Clearing and Settlement during the Crash

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This article is a reexamination of the clearing and settlement process in financial markets (particularly the futures market) and its performance during the 1987 stock market crash. It provides both some institutional background and some conceptual perspective on the problems faced by the system during the week of October 19. Much of the discussion is based on the useful analogies that can be drawn between the clearing house and other financial intermediaries, such as banks and insurance companies. A major conclusion is that the Federal Reserve played a vital rob in protecting the integrity of the clearing and settlements system during the crash.

The remarkable events of October 1987 were even more remarkable for the lack of any clear-cut change in economic fundamentals that might explain what happened in world financial markets during those days. This absence of an identifiable external cause has motivated an intense examination of the mechanics of the markets themselves: Specific trading strategies, the existence of certain financial instruments, the technologies of order placing and information transmission, and the performance of specialists and other market-makers have all received attention and criticism as possible contributors to the crash.

The clearing and settlement process, long ignored by most financial economists and even market partic-

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ipants as an institutional detail, has come in for a good share of this attention and criticism. Although the clearing and settlement system did survive the critical days intact, there were undeniably severe stresses and strains. Rumors about possible clearinghouse failures added to the sense of panic in the markets, especially on October 20; and while these rumors proved unfounded, it has been argued that the events of that week did reveal structural problems with the system. Recommendations for reforming the clearance and settlement system, including controversial proposals for unified settlement among different markets, were prominent features of the Brady Report (1988) and several of the other reports on the crash.

This article is a reexamination of the clearing and settlement process in financial markets and its performance during the crash. For concreteness we focus on futures markets, although much of our discussion applies to clearing and settlement more generally.

To avoid ground that has already been covered by half a dozen lengthy studies, we do not attempt here to provide new information about the events of the week of October 19 or to make any detailed recommendations for reform. Our goal instead is to provide some background and some conceptual perspective on the problems faced by clearing and settlement systems during the crash. The origin of much of our discussion is the simple observation that the clearinghouses—which along with the exchanges are responsible for the clearing and settlement process—are financial intermediaries; and, moreover, that they function in ways analogous to other more familiar intermediaries. In particular, in some of its operations a clearinghouse is like a bank; in others, it is like an insurance company. These elementary analogies turn out to be useful for thinking about the operations of the clearinghouse both in normal times and under stress as well as for examining the potential role of government policy.

With respect to the events of October 1987, our principal conclusion is that the praise that the Federal Reserve has received for its handling of a crisis situation is warranted. The Fed performed its proper function of providing liquidity to the markets and helping them to weather an extraordinarily unusual shock. However, it does not necessarily follow from the fact that the Fed had to intervene that a structural reform of the clearing and settlement system must be undertaken. Rather, it should be recognized that, from a broader perspective, the Fed is a part of the clearing and settlement system; thus, it is arguable that the system taken as a whole (i.e., including the Fed) performed acceptably during the crash.

The article is organized as follows: Section 1 is a brief introduction to the institutional arrangements for clearing and settlement, which those already familiar with clearinghouses and their functions may

wish to skip. Section 2 draws out the comparison between clearinghouses and other financial intermediaries, emphasizing in particular issues raised by a systematic shock such as the crash. Section 3 summarizes the major clearing and settlement problems during the crash and discusses them in light of Section 2. Section 4 concludes.

1. Institutional Arrangements

A number of good discussions of the mechanics of financial market clearing and settlement are available; including those contained in some of the recent official studies of the crash. The brief introduction to the subject given in this section draws heavily on the excellent treatments of Edwards (1984) and Rutz (1989), to which the reader is referred for more details.

In all U.S. financial markets, the two institutions responsible for the clearing and settlement functions are the exchange and the clearinghouse, particularly the latter. In some cases, the clearinghouse is part of the exchange; otherwise, it is a separate nonprofit corporation. Whatever its formal organization, the clearinghouse also functions as an association of clearing members. Clearing members are private firms that, by joining the clearinghouse, gain the right to clear trades for their own customers and for nonmember firms. The clearing members also elect a board of directors who oversee the management of the clearinghouse.

There are quite a few independent clearinghouses operating in the U.S. financial system: Rutz (1989, chart 1) reports that there are nine clearinghouses, serving 13 exchanges, in futures markets; one clearinghouse (the Options Clearing Corporation), serving five exchanges and the NASD, in options markets; and three clearinghouses (with associated depositories), serving six exchanges and the NASD, in stock markets. As was stated In the introduction, this article focuses particularly on clearinghouse operation in a typical futures market; many of the basic principles are the same in the other types of markets. In futures markets the clearing members are called futures commission merchants, or FCMs.

