Clearing and Settling Financial Transactions, Circa 2000

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The convenience, safety, and trust required for national and global financial markets to function are largely provided by clearing and settlement arrangements. Well-designed settlement arrangements can address the most serious risk of loss of the entire principal value of an asset being traded. A spectrum of risk-control arrangements and procedures at the clearing stage of a transaction provides further benefits. The resulting strength and flexibility of current practices have contributed to financial markets' responsiveness to three major challenges and opportunities: the invention of financial derivatives (for example, futures, options, and swaps) and the establishment of exchanges to trade many of them; the availability of computing and telecommunication technology that can simultaneously link a large, geographically dispersed group of traders, and the consequent feasibility of conducting trading by means other than open outcry on a trading floor; and the explosive growth of transaction volume on a number of exchanges.

[1] The views expressed in this article are solely those of the author and do not necessarily represent the views of the Federal Reserve Bank of Chicago or of the Federal Reserve System. The author is a layperson in the law. Where some discussion of legal issues in general terms has been necessary in the article, it should not be regarded as an authoritative statement of law. The author has benefited from discussions with Sujit Chakravorty, Robert Eisenbeis, John McPartland, Anders Revemann, William Roberds, Robert Steigerwald, and Staffan Viotti and from the discussion provided by Richard Lindsey at the 2000 Financial Markets Conference of the Federal Reserve Bank of Atlanta.

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In order for a market to exist there must be a mechanism to convey whatever is traded conveniently and safely between the parties to the trades. Moreover, the scope of the market can only be as large as the community of traders who have access to such means of transfer. Traders who do not know one another, particularly in a large market, must deliver assets and money in order to complete their trades. Each trader will only be willing to do so if he is confident that the reciprocal payment or asset transfer due to him will also be made. Such trust in the integrity of the market must be supported by formal, institutionalized safeguards.

In the context of financial transactions, the convenience, safety, and trust required for national and global markets to function are largely provided by clearing and settlement arrangements. The process of making a transaction can be divided roughly into three stages: execution, clearing, and settlement. Only the initial, execution stage typically requires the active attention of the traders or their clients.[2] Clearing and settlement are nevertheless vital, although they occur in the background.

This paper is a broad introductory survey of how clearing and settlement are typically accomplished in financial markets today. Primary securities (such as debt and equity), exchange-traded derivative securities, and assets and contracts traded outside exchanges (over-the counter trades) will all be discussed. This survey should convey an understanding of the crucial role of clearing and settlement arrangements in enabling such financial-markets developments as the invention of financial derivatives, the explosive growth of trading volume, and the use of telecommunications networks to conduct financial trading. It should also provide an appreciation of the business and public-policy objectives that motivate the arrangements' ongoing development. The survey is not comprehensive. For instance, cross-market and cross-jurisdiction transactions (and especially international transactions) are not discussed. Nevertheless, this paper should provide sufficient background to facilitate the reading of industry and supervisory policy documents guiding the evolution of these arrangements.[3]

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[2] There are issues of convenience, safety, and trust at this stage, as well as at the subsequent stages that are the subject of this article. As traders increasingly deal with one another and with clients fairly anonymously via electronic networks, new and significant issues are raised. In large part the issues seem parallel to those that arise in other areas of electronic commerce (Rutstein et al. 1999).

[3] In particular, BIS (1995) deals with cross-border securities settlements.

Clearing and settlement are discussed primarily in the context of U.S. laws, institutions, and practices. There are broad similarities, but also numerous differences in detail, between this U.S. context and those of other industrialized countries.

Institutional description per se is not the focus of this article, however. Rather, the focus is to understand clearing and settlement processes as risk-management techniques for financial trading. A delivery-versus-payment settlement arrangement is introduced as the basic risk-control technique, and then other arrangements and practices are discussed as ancillary measures that can be successively employed. Not surprisingly, many financial markets have developed historically in approximately the sequence that this exposition follows. Nevertheless, it bears emphasizing that the guiding principle of the exposition is economic logic rather than historical sequence. Some of the regimes discussed in this paper are merely hypothetical or have been observed in actual markets only during brief transitional episodes.

