wealth from speculators on the losing side (the ones who sold high) to the speculators on the winning side (the ones who bought low) without affecting real economic activity, it could not be regarded as a systemic crisis. Crises

must hurt Main Street, not just Wall Street.

5. A systemic crisis calls for a policy response. In particular, a systemic crisis must result in a Pareto-suboptimal allocation. This may be due to some externality, or to the presence of multiple equilibriums that can clearly be ranked from a welfare standpoint. If a particular definition of systemic risk does not imply costs in terms of economic efficiency (and therefore the possibility of corrective policy action), it would not correspond to a useful characterization of systemic risk for regulatory purposes.

In addition to these characteristics, another aspect of systemic crises which bears noting is that the crises can seem to arise almost spontaneously. The recent Asian crisis provides an example. It is generally agreed (ex-post) that there were structural problems in many Asian economies, including a high reliance on short-term external capital, a poorly developed banking system (with an even more poorly developed regulatory apparatus), cronyism between the financial sector and high government officials, and a remarkable lack of transparency in the workings of financial institutions, among others. However, all of these problems were well known during the period before the crises, when these economies were performing very well. Foreign investors were perfectly willing to provide capital during this earlier period. What happened to shift the confidence of foreign providers of capital so dramatically and so quickly? Radelet and Sachs (1998a) argue forcefully that the crisis caught the financial world completely by surprise. For example, interest rate spreads between the sovereign debt of key countries in the Asian crisis and U.S. treasury debt declined between mid-1995 and mid-1997. Similarly, credit ratings of these countries' sovereign debt remained unchanged through June 1997.

(The only exception was the Philippines, whose credit rating was actually *upgraded* in early 1997.) Early warning signs like nominal interest rates and forward premiums in the currencies of the crisis countries did not budge until the speculative attacks that initiated the crisis. In addition, Krugman (1997) notes that macroeconomic fundamentals were strong in all these countries. The governments were in fiscal balance, there was no irresponsible credit creation or monetary expansion, and inflation and unemployment rates were generally low. The closest one can find to a triggering event was the failure of Finance One, the largest Thai finance company. Why should this failure induce a profound plunge in the level of economic activity in five countries? The economic response seems wholly disproportionate to the size of the apparent triggering shock.

The challenge then is to construct a model of financial markets in which a *small* shock can induce *widespread* difficulties in obtaining financing (especially short-term liquidity), resulting in a *large* decline in economic activity relative to the social optimum. Models with these characteristics are known as *financial fragility* models. In the next section, we consider a number of proposed models of this type.

IV. Cataloging the Sources of Systemic Risk

Recently, several efforts have been made to catalogue and clarify the various sources of systematic risk and financial fragility.[3] In this section we discuss five sources of systemic risk that have been proposed in the literature. For each source, we ask whether it is adequate in scope to form the basis for a reasonably complete model of systemic risk, and we look at its implications for public policy.

A. Excessive debt

Minsky (1982a,b, 1995), Kindleberger (1978), and Feldstein (1991) attribute systemic risk to an excessive piling-on of debt. In particular, firms finance capital investment with ever-increasing leverage ratios. Eventually, this debt level becomes "unsustainable", leading to an "inevitable" collapse. According to this view, periods of over-leveraging are inevitable in capitalist economies, so both an extensive government safety net[4] and government financial regulation[5] are essential.

This theory clearly has the characteristics needed for a model of financial fragility. If many firms have extremely high leverage, a small shock to aggregate demand can induce multiple simultaneous corporate defaults, giving the appearance of a "wave" of bankruptcies. Indeed, some authors (for example, Davis, 1992) *define* financial fragility as a state of pervasive over-leverage. Where this theory is problematic is that it relies explicitly on irrationality. "Greed overcomes fear and individual investors take greater risks in pursuit of greater returns. A shock occurs and the market prices of assets begin to collapse. Bankruptcies ... follow. . . . The resulting failure of the payments mechanism and the inability to create credit bring on an economic collapse." (Feldstein, 1991, quoted in Benston and Kaufman 1995). Clearly, the key question is why firms with money at stake would systematically and pervasively choose leverage ratios so far from the level that maximizes expected shareholder value. Should governments impose regulations to keep these exuberant firms from over-leveraging? It is difficult to believe that the firms whose survival is at risk cannot determine the proper level of debt, but that government bureaucrats somehow can.

Furthermore, there is no basis for regulatory action if the costs of default induced by this excessive debt are borne primarily by the firm and creditor. Bankruptcy is a transfer of assets from debtor to creditor in the event of a default. Unless there are substantial costs borne by third parties, there is no rationale for government action to prevent this transfer. An example of poor policy

induced by a misunderstanding of the nature of bankruptcy is the 1979 Chrysler bailout legislation. At the time, the popular press justified this action by asserting that jobs were at stake. Of course, bankruptcy per se does not destroy jobs. The productive capital represented by Chrysler's plant, equipment, technical knowledge, and marketing network would not have disappeared in the event of bankruptcy. It would have been transferred to new owners. If there was a need for capacity reduction, this would (and did) happen regardless of whether Chrysler went through the formal bankruptcy procedure.