Rutz usefully distinguishes the operational and financial components of the clearing and settlement process, as overseen by the clearinghouse. The operational components are (1) trade entry, or trade capture; (2) trade matching, or trade comparison; and (3) trade registration, or trade clearance. Trade entry is the process of getting trade data from the floor to a central location. Trade matching is the process of checking to see if buy and sell orders agree on price and quantity and then assisting in the process of reconciliation. In the trade clearance stage, long and short transactions are netted out to

arrive at the new number of open positions held by each clearing member.

A crucial part of the clearinghouse's role comes into play during trade clearance. At this point the clearinghouse becomes an official "party to every trade," substituting itself as a seller to every buyer and a buyer to every seller. In interposing itself this way, the clearinghouse legally assumes the obligation of guaranteeing the execution of each trade to other clearing members, should one of the clearing members default or fail. As all writers on this subject have emphasized, this performance guarantee by the clearinghouse is an integral part of the futures contract. Its purpose is to enable investors to trade without concern about the creditworthiness of the individuals with whom they are dealing. As is pointed out by Edwards, the arrangement of making the clearinghouse a party to every trade also gives the clearinghouse an additional convenient power, the power to settle trades "by offset." Under the offset mechanism, the clearinghouse is able to cancel a trader's obligation once he has entered into an offsetting trade.

The second part of the clearinghouse's responsibilities, in Rutz's taxonomy, is the financial component of the settlement process. This refers to actions taken by the clearinghouse to ensure that it will be able to honor its guarantee of trades, even in the event of large price moves. There are, in turn, two aspects to this function.

First, the clearinghouse attempts to reduce the risk that a clearing member will not be able to honor its commitments. Toward this end the clearinghouse sets capital requirements, position limits, and other financial standards for members;[1] collects margin payments on open positions (more on this below); and continuously monitors the financial strength and portfolio positions taken by member firms.

Second, the clearinghouse makes provisions for fulfilling its guarantee should a clearing member fail. For example, the clearinghouse typically holds some capital of its own, collected from members, as a guarantee fund; it may also establish rules permitting it to make an ex post assessment of its solvent members to cover any defaults.

In practice, the most important device for ensuring performance on trades is the collection of margin.[2] While in stock markets margin is effectively a "down payment" on the purchase of securities (with the rest of the purchase being financed by credit from the broker), in futures (and options) markets the margin is more correctly thought

[1] In futures markets, capital requirements depend on gross customer positions and not on either net customer exposure or the exposure of the firm's own portfolio. Thus margin collection and position limits are important complements to capital requirements.

[2] An extensive study of margins, their economic significance, and their regulation is given in Board of Governors (1984). An up-to-date discussion of margin requirements on equity instruments is provided by Sofianos (1988).

of as a "performance bond." The purpose of the bond is to ensure that the trader will be able to cover his position in the event of a large price move (but not, obviously, for any possible price move).

Upon making a transaction, a trader must post an initial, or original, margin. Initial margins for individuals are set by the FCMs, subject to exchange-determined minimum levels. Methods for setting margin range from the setting of fixed margins for each type of contract to sophisticated analyses of the individual investor's entire portfolio position. Traders' positions are "marked to market" daily, or sometimes even more frequently; additional margin, called variation margin, must be supplied by the trader to make up the full value of any adverse price moves.[3] Margins must be in cash or government securities; in some cases initial margin, but not variation margin, can be covered by bank standby letters of credit, or SLCs [Board of Governors (1984)].

Margin collection is actually administered in a pyramid structure. [A useful illustrative example is given in Edwards (1984, pp. 227ff).] Futures commission merchants collect margin from their own customers. Nonclearing member FCMs in turn have to post margin with a clearing member. This collection of margin from nonmember FCMs is on a gross basis; that is, the amount collected depends on the total number of contracts traded by the nonmember FCM and its customers, not on the nonmember FCM's net exposure. Effectively, then, all margins collected by nonmember FCMs are passed through to and held by clearing member firms.

The clearing members in turn post margin with the clearinghouse. This is usually on a net basis, that is, the margin depends on the open position of the member FCM; a member firm whose customers held an equal number of long and short contracts would post no margin with the clearinghouse, but would retain its customers' margins in its own account. The clearinghouse itself always has a zero net position, since the net long positions of some clearing members will cancel out the net short positions of others.