Financial clearing and settlement services are continuously being improved and extended to new assets. This progress reflects both the high priority that the securities industry autonomously places on clearing and settlement and also the further stimulus that securities-market commissions and central banks provide. In comparison to the situation three or four decades ago, when deficiencies in the U.S. securities clearing and settlement arrangements reached crisis proportions, these systems today perform admirably under normal market conditions and have survived—and seem to have contributed to stability during—episodes of moderate market stress in 1987 and 1998.[4] The arrangements' strength and flexibility arguably have been essential to financial markets' responsiveness to three major challenges and opportunities: the invention of financial derivatives (for example, futures, options, and swaps) and the establishment of exchanges to trade many of them; the availability of computing and telecommunication technology that can simultaneously link a large, geographically dispersed group of traders, and the consequent feasibility of conducting trading by means other than open outcry on a trading floor; and the explosive growth of transaction volume on a number of

[4] Nevertheless, the 1987 episode revealed some weaknesses and stimulated subsequent improvements. The Group of Thirty, an organization of senior bankers and financial executives, central bankers, and academics, played a prominent role in suggesting and promoting reforms.

exchanges.[5] Ongoing efforts to make further improvements are key to meeting present and future challenges.[6]

Execution, Clearing, and Settlement

A financial transaction consists of the formation of a sale contract for a financial asset (or multiple assets) and the subsequent discharge of the buyer's and seller's obligations under that contract. Execution of the trade is simply the procedure by which the contract is formed.[7] The contractually specified way for the buyer's obligation to be discharged is typically for his bank to pay the asset's sale price to the buyer's bank. Settlement is the completion of this interbank payment.

In practice a sale contract is often formed with the expectation that it will be modified or replaced before the specified settlement date. For example, if some third party is better able than the seller to bear or control risk of the buyer's possible default and is thought by the seller to be less risky than the buyer, then the buyer and seller may arrange with the third party to guarantee payment to the seller and to accept settlement from the buyer. In that case the buyer's obligation under the original contract to settle with the seller will be replaced by an obligation under a new contract to settle with the third party. Another example, provided because it makes a conceptually important point, is that settlement would not have to occur at all if the buyer were to make an offsetting sale of another asset having precisely equal value to the seller (in the original transaction) before the settlement date. In this event the two parties might agree simply to swap assets without either transaction's needing to settle.

[5] The National Securities Clearing Corporation (NSCC) is the clearing organization for the major U.S. exchanges for stocks, corporate and municipal bonds, and transactions of mutual funds and pension funds. Its peak-day transactions volumes (counting a matched pair of purchase and sale orders as a single transaction) have grown from approximately three billion in 1998 to five billion in 1999 to nine billion in the first half of 2000 (Depository Trust & Clearing Corporation press release, April 7, 2000, <http://www.dtcc.com/press/>).

[6] Increased burdens are being put on the clearing and settlement system by current and prospective developments such as the extension of trading hours, further volume growth due to narrowing of bid-ask spreads (facilitated by decimalization of trade quotes), and growth of cross-border securities trading. A main focus of efforts to meet these challenges is the reduction of the time between trade execution and settlement to one business day. The U.S. initiative in this regard is described in Securities Industry Association (2000).

[7] The execution stage may involve submission of trading orders to an exchange, as well as matching (that is, ensuring that the buyer's and seller's trading orders are mutually consistent), and possibly registration and confirmation of the trading contract between the buyer and seller.

In this paper, clearing is defined as the modification or replacement of sales contracts prior to settlement.[8] That is, clearing consists of activities such those described in the preceding paragraph. A transaction does not necessarily have to be cleared, since the buyer's and seller's obligation under the original contract can be discharged. Similarly, as the second example in the previous paragraph illustrates, it is possible for a sale to be completed without settlement.