B. Moral Hazard

There is an alternative reason why firms (particularly financial firms) may take on excessive debt (or, more generally, may pursue excessively risky policies) that is consistent with full rationality of firm managers. There may be an externality that drives a wedge between the privately optimal debt level and the debt level that is optimal for society as a whole. An obvious candidate is the moral hazard induced by government-provided safety-net institutions. These institutions can affect the incentives of private agents operating in financial markets. In particular, the presence of a lender of last resort could induce excessive risk-taking and excessive indebtedness under the presumption that the lender (i.e., the central bank) will step in during a liquidity crisis and provide the needed liquidity to the system. Whether the perception is accurate or not, if market participants believe that the central bank will act this way during a financial crisis, institutions may choose to hold less capital as a safety cushion than they otherwise would. In effect, the central bank- and indirectly the taxpayer- is pushed into assuming the cost for safeguarding the financial markets.

Under this approach, "systemic risk" is a state of over-leveraging due to perverse incentives

of the safety net, and "systemic crises" occur when, due to an external adverse shock, there are excessive defaults (relative to the number of defaults one would expect in the absence of the safety net). The externality is that costs of default are borne in part by the taxpayers who provide the safety net.

The moral hazard theory of financial fragility is similar to Minsky's approach, in that both result in pervasive high leverage. However, these two theories have very different policy implications. In Minsky's view, a key role of government is to provide a capacious safety net. Under the moral hazard theory, however, the optimal policy response to the problem of systemic risk is to *reduce* safety net provisions, thereby forcing private firms to internalize more of the costs of excessive debt financing. These conflicting policy prescriptions emerged in discussions about the role of the International Monetary Fund in alleviating the 1997 Asian financial crisis. The standard argument that the Asian crisis required an IMF "bailout" follows Minsky's intuition. The alternative position, that IMF bailouts increase the possibility of systemic crises by exacerbating the moral hazard problem, has received a scant hearing.

C. Complex Inter-networking Among Counterparties

A third theory of systemic risk focuses on the possibility of contagion due to the complexity of trading networks and payments systems. An institution has both direct exposure to the credit-worthiness of its direct counterparties, and indirect exposure to the credit-worthiness of its counterparties' counterparties, and so on. These indirect exposures render the institution vulnerable to disruptions caused by the failure of a firm with which it has no direct exposure. The size and complexity of these interlinkages has increased enormously as banks expand their activity in

derivatives trading and market-making. It has been claimed that these complex linkages can propagate a shock rapidly through financial markets, with adverse consequences for the general economy.[6]

While indirect credit exposures have certainly increased in recent years, it is not clear why this state of affairs calls for any policy response. Why is this different from a steel worker noting that his personal solvency is affected by problems in General Motors, a firm with whom he has no direct contractual relation? In both cases we have a (chain of) contractual relations, where, if one contractor fails, all contractors are potentially affected. In neither case is there necessarily an externality that calls for government intervention.

Furthermore, creditors should internalize all risks both direct and indirect. "Know thy counterparty" requires an assessment of all factors that could impair the counterparty's credit-worthiness, including his exposure to other firms' distress. The fact that a bank may have incomplete information about its counterparties' exposure to other institutions does not change this conclusion. Incomplete information is merely another dimension of risk.[7] Institutions should manage the risk associated with these informational lacuna in the same way they manage other types of risk. Formally, the probability that a bank will be impaired by the failure of its counterparties' counterparties can be computed as a compound probability. Unless banks are unable to estimate such compound probabilities, this notion of systemic risk reduces down to ordinary credit risk.

D. Abrupt Reduction in Aggregate Liquidity

There is widespread belief that systemic crises are associated with a rapid reduction in the amount of liquidity in financial markets. The 1994 GAO report on financial derivatives focuses on the role of dealers in providing liquidity. In this scenario, the fear of an abrupt withdrawal or failure

of one major dealer causes many dealers to withdraw, leading to chain of defaults that shuts down the entire OTC derivatives market. Schwartz (1986) focuses on the role of banks. A public loss of confidence in banks induces a flight to currency and (with fractional reserve banking) widespread default. Such theories are incomplete, in that they do not explain what initiates the liquidity crisis. (The coordination failure mechanism, described below, provides one such explanation.) However, they imply an essential for the central bank in forestalling and managing systemic crises. We shall return to this point in section VI.D, below.