A change in the price of a futures contract triggers a sequence of margin calls.[4] Say the price falls. Then the clearinghouse will require additional margin of the member FCMs who are net long; these funds are credited to the accounts of the short member FCMs, who may withdraw them if they wish. (Usually there is some delay, generally overnight, between when the variation margin is collected by the clearinghouse and the extra funds are credited to the winning trad-

[3]In some cases, a losing trader is not required to post additional margin until his account drops below a threshold somewhat below the initial margin level. This lower threshold is called the maintenance margin requirement.

[4]For simplicity we assume that traders are not holding excess margins in their accounts.

ers.) Similarly, clearing members collect variation margin from nonmembers, and all FCMs collect from their customers.

As long as daily[5] losses per contract resulting from price changes are smaller than posted margin, the performance of contracts is automatically assured. The clearinghouse only has to transfer funds from winners to losers, incurring no exposure itself. However, if losses are so large that margins are not sufficient, and if losing traders decide or are forced to default, then there is a danger that the clearinghouse may have to make good nonperforming contracts.

An interesting question is how far the clearinghouse's guarantee of performance extends. Under a net margin system, the clearinghouse collects margins from members only on their net exposure (their net long or net short position with the clearinghouse). This suggests that the clearinghouse's goal is not to guarantee all futures contracts, but only to protect clearing members from the default of other members.

To illustrate this distinction by an example, consider a clearing member FCM with a balanced portfolio of longs and shorts: This member has no open position and thus would post no margin with the clearinghouse. It is nevertheless possible that a large price move could cause some of the clearing member's customers to default, threatening the solvency of the firm. If the FCM failed, would the clearinghouse guarantee performance of the contracts of the defaulted member's customers? Edwards (1984, pp. 231-232) claims that the answer is no; he goes on to suggest that this may be the most efficient arrangement, since it gives customers and FCMs some incentive to monitor each other's financial condition. Other sources are more ambiguous about whether the clearinghouse would assume any responsibility in this case; for example, the Brady Report (1988, pp. VI-28) points out that the Chicago Mercantile Exchange maintains a trust fund that could be used on a discretionary basis to help customers of a failing FCM. Evidently, though, not only the solvency of the clearinghouse but also the solvency of the member FCMs is a necessary condition for the integrity of all futures contracts.

A prominent part of the institutional structure is the interconnection of the clearing and settlement systems with the banking system. This interconnection exists at several points.

First, banks are operationally a part of the clearing process. Clearinghouses typically maintain accounts at a number of "clearing banks." Member FCMs are required to maintain an account at a minimum of one of these banks and to authorize the bank to make debits or credits

[5] Again, margin calls can be intraday as well as daily, which reduces the risk still further. Intraday calls are routine in some exchanges and are reserved for volatile periods in others. Clearinghouses can also require special "super" margins from members during extraordinary circumstances.

to the account in accord with the clearinghouse's instructions. This facilitates the settling of accounts and the making of margin calls. Note that the bank's role may exceed simple accounting if, for example, it must decide whether to permit an overdraft on an FCM's account.

Second, banks are a major source of credit, especially very short-term credit, to all of the parties, including the customers, the FCMs, and the clearinghouse itself. As was noted above, bank letters of credit can in some cases be used as initial margin. Customers and FCMs often rely on bank credit to facilitate the speedy posting of variation margin, and FCMs would typically have to turn to banks to finance payments made necessary by customers' defaults or slow payment. In equity markets, banks are often the ultimate source of credit for the purchase of securities on credit.

Finally, it should be noted that while, in the conventional language, most margin postings and settlement payments are made in "cash," these transactions are, of course, not really made in cash but by the transfer of bank deposits. Thus, the smooth operation of the financial market clearing and settlement system is based at all times on the presumption that the banking system is sound and can satisfy demands for withdrawals of funds.

2. The Clearinghouse as a Financial Intermediary

Futures markets serve several economic functions: They allow the hedging of price risk by permitting producers or inventory holders to sell forward at a currently determined price. They enable traders to gain information about market price expectations ("price discovery"). Finally, in some cases, trading in futures is a low-transactions-cost alternative to trading current goods or assets. For this last reason, financial futures in particular have become an important tool for general portfolio management: Trading in financial futures provides a low-cost method of speculating on the future course of the broad market or of making bets on the performance of particular stocks or stock categories relative to the market as a whole.

Essential to each of these economic functions is that the futures market be liquid: that is, prices must be good aggregators of current market information and it must be continuously possible to execute non-information-based trades at net prices close to the information-based price. The role of the clearinghouse and the exchange is to provide an institutional setting that promotes liquidity in the market. The clearinghouse in particular helps make the futures market more liquid in two ways, which correspond roughly to Rutz's distinction between the "operational" and "financial" components of the clearing and settlement process. First, the clearinghouse helps to minimize

the transaction cost of consummating agreed-upon trades. Second, the clearinghouse attempts to ensure that a futures contract is a homogeneous product from the perspective of traders.