Principal Risk, Replacement Cost Risk, and Delivery versus Payment

Consider a very primitive, hypothetical regime of financial transactions in which a security, such as corporate equity, is exchanged for cash. [9] Assume that cash payment is final, that is, that the cash cannot be taken back by the payor or taken away from the payee by third parties (for example, in the event that the payor had obtained it by theft). Suppose that the security is issued in bearer form, that is, that ownership is evidenced by possession of a transferable certificate that was given by the issuer to the original purchaser of the security and that has been handed over to the new owner every time the security has been sold. In the present transaction as well, ownership of the security will be transferred by handing over the certificate. Furthermore, as with cash, transfer of the security is final.

Suppose that in this regime the security's owner contracts to sell it to a buyer at a specified price. That is, they make a legally binding agreement that the seller will hand the certificate over to the buyer in exchange for the cash as soon as they can retrieve the certificate and the cash from their respective vaults. Making this contract constitutes the execution stage of the transaction. After execution the seller still owns the security because the certificate is still in the seller's vault. That is, delivery of the security and payment for it still have to be made.

Consider now how this delivery and payment might take place. The seller might send the certificate to the buyer by courier, expecting the buyer to send cash in return. In this informal arrangement, the seller is exposed to the risk that the buyer may have an urgent and unanticipated need for cash—both the amount in the vault and the additional amount that could be gotten by reselling the security—such as might happen in catastrophic circumstances such as

[8] Clearing, or clearance, has traditionally been defined as "computation of the amounts to be settled." The present definition seems to capture better than the traditional definition many of the activities that clearing is generally agreed to comprehend. The present definition is also more closely related to the economic rationale for clearing to occur than the traditional one.

[9] This section draws on BIS (1992). Note that direct cash payment to the seller, rather than settlement by interbank payment, occurs in this primitive regime.

insolvency. Subject to this force majeur, the buyer could resell the security and pay all the cash—both the amount in the vault and the proceeds of the sale—to persons other than the seller. Because both the resale of the security and the payment of cash are final, the original seller can neither take back the security from its new owner nor take cash from the person to whom the buyer paid it. The seller has lost the entire value of the security. All that the seller can do is to sue the buyer for breach of contract. Given the buyer's unfortunate situation, though, a judgment that the buyer must pay the seller is likely to be unenforceable. This loss of the principal value of the security is essentially the worst outcome that the transaction could possibly have for the seller.[10]

Alternatively, the buyer and the seller could mitigate their risks by agreeing to meet face-to-face at a specified time and place to exchange the security and the cash.[11] Such an agreement exemplifies a delivery-versus-payment settlement arrangement, that is, an arrangement by which the security and the cash paid for it are transferred simultaneously and neither transfer can occur without the other.[12]

Consider how a delivery-versus-payment arrangement mitigates risks. Under this arrangement the buyer could do no worse than to default by showing up empty-handed (or not showing up at all). Then the seller would have the option of selling the security to someone else at prevailing market terms and might receive less for it than the amount contracted with the buyer if the market price had fallen since the previous day. If the seller urgently needed the sales proceeds to make a payment on the intended settlement day and would have to take out a loan or pay a penalty for lateness, that would be a further loss attributable to the buyer's default. Under usual circumstances these two losses do not add up to anything so catastrophic as loss of the principal value of the security.[13]

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[10] Given the symmetry between the buyer and the seller (since transfers of both money and securities are final), a story could alternatively be told that the buyer lost the money but did not gain the security and had no effective recourse through contract enforcement. Again, this would be essentially the worst possible outcome of the transaction.

[11] The U.S. Securities and Exchange Commission (SEC) currently requires that equity trades should be settled by the third business day after the contract for sale has been executed.

[12] The following discussion assumes that payment is immediately final. That is, it cannot later be cancelled by the buyer or dishonored by the buyer's bank. Funds transfer systems that provide immediate finality are almost universally used for securities settlement.