E. Coordination Failure

The possibility of coordination failure can arise if a particular strategy chosen by an economic agent (investor) becomes profitable only if a sufficient number of other agents choose the same strategy. As an example, consider the consortium that extended additional capital to Long Term Capital Management (LTCM) in September 1998. Presumably, it was in the interests of all of LTCM's creditors to prevent a forced liquidation and the attendant market disruptions. However, no single creditor of LTCM was able to provide the requisite $3 billion. A sufficient number of these creditors had to coordinate their liquidity provisions for the first-best outcome to obtain. Absent this coordination, the rational decision for each individual creditor would have been to refrain from providing liquidity altogether, in which case the forced liquidation would have occurred.

The most well-known model incorporating coordination failure is the Diamond and Dybvig (1983) model of bank runs. In this model, banks provide households with insurance against liquidity risk by pooling these risks, and by offering households financial assets redeemable upon demand at par. At the same time, banks provide borrowers with long-term loans. This duration mismatch

makes the bank vulnerable to runs. In particular, all depositors are better off if no one runs the bank, but there is no mechanism whereby depositors can coordinate their actions and mutually agree not to run the bank. If a run occurs, then it is individually optimal for everyone to run the bank. In this sense, a bank run represents a failure of coordination. Furthermore, if a run on one bank acts as a signalling mechanism for depositors to run a second bank, then a wave of contagious bank runs could severely damage the banking system as a whole.

While the Diamond and Dybvig (1983) model is theoretically attractive and intuitively plausible, several empirical studies of the banking industry before establishment of federal deposit insurance cast doubt whether any waves of bank failures actually were characterized by widespread bank runs. (See Benston and Kaufman, 1995, Calomiris and Gorton, 1991, Calomiris and Mason, 1994.) In particular, it appears difficult to find support for a direct link between bank runs and widespread bank failures. Rather, it appears that depositors generally can distinguish between sound and insolvent banks. The banks that are run in most cases are those that are truly insolvent due to nonperforming loans.

While this direct link between bank runs and bank failures may not characterize the historical record, the notion of a coordination failure remains a useful basis for a theory of systemic risk. The potential for a Diamond/Dybvig crisis arises any time there is a duration mismatch between short-term liabilities and long-term assets. The Asian crisis of 1997 provides an example. Radelet and Sachs (1998b) document that, in the East Asian countries most affected by the recent crisis, the ratio of short-term loans to short-term assets had exceeded 1.0 for several years. Marshall (1998) and Chang and Velasco (1999) argue that the flight of foreign short-term capital characterizing the Asian crisis was analogous to a Diamond/Dybvig bank run, with short-term foreign capital for these Asian

countries serving a role analogous to deposit funding for a bank.

V. Are Derivatives Special?

In the previous section we discuss a number of theories of systemic risk and financial fragility. We are now in a position to examine how the growth of derivative trading might affect government policy towards systemic risk. Before doing so, however, we wish to consider a more fundamental question. Are derivative markets inherently different from other financial markets? As noted in the introduction, derivatives are often thought to play a special role in either initiating or magnifying systematic risk. Much of the recent concern regarding the role of derivatives in inducing or propagating shocks stems from the large losses suffered by the users of OTC derivatives and the fear that the failure of a large OTC derivatives dealer could set off a chain reaction of defaults that would culminate in a systemic crisis. Feeding these concerns is the fact that these instruments and the markets in which they trade are thought to be excessively leveraged, less transparent, more interconnected, excessively concentrated, and inadequately regulated. These characteristics are said to make derivatives markets prone to disturbances and/or to make them key propagators of disturbances. Because most of the large derivatives dealers are banks, some argue that defaults on OTC derivatives could undermine the solvency of major banks, with potentially serious consequences for the banking system.

As argued by Edwards (1997) and Hentschel and Smith (1997), many of these fears regarding derivative dealers and markets do not appear to be well founded.[8] According to data published by the U.S. General Accounting Office (reported by Edwards, 1997), U.S. derivative markets are not particularly concentrated. For example, the largest eight U.S. dealers accounted for

only about 33 percent of the worldwide notional amounts held by dealers. Furthermore, the largest U.S. derivatives dealer held only 6 percent of the total. Similarly, while it is true that derivatives have increased the linkages among financial markets, it is not obvious that such linkages have increased the likelihood of a systemic crisis. As markets become more interlinked, market participation widens, resulting in greater market liquidity. Greater substitution across assets implies a more elastic the demand for those assets, so a demand or supply shock should result in smaller (not greater) price changes. Thus, rather than exacerbating market disturbances, increased market linkages should cushion financial disturbances by spreading price shocks over many markets.