In both of these functions the clearinghouse acts as a financial intermediary, standing between opposite sides of a financial transaction. We elaborate on this point as we discuss each of the clearinghouse's two liquidity-enhancing functions in turn.

The clearinghouse as a bank. The first way in which the clearinghouse promotes liquidity is by keeping the costs of trade completion as low as possible. In this respect, there is an obvious analogy between the clearinghouse in a futures market and a bank handling transactions in the markets for current goods and services. After matches are made in the goods market, the bank facilitates the payment process. In clearing checks, the bank determines the identities of the two parties to any transaction; it then debits and credits the appropriate accounts. Similarly, after forward-contract matches are made on the exchange floor, the clearinghouse verifies the transaction and records credits and debits. The clearinghouse similarly accounts for any subsequent trades of the contract and oversees the ultimate delivery and liquidation of the contract. Operationally, as was noted in Section 1, the clearinghouse interacts with the banking system in the accounting function; indeed, much of the actual accounting and fund transferral is done by banks with the oversight of the clearinghouse. The delegation of the accounting function by traders to the clearinghouse and the subcontracting by the clearinghouse of some of this function to the banking system reflect some obvious economies of scale and scope in the clearing and accounting process. In taking advantage of these economies, the clearinghouse enables trading to take place at a lower total cost.

Trade completion is normally a straightforward, even mechanical, process. In anticipation of our discussion of the crash, however, it is worthwhile to ask what sorts of problems might impede the clearinghouse's attempts to fulfill its "banking" role. Two types of potential problems can be identified:

The first type could be classified as *technological.* Examples would be breakdowns of communications or an overload of record-keeping systems.

The second type of problem we will call *financial,* since its occurrence requires that the financial condition of one or more important participants in the market or the payments mechanism be in doubt. In practice, transactions such as a settlement or a margin call can involve quite a few intermediate steps, each one involving a transfer of assets, an extension of credit, or both.[6] Uncertainties about the

liquidity or solvency of a participant in the payments sequence (be it a broker, a trader, a bank, or the clearinghouse itself) can thus inject risk into the clearing process, where normally there would be none. Concern about potential default risk in turn may block or delay steps of a transaction sequence. Thus financial problems in the market have the potential to interfere with a smooth operation of the clearing mechanism.

The clearinghouse as an insurance company. A spot market is much more likely to be liquid when the good being traded is homogeneous; thus, the market for gold or for oil of a certain grade can function as a liquid, auction-type market, while the markets for houses or labor cannot. Similarly, liquidity in the futures market depends on the futures contract being a standardized and homogeneous commodity, fungible and anonymous. The clearinghouse standardizes the futures contract in part by helping to set its terms and format. More important, though, it homogenizes individual contracts (makes them into "commodities") by guaranteeing performance to both sides of the trade. This guarantee means that neither trader has to be concerned with the creditworthiness or reliability of the other party to the trade and can therefore treat all futures contracts as interchangeable.

If in its trade-completion function the clearinghouse is analogous to a bank, in its contract-guarantee function the clearinghouse is analogous to an insurance company. The hazard against which it is insuring is default by one of the parties to the contract. The premia paid for this insurance come out of the fees and assessments that the clearinghouse charges its member FCMs, which presumably are ultimately paid by all market participants.

An important issue for any insurance arrangement is whether the risk being insured against is idiosyncratic or systematic; this distinction will be key to our discussion of the crash. For the moment we consider only idiosyncratic default risk, that is, the risk that a trader defaults for reasons related to individual circumstances and not because of problems in the market or the economy as a whole.

If individual defaults were purely random events, as equally unpredictable by the individuals involved as by the clearinghouse, then the guarantee of contracts would be a simple matter. Risk pooling and the law of large numbers would imply predictable default costs, which would be covered by a regular fixed assessment of FCMs or traders. The clearinghouse's role would be one of passive collection and distribution of funds.

[6]See, for example, Brimmer (1989, p.13).

However, as in most insurance arrangements, the insured risk in the futures market is not purely random, but subject (because of asymmetric information) to problems of adverse selection and moral hazard. Absent controls, it would be profitable for traders with low wealth to speculate in futures, collecting if they win but defaulting if they lose. Similarly, it would pay a trader with a position in the futures market to take excessively risky gambles on other markets, since some of the downside risk would be involuntarily shared by the other party to his futures contracts. In order to run a workable insurance scheme, the clearinghouse must somehow limit its exposure to these types of behavior by traders.