[13] The two risks described here are often called replacement-cost risk and liquidity risk, respectively, To say that they are typically less severe than principal risk is not to dismiss the problem. Assuredly there are instances in which value of a security has fallen appreciably within the time that it takes to complete a sale. For some financial derivatives and other assets that have volatile prices, replacement-cost risk is especially salient.

This description of a delivery-versus-payment arrangement suggests that securities delivery and money payment are accomplished with exact simultaneity. In the interest of convenience and cost effectiveness, many actual systems are designed to achieve only approximate simultaneity of securities transfer and settlement. The risks inherent in such a design and the ways of controlling and insuring that risk are similar to those associated with settlement after netting in a clearing system, which is discussed later in this paper.

Interbank Funds Transfers

An alternative to making cash payment directly to the seller, as envisioned in the primitive regime just discussed, is for the buyer to use an interbank payment system to transfer balances from his bank to the seller's bank—that is, to settle the transaction. Such a system consists of (1) one or several institutions that maintain deposit accounts, among which money balances can be transferred; (2) a system of contracts and legal rules, supported by accounting principles, that serve especially as a basis for allocating and managing risk in the payments process; and (3) a technological pipeline to support the flows of assets and information involved in the payments process.

In order for settlement via an interbank payment system to be a good alternative to cash payment for trade in financial assets, the payment system must be secure and reliable. It must also provide prompt finality. There are a variety of ways to meet these requirements; real-time gross settlement on the accounts of a central bank is the most widely adopted.[14] Real-time gross settlement implies that the operator of the system makes the payment immediately available and final to the receiving bank and that the full amount of the payment is debited from the account of the sending bank. Alternative payment system designs may include netting or deferred finality (or both) of payments, involving parallel considerations to those discussed later in this article regarding netting in securities transfer systems.

Delivery-versus-Payment Settlement and Legal Risk

Separate transfer of securities and payment of funds was the norm for settling U.S. securities transactions until the 1970s. Even then, when the daily New York Stock Exchange

[14] Real-time gross settlement and alternative payment system designs are discussed in BIS (1997b). BIS (2000) is a draft issued, in the course of a consultative process, by a task force to consider what principles should govern the design of payment systems in all countries.

(NYSE) transaction level was in the range of 20–100 million shares rather than today's level of a billion, settlement by means of face-to-face meetings was out of the question as a routine practice.[15] Two alternative means to achieve delivery-versus-payment arrangements came into widespread use: (1) the issuance of uncertificated (or dematerialized) securities that an owner must hold directly by being registered as owner by the issuer and (2) a tiered holdings structure, that is, a hierarchical account structure of indirect security holdings.[16] In the United States, the correct ways of using both of these means of settlement (including the rights and responsibilities of all principals and agents in the transaction) are set forth in Article 8 of the 1994 revision of the Uniform Commercial Code (UCC). UCC Article 8 governs most securities transactions in the United States because it has been adopted by the states in which the transactions occur, because parties to transactions in other states agree explicitly to adopt it and the law makes such an agreement enforceable, or—in the case of sales of Treasury securities—because the federal regulations governing those sales are based on Article 8 (ALI 1994).

A security is said to be issued in uncertificated form if the issuer does not provide a physical certificate to document ownership but only maintains a database (that is, a set of accounts) called a book-entry system that definitively registers who owns how much of the security.[17] Change of ownership is effected by instructing the issuer to record the change in the database. An intermediary can accomplish delivery-versus-payment settlement by a three-stage process. First, the intermediary obtains authorization from the seller to act as agent to instruct the issuer to change ownership after payment from the buyer has been received. Second, the intermediary obtains confirmation that the buyer has made payment. (The most straightforward way is for the intermediary to control the bank account into which payment is made.) Third, the intermediary submits to the issuer an instruction to make the buyer the new owner of the

[15] The sources for former and current NYSE share volumes are <http://www.nyse.com/about/about.html> and the August 18, 2000, *Wall Street Journal*, page C3, respectively. Note that these are share volumes, not transactions volumes.