Hentschel and Smith (1997) also conclude that defaults across derivative markets are not likely to be highly correlated. They argue that there are strong reasons to expect that defaults on derivatives contracts are approximately independent across dealers and over time. Their argument is based on two facts. First, dealers have powerful incentives to assess default risks of their customers. In cases where dealers consider a transaction with a lower-rated counterparty, extensive efforts will be made to assess the counterparty's exposure to interest rates and to ensure that the transaction is being used to offset, not magnify, its risk exposure. Second, firms using derivatives to hedge their exposures are most likely to become insolvent precisely when their derivatives are in-the-money. Thus, shocks to the price of the asset underlying the derivative do not cause these firms to default on the derivative. Between parties of a given derivative contract, default is negatively correlated. That is, at any point in time, only the side of a derivative 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 these reasons, a simple summation of derivatives positions across the economy overstates total default

risk.

Regarding the so-called gap in the regulation of non-bank derivatives dealers (dealer banks are subject to extensive regulation) and the risk this poses to the financial markets, there is no significant evidence that nonbank dealers take more risks or are more vulnerable to counterparty defaults than are bank dealers. Indeed, there is evidence that nonbank derivatives dealers are subject to substantial market discipline (see GAO, 1994).[9]

Regarding opaqueness and transparency, over the last several years many regulatory bodies have increased the level of public disclosure required in derivative transactions. The requirements by the Financial Standards Advisory Board and the bank regulatory agencies in the U.S. are but two of many examples world-wide.

Based on these type arguments, the possibility of widespread default throughout the financial system stemming from the use of derivatives appears to be somewhat overstated. Certainly, the traditional measure of derivatives exposure- notional value- overstates the amount of capital at risk. Nevertheless, it must be recognized 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 derivatives risk.

VI. Implications of Derivatives for Specific Models of Systemic Risk

As is evident from the discussion in section IV, above, much attention has been directed towards establishing a workable theory of systemic risk. Why it is important to settle upon a particular theory? The answer is straightforward. If certain central banking and regulatory actions are justified as a means of eliminating or containing systemic risk, the model of systemic risk will be a key determinant of which types of regulatory or central bank interventions should be implemented.

As noted by Federal Reserve Board Chairman Alan Greenspan, it would be useful to central banks to be able to measure systematic risk accurately since they are typically charged with monitoring it and engaging in actions to eliminate or mitigate its effects.[10]

A. The excessive debt theory

The excessive debt theory of systemic risk can be used to justify the keen interest taken by financial market regulators and central banks in the risks that derivatives may pose to the financial system. Many derivatives represent highly leveraged positions. It has been asserted that this high implicit leverage can disrupt markets in times of rapid change or turmoil. This controversial point has been a much-debated rationale for more derivatives regulation.

One can argue, however, that the increase in derivative usage may actually *reduce* systemic risk. In models of financial fragility, small shocks are magnified by the financial system. Derivatives provide a means of hedging the risk of these adverse shocks, re-allocating this risk to those market participants best able to bear the risk. Furthermore, derivative markets serve as an efficient mechanism for disseminating new information affecting financial markets, thereby facilitating timely risk management responses to potential systemic disturbances. Both of these effects serve to reduce the degree of fragility in financial markets. These arguments represent strong justifications for regulators *not* to impede innovation in financial engineering.

B. The moral hazard theory

The theory of moral hazard does have potential implications for regulating derivatives usage. The danger here is that unhedged derivatives exposures by banks and other institutions protected by

the government-provided safety net may be improperly accounted for in determining capital requirements. In particular, methodologies like value-at-risk are not well-suited for evaluating the risk of securities, such as derivatives, with highly non-linear payoff functions. One important regulatory proposal that potentially can better account for the risk of derivatives portfolios is the pre-commitment proposal.[11] Pre-commitment is an incentive-based approach to capital regulation, in which the bank chooses its own level of capital for its trading portfolio. However, penalties are assessed against the bank if *ex post* this capital level proves inadequate (in a well-defined sense). This places the responsibility for determining the risk of a derivatives portfolio squarely with the bank itself, which arguably has the best risk-assessment technology.

C. The theory of network complexity

A major application of the theory of network complexity is in the area of interbank payments.[12] The volume and complexity of these payments has grown enormously in recent years. Humphrey (1986) estimated that the failure of one major US bank could saddle up to 50 banks with net settlement obligations at the end of the day in excess of their capital. The growth of derivatives usage interacts with the increased complexity of interbank payments because many large banks act as major OTC derivatives dealers. It is feared that a major loss in derivatives markets could render a large bank incapable of completing payments owed to other institutions, with the complex interbank linkages then inducing payment failures by numerous other institutions.