As discussed in Section 1, a principal way in which the clearinghouse protects itself against adverse selection and moral hazard on the part of traders is through the collection of margins. The posting of margin in advance makes default impossible when price changes are in the normal range. However, assets used as margin must themselves be liquid, both so that their value can be easily monitored by the clearinghouse and so that they can be quickly disposed of, if necessary, in order to settle obligations to other traders. Since liquid assets pay a lower return than other assets, the imposition of margin requirements has a real cost in terms of return foregone by traders. Because of this cost, the clearinghouse will be reluctant to impose high margin requirements; it will certainly not set margins high enough to cover any *conceivable* price move.[7]

Because reliance on margin alone is costly and is not always sufficient protection against adverse selection and moral hazard, clearinghouses, together with their member FCMs, also monitor the financial conditions of traders. To the extent that the costs of verifying that a trader is creditworthy are lower than the costs of posting margin or of accepting some adverse selection, monitoring will reduce the total cost of providing default insurance.

The monitoring of traders could in principle be centralized, but in practice it is accomplished by means of a hierarchical arrangement. The clearinghouse monitors directly only the member FCMs (although the clearinghouse and the exchange together set some guidelines); the member FCMs monitor their own customers and nonmember FCMs; and the nonmember FCMs monitor their own customers. The advantage of this pyramid structure is that there is close and regular contact, in the course of normal business, between the monitors and the monitored; this reduces the costs of information collection. On the other hand, this arrangement reduces the comprehensiveness of information available on any given trader; it also increases the number

[7] For discussion of optimal margins, see Telser (1981) and Board of Governors (1984, chap. III).

of points in the system where financial problems on the part of the monitors could possibly interfere with responsible monitoring. A similar trade-off between centralized and decentralized monitoring arises in the question of whether clearinghouses in different markets should be consolidated.

In its margin-setting and monitoring activities, the clearinghouse is itself an agent of its member FCMs, which are in turn to some degree agents of their customers. As a delegated monitor, will the clearinghouse have incentives to set margins and to monitor in an optimal way? If we continue to restrict ourselves to the case with only idiosyncratic default risks, the answer is probably yes. First, since there is competition or potential competition from other markets or exchanges, the clearinghouse will face competitive pressures both to satisfy traders that its performance guarantees are valid and to do so at minimum cost. Second, both the clearinghouse and the member FCMs have capital of their own at risk; they thus directly bear part of the cost should defaults occur. Finally, there are incentives for other agents to monitor the monitors. Holders of margin accounts, for example, face some risk of loss in the event that an FCM goes bankrupt. The threat of a "run" on margin accounts imposes some discipline on the management of an FCM in a way not much different from the traditional (pre-FDIC) banking context. Probably more important as monitors of the monitors are commercial banks and other suppliers of credit, whose funds would be at risk if the clearinghouse or its members performed poorly. This is one more link between the clearinghouse and the commercial banking system.

The issue of systematic risk. While normally the default risks insured by the clearinghouse are idiosyncratic to relatively small subsets of traders, systematic risks are also present, as the crash once again demonstrated. The principal type of systematic shock that could occur is a large price move in the futures market, which, particularly if it were coupled with severe declines in asset valuations in the rest of the economy, might lead to a large number of defaults.[8] How would such a shock be expected to affect the clearinghouse and the futures market itself?

In general, insurance arrangements are not able to cope completely with systematic risk. It is not possible, for example, to insure property against damage caused by a major war. For the same reason, while a conservative clearinghouse might try to prepare itself for even a very large shock, there must be some eventualities for which, ex ante,

[8] An unexpected collapse of a large trader or FCM might also qualify as a "systematic" shock, depending on the size of the default.

insurance is just too costly. The issue then becomes, what if a shock so large as to be judged nearly impossible ex ante actually occurs? What are the mechanisms to minimize the damage to the functioning of the market ex post?

Let us put aside the possibility of government intervention for the moment. Then there seems to be a potential structural problem with the clearinghouse arrangement. The problem is not that some traders who thought they had a guaranteed contract would end up not being paid off; as we have said, perfect insurance against systemwide shocks is not possible. Rather, the problem is that a shock large enough to exhaust the clearinghouse's capital and assessment powers would have a serious *prospective* effect on the ability of the clearinghouse and thus of the futures market itself to function. Presumably, over a period of time reorganization and recapitalization would occur. But in the shorter run the poor functioning or shutdown of the futures market might exacerbate the adverse conditions that precipitated the problem in the first place.