[16] Today, mutual funds issue shares are held directly in uncertificated form, but most equity and debt securities continue to be issued in certificated form and held indirectly. Sales of the latter securities are settled by transferring securities entitlements between accounts. The Federal Reserve issues Treasury securities in dematerialized form through its Treasury Direct system, but most Treasury securities are owned and traded via a hierarchical system of accounts. Sales at the top level of the hierarchy are settled via the Fedwire Book Entry Security System, which effects delivery-versus-payment transfers between financial intermediaries' reserve accounts and their Treasury-securities accounts with the Fed.

[17] Either a certificated or uncertificated security can be issued in registered, or book-entry, form. In practice the issuer's tasks described in this section are almost always delegated to an agent.

security, along with documentation that the intermediary is submitting a valid instruction as agent of the seller.

According to the foregoing settlement procedure, the issuer must take an action (namely, to amend the database) every time a security is sold. In markets where sales are ordinarily made through brokers and where these brokers also maintain records of their customers' portfolios for business purposes, duplicate records of ownership are actually being kept. If the issuer's involvement in secondary-market securities transactions is inconvenient or expensive, then it can be minimized by stipulating that the broker's record that the customer owns a security or other financial asset is essentially identical to the issuer's record as evidence of the customer's property right. In the language of UCC Article 8, the account owner has a security entitlement to the financial asset in the account.[18] Incidentally, the class of financial assets that can give rise to security entitlements is somewhat broader than the class of assets that are characterized as securities in Article 8. This extra breadth permits derivative securities, as well as equity and debt securities, to be traded as security entitlements within the scope of the UCC.

In a legal system where a security entitlement is a recognized form of property, the issuer's record can indicate that the broker owns the security while the broker's record indicates that the customer owns the security. If one customer of the broker sells the security to another, then the broker's database must be amended to reflect the change of ownership but no change needs to be made in the issuer's database. That is, as far as the issuer is concerned, the same broker remains the owner of the security. Only the broker and the customer need to know, and the customer needs to be able to prove, that the customer is the beneficial owner—that is, the person who exercises the rights and enjoys the benefits of ownership—of the security. Only when a customer of one broker sells the security to a customer of a different broker does the issuer need to record a change of ownership—from one broker to another.

In many cases further economy has been achieved by inserting a special-purpose intermediary, a securities depository company, between the issuers and the brokers. This intermediary achieves an economy of scope by, in effect, holding all certificates and maintaining the databases of all issuers. (The certificates held by the depository company are said to be immobilized.) Each issuer maintains a trivial database, in which the depository company is

[18] A security entitlement should not be confused with the similarly named legal concept of a security interest.

recorded as being the owner of all the securities that have been issued.[19] The depository company keeps a set of accounts for its participants (that is, its customers), which in practice are mostly brokers and banks. Each of those intermediary participants, in turn, maintains a set of accounts for its customers, most of which are the nonintermediaries who are the beneficial owners of the securities.

The account structure of this indirect-holdings system is closely analogous to that of a banking system, where nonbank entities hold accounts at banks, which may hold accounts at correspondent banks, which may in turn hold accounts at the central bank. The bank takes funds deposited by the customer and deposits them with the correspondent bank. The bank's customer is unknown to the correspondent bank, and the customer cannot withdraw the funds directly from there despite being the ultimate source of the funds deposited at the correspondent bank. The proper analogy is actually between the hierarchical system based on UCC Article 8 and a banking system with a 100 percent reserve requirement. That is, Article 8 requires an intermediary to own securities to cover the security entitlements owned by its customers by virtue of their accounts. The intermediary can satisfy this requirement either by being the direct holder of the security (that is, by possessing the certificate and/or being the registered owner in the issuer's book-entry system) or by having a security entitlement by virtue of owning an account at another intermediary.

Another requirement that the 1994 revision of Article 8 places on intermediaries is that customer securities must be in a separate account from securities of which the intermediary itself (specifically, a broker-dealer) is the beneficial owner.[20] This requirement gives teeth to a protection afforded to customers, that their security entitlements cannot be used to satisfy claims against the intermediary. In addition the 1994 revision provides protection to holders of security entitlements against adverse claims (for example, that ownership must be relinquished because the security entitlement was purchased, albeit in good faith, from a seller who had obtained it illegally) that is analogous to the protection that direct holders of securities had already enjoyed.