Suppose this scenario actually occurred. What is the proper policy response? We note that while interlinkages are becoming more complex, the computing power to handle these complexities has grown in train. The main societal costs associated with this version of systemic risk are the costs

of unwinding obligations in a net settlement system. These costs are borne not only by the direct participants in the system; all individuals in the economy who need to make payments suffer if the payments system (which acts as a classical "common carrier") shuts down. However, while these costs are large, it is not clear that the heavy superstructure of financial regulation is the best policy response. A better response is to reduce the costs of unwinding. This could be done by increasing the frequency of netting, moving to real time gross settlement systems, or through more intensive monitoring of positions.

D. Liquidity shortfall and coordination failure

The possibility of coordination failure, along the lines modelled by Diamond and Dybvig (1983), provides a theoretical foundation for an abrupt decline in the aggregate quantity of liquidity. Even those who are not convinced by this particular theory must consider the possibility that liquid institutions may be reluctant to provide short-term financing to temporarily illiquid but solvent institutions. In such a situation, the central bank, as the only infinitely liquid institution in the economy, has a crucial role to play. We do not envision direct discount-window loans to non-bank institutions. However, the central bank clearly is the ultimate provider of liquidity, either as the lender of last resort or through open market operations.

In practice, the Federal Reserve's response to incipient financial crisis in recent years has been to increase economy-wide liquidity via open market operations, and by encouraging large banks to channel this liquidity to illiquid dealers as needed. (Notable examples include the October 1987 and Fall 1998.) These actions are often accompanied by a signal that further liquidity provision would be implemented if needed. This practice ties together the twin central bank tasks of guarding against

systemic crises and of implementing monetary policy.

In addition to its open market operations, the central bank also provides liquidity in its capacity as lender of last resort. How should this function be implemented in a systemic crisis? In the modern era, financial policy on the part of the U.S. central bank and bank regulators in the face of systemic crises has most often involved use of the discount window and, in the case of large banks, blanket coverage of all depositors. It has been argued that it is inappropriate to mix discount-window policy with responses to systemic events if doing so increases moral hazard and closure costs without reducing the costs of systemic events.[13] Ideally, the central bank should lend only to solvent but temporarily illiquid institutions. As argued by Corrigan (1989/90), however, in a crisis it may be difficult to distinguish between temporary illiquidity and true insolvency. Central banks may decide that the most prudent course of action in a crisis is to lend freely to all liquidity-starved institutions, possibly including nondepository institutions.[14] While one would not want to rule out such actions unequivocally, the possibility that discount-window loans may be offered indiscriminately in a crisis raises the specter of moral hazard. Private institutions may be less inclined to prepare for possible crises if they believe that a systemic crisis triggers unrestricted access to central bank liquidity. Smith and Wall (1992) recommend instead that the central bank work through the commercial banking sector to provide the liquidity, since the banks are typically better able to evaluate the solvency of illiquid firms.

VII. Derivatives, Systemic Risk, and the Conduct of Monetary Policy

There is general agreement among central bank analysts that the growth of derivatives has affected the manner in which monetary policy is conducted. Clearly, derivatives have had a

fundamental impact on traditional quantity indicators of monetary policy such as monetary and credit aggregates (BIS, 1992; Townsend, 1995; and Deutsche Bundesbank, 1994).

First, derivatives alter the demand for money. By providing for efficient management of risks and innovative investment strategies tied to market events, derivatives reduce the transactions, precautionary, and speculative demands for money. Furthermore, derivatives reduce transactions costs in financial markets, allowing economic agents to operate with lower transactions balances. In particular, a major transaction cost in financial markets is the bid-ask spread. Informational asymmetries and trading volume are important factors in determining the spread. Derivatives affect both of these factors. The higher leverage in derivatives markets attract information-motivated traders, allowing the traders' private information to be more efficiently incorporated into publicly observable prices. Furthermore, since arbitrage between the derivative and underlying cash market keeps prices in these two markets linked, the information of derivatives traders is also reflected in the underlying cash market. As a result of this greater informational efficiency, the spread in the underlying cash market is narrowed, reducing transactions costs, and therefore reducing the demand for narrow money. These structural shifts in money demand increase uncertainty about the demand-for-money function, complicating the traditional conduct of monetary policy.

Second, the general usefulness of the broader monetary aggregates has been adversely affected as derivatives markets have grown. The low cost of hedging the price or interest rate risk of government bonds, for example, has reduced the risks associated with these securities and transformed them into keen competitors with the traditional interest-bearing components of the broad monetary aggregates. These developments are a key factor eroding the previously stable relationship between the monetary aggregates and nominal GDP. For more than a decade, this erosion has been

apparent in the U.S. with respect to narrow aggregates such as M1 and broader aggregates such as M2 and total credit. Similar developments have occurred in Germany with respect to M3 and the relevant German macroeconomic targets.