Can anything be done about this potential weakness? Conceptually, drawing again on the analogy with insurance, it might seem desirable to limit explicitly the exposure of the clearinghouse to large, systematic shocks. (The operative word here is "explicit." The exposure of the clearinghouse is *always* limited de facto by the extent of its capital and assessment powers. The issue is whether the obligation of the clearinghouse to insure against systematic shocks should be formally set at a level below that which exhausts its reserves.) Property insurance policies, for example, exclude acts of war as an insurable risk; thus, should a war occur, while uninsured losses may be sustained by policyholders, at least the market for non-war-related insurance is not destroyed by company defaults. Before the advent of deposit insurance, commercial banks collectively protected themselves from systemwide panics by suspending convertibility of deposits to cash; this allowed the banking system to function normally after the panic was over. In a similar way there would seem to be an argument for the clearinghouse to limit its exposure to systematic shocks in some way, so as to preserve its financial integrity and ability to operate alter the shock.

Unfortunately, there are practical difficulties with explicitly excluding systematic shocks from clearinghouse insurance.[9] One problem is that the default risk faced by a given futures market depends not only on the change in the futures price but on what is happening simultaneously in other asset markets. Thus the contingencies that

[9] These difficulties were emphasized by the discussant Franklin Edwards and some other conference participants.

the clearinghouse would want to exclude from insurance are probably too complex in practice to specify ex ante; it is too hard to write down a legal definition of "major systemwide shock."

Another issue is that, while a decision of a property insurance company not to insure against wars or hurricanes does not materially affect the probability of a war or hurricane, in futures markets the insured-against events—major changes in asset valuations—are not exogenous with respect to the clearinghouse's actions. If the clearinghouse announced, say, that it would not insure contracts past a certain price level, the effect might be a collapse of trading and prices when the market approached the critical level.

Finally, for hedging and arbitrage reasons, purchases and sales of futures contracts are often bundled with other types of transactions, including but not restricted to transactions in other financial markets. For example, stock index arbitrageurs may combine a long position in stock index futures with a short position in the spot market for stocks; or a meat broker may hedge a contract to deliver processed pork at a future date with a long position in pork belly futures. This bundling leads to complex interactions between the futures markets and other markets; an attempt by a clearinghouse to limit insurance in its own market might have the perverse effect (from a social point of view) of exporting default risk to many other parts of the economy.

It does not seem likely, then, that in practice a clearinghouse can exempt systematic risks from its insurance coverage, despite the severe costs that a default and decapitalization of the clearinghouse or several major FCMs might impose. Is this something that we should be worried about?

One argument that has been made for notworrying says essentially that the safeguards currently put in place by the clearinghouses are so extensive that the probability of some kind of mass breakdown is close to zero. After all, futures markets did make it intact through October 1987, as well as many previous crises.

It is certainly true that the safeguards are substantial and the chances of a "meltdown" are small. But there are experienced policy makers and other financial market observers who believe that financial futures markets were very close to such an event on October 20, and were relatively lucky to escape it. While some might disagree with this assessment, it does not seem wise to dismiss the possibility of such an event out of hand.

A better argument against extreme concern is based on the view that the government, especially the central bank, should be thought of as part of the system. As will be explained in the next section in the specific context of the events of October 1987, there are actions that the government can take (and likely will take, for political econ-

omy reasons) to protect the clearing and settlement systems, should they be in danger. When the financial system is conceived broadly to include the government as the "insurer of last resort," the current institutional setup seems satisfactorily robust to the threat of financial crisis.

3. Clearing and Settlement during the Crash

In this section we briefly describe some of the difficulties that clearing and settlement systems faced during the week of October 19 and comment on them in the light of the discussion of Section 2.

Both the "banking" and "insurance" functions of the clearing and settlement system were affected by the chaotic conditions of that week. On the banking side (trade completion and payments), the clearinghouses were plagued by what we called (in Section 2) technological problems. The sheer volume of trade clogged the system and caused malfunctions of communications and information processing systems. For example, the SEC report cited difficulties in the trade comparison process in several markets, which were worsened by insufficient DOT capacity and reporting delays. According to the Brady Report (1988, p. 51), questioned trades in the NYSE were 4.02 percent of the total on October 19 and 4.25 percent of the total on October 20, about double the normal rate.

A rather unanticipated communications problem was the near-"gridlock" that emerged, in some cases, as large sums of money were rapidly moved around. In a widely reported incident, Ridder-Peabody and Goldman-Sachs found themselves collectively short more than $1.5 billion after they advanced funds for margin calls for customers and then had the bank reimbursements delayed [see Eichenwald (1988)]. In other cases, it was reported that individual firms circumvented usual bank or clearinghouse channels to transfer funds directly among themselves.

Probably the most notorious communications problem, though, was the Fedwire shutdown between 10 A.M. and 12:30 P.M. CST on October 20 [see, e.g., Garsson (1988)]. This system for transferring funds from New York to Chicago closed down at a critical time as a result of a programming glitch. According to the Brady Report (1988), this was only one of several interruptions of the flow of funds to Chicago; for example, there are numerous anecdotes about how large funds transfers were delayed for hours because the home phone numbers of key New York bankers were not readily available.

The technological problems were compounded by what we have called financial problems with the payments system. The large moves

in asset prices cast doubt on the creditworthiness of many traders and firms (including specialists who had tried to carry out their shock absorber function by buying into the decline). This worsened the financial gridlock as banks and other creditors became cautious about transferring funds to individuals or institutions whose solvency might be in doubt.

The payments problems occurred at a time when, as a consequence of the price declines, many traders and firms found themselves in need of large quantities of funds in order to meet settlements and margin calls.[10] Some of the largest demands came from the clearinghouses of the Chicago futures markets, which issued over $4 billion in variation margin calls on Monday and Tuesday. Although the clearinghouses had no choice but to make the margin calls (there surely would have been severe consequences for the markets if they had not), these demands for funds were widely criticized in postmortems for "draining liquidity from the system."

When called upon to provide these funds, the banks were initially reluctant to comply, and concerns about the availability of credit were extensive [Stewart and Hertzberg (1987)]. A major problem was that, in a highly volatile situation, the banks had difficulty updating their information about the balance sheets of their customers. This forced banks into hard choices. For example, according to the SEC report (1988, pp. 10-41): "On several occasions during the week, OCC [Options Clearing Corporation] clearing members had inadequate funds in their clearing bank to satisfy OCC debit instructions. At the same time, the clearing banks were unable to establish whether OCC clearing members could immediately transfer the necessary funds to the bank. As a result, the clearing banks were forced to decide whether to allow clearing members to overdraft their account, or to refuse to pay OCC and risk OCC declaring those members in default and OCC liquidating their options positions." In this particular case, most of the banks permitted overdrafts.

The malfunctioning of the banking side of the clearing and settlements systems during this period is indisputable. The threat to the insurance aspect of the clearinghouse's function may have been more subjective than objective, but even so it may have had adverse effects.

Recall from our earlier discussion that the insurance of traders against counterparty default risk is the joint responsibility of the clearinghouse and the member FCMs. To the extent that traders believed that member FCMs—and thus, potentially, the clearinghouse—were

[10]Because of the overnight delay in crediting collected margins to winners, even some traders whose gains in some markets offset losses in others found themselves subject to severe pressure when trying to meet margin calls.

in financial jeopardy, they would also have doubts about the futures-contract performance guarantee.

While fears of clearinghouse and FCM default ultimately proved overstated, it appears that rumors of broker, FCM, and clearinghouse insolvencies contributed to market declines, especially on October 20 [see, e.g., Stewart and Hertzberg (1987)]. Concerns about the futures market settlement systems may have been part of the reason for the existence of large apparent arbitrage opportunities between spot and futures markets, as well.

Overall, both the banking and insurance aspects of the clearing system faced severe problems on October 20. Delays and breakdowns in the payments and clearance process and the perception that the insurance function of the clearing system was also in danger added to the confusion in financial markets and probably contributed to the falls in prices.

The policy response. The official reports and other observers generally agree that the Federal Reserve's attempts to alleviate the crisis were very constructive. On Tuesday morning, October 20, the Fed issued a brief statement: "The Federal Reserve, consistent with its responsibilities as the nation's central bank, affirmed today its readiness to serve as a source of liquidity to support the financial and economic system." This statement was backed up by three types of actions: First, the Fed reversed its tight monetary stance of the previous weeks and flooded the system with liquidity. Second, the Fed "persuaded" the banks, particularly the big New York banks, to lend freely, promising whatever support was necessary. (The 10 largest New York banks nearly doubled their lending to securities firms during the week of October 19.) Finally, the Fed monitored the situation and took some direct actions where necessary, notably in the case of First Options of Chicago. When that large clearing firm was in danger of defaulting, Fed Chairman Greenspan acted quickly to enable its parent firm, Continental Illinois, to inject funds into its subsidiary; according to some observers, this action may have helped avoid the closing 'of the options exchange [see Murray (1987)].