Based on these developments, it seems clear that the advent of derivatives has made implementation of monetary policy more complex. However, the development of derivatives markets should not affect the ability of central banks to establish the desired level of short term interest rates. The existence of derivative instruments do not alter the central bank's monopoly position as the supplier of the ultimate means of settlement, central bank reserves. Because of their pervasive influence in financial transactions, derivatives may have altered banks' demand for central bank reserves, requiring a recalibration of monetary policy actions. However, as long as there is a positive demand for central bank reserves, the central bank should have a means to control short term interest rates and hence, an effective policy instrument.

There is much disagreement on the overall effectiveness of monetary policy in a world of sophisticated financial derivatives. It could be that derivatives, in addition to complicating monetary policy, may also reduce the impact of such policies on real economic activity. That is, a given amount of monetary stimulus may have a smaller effect. For example, the existence of foreign exchange derivatives may reduce the ability of central banks to influence exchange rates. Since money should be neutral in a frictionless economy, the sources of monetary non-neutrality must lie in economic frictions such as informational imperfections and transactions costs. By increasing the liquidity, depth, flexibility, and transactional efficiency of financial markets, derivatives increase the speed with which monetary policy actions are transmitted throughout the financial system. As noted above, lower transaction costs and reduced frictions resulting from derivatives activities increase the rate at

which new information, including policy actions, is impounded into market prices. Since derivatives markets reduce these sorts of frictions, they provide a more efficient mechanism for price discovery, speed up information transmission, and reduce informational asymmetries. It follows that by reducing frictions, derivatives markets reduce the real effects of monetary policy actions. Furthermore, derivatives markets act as a mechanism for spreading shocks across the economy as a whole. As discussed earlier, this can be viewed as an advantage or disadvantage with respect to systemic risk (see Edwards, 1997 and GAO, 1994 for opposing views).

To the extent that derivatives reduce the force of monetary policy, monetary policy may become a weaker tool for countercyclical stabilization policy. However, if derivatives do provide the economy with the benefits cited by their proponents, i.e., a more efficient, self-correcting, and shock resistant economy, then there should be less of a need for countercyclical monetary policy. Stated differently, derivatives activity might actually reduce the incidence and severity of business cycles themselves, rendering monetary policy less important.

To elaborate, modern business cycle theory focuses both on the impulses that precipitate a downturn and the propagation mechanism that translates these impulses into a contraction of economic activity. While there is much controversy over the nature of cyclical impulses, some of the more notable downturns in the U.S., for example the 1929 stock market crash, appear to have been instigated by disturbances in the financial sector. The propagation mechanism may also involve the financial sector in a significant way (for example the massive bank failures in the early 1930s). To the extent that derivatives markets provide greater resiliency in the financial services industry, better allocation of risks in financial markets, and easier international and cross-market diversification, business cycle disturbances arising from the financial services sector would be less severe.

VIII. Conclusion

In this paper, we ask how the growth of derivatives trading affects the policy concerns of central banks. We argue that the implications of derivatives for the systemic stability of financial markets cannot be properly addressed without a model of systemic risk. Since there is no consensus model, we discuss five proposed theories of systemic risk, and consider their implications for public policy. We argue that concerns about systemic effects of derivatives appear somewhat overstated. In particular, derivative markets do not appear unduly prone to systemic disturbances. Furthermore, derivatives trading may increase informational efficiency of financial markets and provide instruments for more effective risk management. Both of these effects tend to reduce the danger of systemic crises. However, the complexity of derivative contracts (in particular, their high implicit leverage and nonlinear payoffs) do complicate the process of regulatory oversight. In addition, derivatives may make the conduct of monetary policy more difficult.

If we were to hazard a policy conclusion from this exercise, we might note that most proposed theories associate systemic crises with reduced liquidity in financial markets. This implies a critical role for central banks as the ultimate provider of liquidity. However, the countervailing danger of moral hazard must be recognized and addressed through vigilant supervision. Since competition and financial innovation best flourish within the context of a safe and sound financial system, this need for systemic supervision by central banks and their regulatory affiliates seems to be a legitimate one.

References

Bank for International Settlements (1992). "Recent Developments in International Interbank Relations."Report prepared by a working group established by the Central Banks of the Group of Ten Countries (also known as the "Promisel Report"). Basel: Bank for International Settlements, October.

Bartholomew, Philip F., Larry R. Mote, and Gary Whalen (1995). "The Definition of Systemic Risk," Office of the Comptroller of the Currency. Presented at the seventieth annual Western Economic Association International Conference, San Diego, California, July.

Benston, George J., and George G. Kaufman (1995). "Is the Banking and Payments System Fragile?" *Journal of Financial Services Research* 9, 209-40.

Bhattacharya, Sudipto, and Douglas Gale (1987). "Preference Shocks, Liquidity, and Central Bank Policy." In *New Approaches to Monetary Economics*, edited by William Barnett and Kenneth Singleton, 69-88, New York: Cambridge University Press.