Ultimately, the insolvency casualties due to the crash were rather few. Only three firms defaulted or withdrew from clearing agency membership; the Options Clearing Corporation assessed its membership for losses due to one of these [U.S. Securities and Exchange Commission (1988, pp. 10-13)]. Something over fifty introducing brokers failed during the week [U.S. SEC (1988, pp. 10-20)], many of whom reopened later. The Federal Reserve's gamble paid off. Problems in the financial markets were eased by the flow of credit, and the banking system did not incur significant losses.

In retrospect we may ask, what really were the dangers to the integrity of the financial markets posed by the crash? And what were the benefits of the Federal Reserve's actions?

The technological problems of communications and information availability that plagued the system, while serious, did not in and of themselves threaten to bring down the markets. For the most part, information availability was a critical issue during the crash only in the sense that illiquidity is essentially a problem of imperfect information. (Clearly, though, improvements in these technologies should be made.)

It was the financial problems-the possibility of insolvency by major players-that were potentially the more serious. As we have emphasized, financial problems impaired the market's functioning in at least two ways. First, concerns about solvency impeded the operation of the payments and clearing systems, contributing to financial "gridlock." Second, the fear that major brokers, FCMs, or clearinghouses might default created uncertainty about the contract performance guarantee. Both aspects reduced market liquidity and disrupted trading. Conceivably these problems could have forced a market shutdown.

In response to this situation, the Federal Reserve, in its lender-of-last-resort capacity, performed an important protective function. The Fed's key action was to induce the banks (by suasion and by the supply of liquidity) to make loans, on customary terms, despite chaotic conditions and the possibility of severe adverse selection of borrowers. In expectation, making these loans must have been a money-losing strategy from the point of view of the banks (and the Fed); otherwise, Fed persuasion would not have been needed. But lending was a good strategy for the preservation of the system as a whole.

The principal effect of the loans was to transfer some trader default risk from the clearinghouses and their members to money-center banks. Under the presumption that the money-center banks were well capitalized, and that in any event their solvency would be guaranteed by the government, this transfer of risk reduced the overall threat of insolvencies in the system. This allowed the payments process to begin to normalize; it also restored confidence in the clearinghouse's guarantee of futures contract performance. The resulting stabilization of the markets served the interest of the banks and the Fed in a wider sense, by avoiding any potential costs that a market breakdown might have imposed on the banking system and the general economy.

In performing its lender-of-last-resort function, the Fed redistributed risks in the system in a socially beneficial way. Conceptually, it is as if the Fed had provided ex post insurance to the clearinghouse

against a shock that it seemed possible would exhaust the insurance capability of the clearinghouse itself. Thus the Fed became the "insurer of last resort."

4. Conclusion

Simplistically put, two schools of thought on the performance of clearance and settlement systems during the crash have been in evidence. Defenders of the status quo emphasize that, despite extreme conditions, the system came through more or less intact. As the report of the U.S. Commodities Futures Trading Corporation (1988, p. 9) put it: ". . . those safeguards already in place for the futures markets worked effectively. No customer funds were lost as the result of a futures firm's failure or default; no futures commission merchant (FCM) failed; exchange clearing organizations collected all margins due them from member firms, including daily and intra-day payments of unprecedented magnitudes; and the futures clearing mechanisms operated effectively despite record volumes, price swings, and margin flows." Those taking this view at one time or other seem invariably to cite the maxim, "If it ain't broke, don't fix it."

The opposing school of thought is less sanguine about the performance of the clearing and settlement system. Members of this school tend to argue that with a few pieces of bad luck here or there (e.g., if the mysterious rally in the MMI futures contract had not rescued the market on October 20; if First Options had not had access to the "deep pockets" of Continental Illinois; if the crash had occurred on the previous Monday, Columbus Day, when the banks were closed; if there had been some real political or economic crisis; etc.), much more severe consequences might have ensued. This school usually singles out the Fed for praise.

Our view is (in a way) intermediate. We think that it is certainly possible that much more serious problems could have emerged than actually did, so luck was with us in that respect. On the other hand, (1) an optimal system is not necessarily a foolproof system and (2) the system, when thought of as *including* the banking system and the Fed, did not perform so badly. Since it now appears that the Fed is firmly committed to respond when the financial system is threatened [Brimmer (1989)], it may be that changes in the clearing and settlement system can be safely restricted to improvements to the technology of clearing and settlement.[11]

[11] The commitment of the government to provide ex post insurance also gives some basis for government interest in, and regulation of, the clearing and settlement system. Government oversight of many aspects of the financial system is of course already a fact of life.

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