Bordo, Michael D (1990). "The Lender of Last Resort: Alternative Views and Historical Experience." Federal Reserve Bank of Richmond *Economic Review* 76, January/February,: 18-29.

Calomiris, Charles W., and Gary Gorton (1991). "The Origins of Banking Panics: Models, Facts, and Banking Regulation." In *Financial Markets and Financial Crises*, edited by R. Glenn Hubbard, 109-73. Chicago: University of Chicago Press.

Calomiris, Charles W., and Joseph P. Mason (1994). "Contagion and Bank Failures During the Great Depression: The June 1932 Chicago Banking Panic," NBER Working Paper No. 4934.

Chang, Roberto, and Andres Velasco (1999). "Liquidity Crises in Emerging Markets: Theory and Policy." Forthcoming in *NBER Macroeconomics Annual*, vol. 14, edited by Ben S. Bernanke and Julio Rotemberg.

Chari, V.V. (1989). "Banking without Deposit Insurance or Bank Panics: Lessons from a Model of the U.S. National Banking System." Federal Reserve Bank of Minneapolis *Quarterly Review* 13, Summer, 3-19.

Corrigan, E. Gerald (1989/90). "A Perspective on Recent Financial Disruptions." Federal Reserve Bank of New York *Quarterly Review* 14, Winter, 8-15.

Crockett, Andrew (1995). "Financial Fragility: Sources, Prevention, and Treatment." In *Coping with Financial Fragility and Systemic Risk*, edited by Harald A. Benink. Boston: Kluwer

Academic Publishers.

Davis, E.P. (1992) *Debt, Financial Fragility and Systemic Risk.* Oxford: Oxford University Press.

Deutsche Bundesbank Monthly Report (1994). "The Monetary Policy Implications of Increasing Use of Derivative Financial Instruments," November.

Diamond, Douglas, and Philip Dybvig (1983). "Bank Runs, Liquidity, and Deposit Insurance." *Journal of Political Economy* 91, 401-19.

Edwards, Franklin R. (1997). *The New Finance: Regulation and Stability* (American Enterprise Institute).

Eichengreen, Barry, and Richard Portes (1991). "The Anatomy of Financial Crises." In *Financial Markets and Financial Crises*, edited by R. Glenn Hubbard, 10-58. Chicago: University of Chicago Press.

Eisenbeis, Robert A. (1995). "Private Sector Solutions to Payments System Fragility." In *Coping with Financial Fragility and Systemic Risk*, edited by Harald A. Benink. Boston: Kluwer Academic Publishers.

Eisenbeis, Robert A. (1997). "Bank Deposits and Credit As Sources of Systemic Risk," Economic Review (Federal Reserve Bank of Atlanta) Third Quarter: 4-17.

Feldstein, Martin (1991). *The Risk of Economic Crisis*. NBER Conference Report. Chicago: University of Chicago Press.

Flannery, Mark J. (1991). "Debt Maturity and the Deadweight Cost of Leverage: Optimally Financing Banking Firms." University of Florida Working Paper, July..

General Accounting Office (1994) "Financial Derivatives: Actions Needed to Protect the Financial System." Report to Congressional Requester, GAO/GGD-94-133. Washington, D.C.: Government Printing Office, May.

Greenspan, Alan (1995). "Remarks at a Conference on Risk Measurement and Systemic Risk," Washington, D.C.: Board of Governors of the Federal Reserve System.

Hentschel, Ludger, and Clifford W. Smith (1997). "Derivatives Regulation: Implications for Central Banks," *Journal of Monetary Economics* 40:305-346.

Humphrey, D.B. (1986). "Payments Finality and the Risk of Settlement Failure," in A. Saunders and L.J. White, eds., *Technology and the Regulation of Financial Markets*, D.C. Heath, Lexington, Mass.

Kanatas, George (1986). "Deposit Insurance and the Discount Window: Pricing under Asymmetric Information." *Journal of Finance* 41, 437-50.

Kaufman, George G. (1995). "Comment on Systemic Risk." In G.G. Kaufman (ed.) *Research in Financial Services* 7: 47-52. Greenwich: JAI Press.

_____ (1994). "Bank Contagion: A Review of the Theory and Evidence." *Journal of Financial Services Research* 8:123-50.

_____ (1988). "Bank Runs: Causes, Benefits, and Costs." *Cato Journal* 7 Winter, 559-87.

Kindleberger, Charles P. (1978). *Manias, Panics, and Crashes.* MacMillan: London.

Knight, Frank H. (1921). *Risk, Uncertainty and Profit*, Boston: No. 16 in series of reprints of scarce texts in economics, LSE, London.

Krugman, Paul (1998). "What Happened to Asia?" Working Paper. MIT.

Marshall, David A. (1998). "Understanding the Asian Crisis: Systemic Risk as Coordination Failure." *Economic Perspectives*, Federal Reserve Bank of Chicago, vol. 22, No. 3.

Meltzer, Allan H. (1982). "Rational Expectations, Risk, Uncertainty, and Market Responses," in *Crisis in the Economic and Financial Structure*, edited by P. Watchel. Salomon Bros. Series on Financial Institutions and Markets. Lexington, MA: Lexington Books.

Minsky, Hyman P. (1982a). "The Financial Instability Hypothesis: Capitalist Processes and the Behavior of the Economy." In *Financial Crises: Theory, History, and Policy,* edited by Charles Kindleberger and Jean-Pierre Laffargue, 13-38. Cambridge: Cambridge University Press.

_____ (1982b). "Financial Instability Revisited: The Economics of Disaster." Reprinted in *Can "It" Happen Again: Essays on Instability and Finance*, edited by Hyman P. Minsky, 117-161. New York: M.F. Sharpe, Inc.

_____ (1986). *Stabilizing an Unstable Economy*. New Haven: Yale University Press.

_____ (1995). " Financial Factors in the Economics of Capitalism." In *Coping with Financial Fragility and Systemic Risk,* edited by Harald A. Benink. Boston: Kluwer Academic Publishers.

Parry, R. (1996). "Global Payments in the 21st Century: A Central Banker's View." *FRBSF*

Economic Letter, Federal Reserve Bank of San Francisco, 3 May.

Radelet, Steven, and Jeffrey Sachs (1998a). "The Onset of the East Asian Financial Crisis," Working Paper, Harvard Institute for International Development, Harvard University.

_____ (1998b). " The East Asian Financial Crisis: Diagnosis, Remedies, Prospects," Working Paper, Harvard Institute for International Development, Harvard University.

Schwartz, A. (1986). "Real and Pseudo-financial Crises." In *Financial Crises and the World Banking System*, edited by Forrest Capie and Geoffrey E. Wood. London: Macmillan, pp. 11-31.

_____ (1988). "The Lender of Last Resort and the Federal Safety Net." *Journal of Financial Services Research* 1, January, 1-18.

Smith, Bruce D. (1991). "Bank Panics, Suspensions, and Geography: Some Notes on the 'Contagion of Fear' in Banking." *Economic Inquiry* 29, 230-48.

Smith, Stephen D. and Larry D. Wall. (1992). "Financial Panics, Bank Failures, and the Role of Regulatory Policy." *Economic Review* (Federal Reserve Bank of Atlanta), January/February, 1-11.

Townsend, John. (1995). "Derivatives and Monetary Policy: A Central Banker's Perspective," Speech at ISDA 10th Annual Conference in Barcelona, March.

NOTES

1. See, for example, Bordo (1990), Kaufman (1994), Eichengreen and Portes (1991), and Calomiris and Gorton (1991), among others.

2. See the speech by Robert Parry (1996). Alternative definitions have been offered by Bartholomew et al. (1995)

3. See Davis (1992), Kaufman (1995), and the special issue of the *Journal of Financial Services Research*, published in 1995 devoted to the subject of systematic risk.

4. "For big government to be able to prevent great depressions, it needs ... to have sufficient muscle in financial markets so that it can refinance failed financial institutions" (Minsky, 1995). See also Minsky (1982b), which places great emphasis on the central bank's role as an activist lender of last resort in countering periods of financial instability.

5. Among the regulatory interventions advocated by Minsky (1986) are restrictions in the amount and rate of growth of bank assets, bank capital, and bank pay-out rates; regulations restricting lending not tied to specific assets; intensive bank examination to induce probity and creditworthiness; and procedures to discourage "speculative and Ponzi finance".

6. See, e.g., GAO (1994), Eisenbeis (1995).

7. A framework in which incomplete information does not reduce down to a compound probability computation is Knight's (1921) theory of uncertainty. Knight argues that there are forms of uncertainty that cannot be formalized as a probability distribution. Meltzer (1982) and Crockett (1995) argue that Knightian uncertainty is at the heart of systemic risk.

8. This discussion draws directly from Edwards (1997) and Smith and Hentschel (1997).

9. For additional arguments refuting the risk of derivatives and derivative dealers to the financial system, see Edwards (1997) and Hentschel and Smith (1997).

10. See Greenspan (1995).

11. The pre-commitment proposal is described in Federal Register, Vol 60, No. 142, pp. 38142-38144.

12. See, also the papers by Smith (1991), Bhattacharya and Gale (1987), and Chari (1989).

13. See Smith and Wall (1992) for a comprehensive review. See also the papers by Flannery (1991), Kanatas (1986), and Schwartz (1988).

14. The Federal Reserve does have the authority to open the discount window to nondepository institutions, although this power has not been used since the 1930's.