[19] Technically, this is an overstatement with respect to the U.S. markets. For example, the Depository Trust Company (DTC) is the depository trust company for most U.S. equities, as well as corporate and municipal bonds and other types of security. The DTC was estimated in 1994 to be the direct holder of only between 60 percent and 80 percent of shares of U.S. equity. However, it holds nearly all of the actively traded equity. About 99 percent of equity trades are cleared through the National Securities Clearing Corporation (NSCC) and then settled through the DTC, so the need for issuers to be involved in settlement is very greatly reduced. (The DTC and the NSCC are both subsidiaries of the Depository Trust & Clearing Corporation.)

Consider what might otherwise happen to such a buyer holding the security in an account at a broker where the broker was the direct holder of the security. The original owner from whom the seller had illegally obtained the security could not sue the broker to get it back because the broker would be protected from adverse claims as direct holder. However, the original owner could sue to force the buyer (that is, the customer of the broker) to relinquish the security entitlement. The effect of a successful suit would be to establish an account of the original owner at the broker and to transfer the buyer's security to it without compensating the buyer. This might be done in spite of the protection against adverse claims that the broker would enjoy as direct holder since the buyer's security entitlement would be a distinct right from the broker's property right to the security, and only the latter would be protected by Article 8 prior to adoption of the 1994 revision.

These features of the 1994 revision of UCC Article 8 are good illustrations of the importance that both securities markets participants and supervisors attach to ensuring that market practices have clear, predictable, and enforceable legal foundations. The practice of indirect holding of securities through accounts was well established by 1994. Securities intermediaries and their customers who elected to hold their securities indirectly in accounts did not consider an imperfection such as the potential exposure to adverse claims to be a serious enough problem to warrant the inconvenience to the account owner of holding the security directly instead. There may have been alternative legal arguments that could ground protections for securities-account owners on other parts of the law than Article 8, or perhaps simply on the basis that courts really have no alternative but to grant the assumptions required to make an essential industry practice viable. However, such alternative grounding might have to be provided by a patchwork of arguments that would be supportable in various jurisdictions. The arguments might be untested in court and subject to differences of expert opinion regarding whether they would be accepted.

If these arguments were to be tested for the first time in the aftermath of a market breakdown, the resulting uncertainty and delay in resolving conflicts might possibly exacerbate problems in the market and even in economy in general. Regardless of whether there were ever a market breakdown or whether the legal arguments were ever tested, uncertainty regarding the

[20] Article 8 does permit a broker-dealer to maintain just two accounts at the depository company, one for the broker's own holdings and the other for the customers' collective holdings.

legal status of indirect holding would tend to discourage the use of indirect holding. The abstention of some owners from holding their securities indirectly arguably could make the settlement system less efficient than it would be if all securities were immobilized. For all of these reasons, the integrity of U.S. securities settlement was strengthened when the practice of holding and transferring security entitlements was codified with explicit safeguards and specifications of rights and responsibilities and when this codification was widely adopted during the past decade.

An episode of market stress is precisely the type of situation that is prone to bring to light unanticipated ambiguities in a legal code or questions about the relationship of the code to actual commercial practice. For this reason, supervisors acknowledge that attempts to achieve sound legal underpinnings are doomed to fall short of certainty(see BIS 2000, part II, section 7.1.3). Nevertheless, such attempts are regarded as being highly productive, and it is good public policy to foster them. Reviewing and improving the legal foundations of clearing and settlement systems has become a continuous process in the United States and other countries.[21] Besides the law of payments and securities transactions, legal frameworks for making contracts, pledging and liquidating collateral, and managing insolvencies receive close scrutiny.

Settlement and the Electronic Execution of Trades

Arrangements for the electronic execution of trades are currently receiving much attention. These arrangements include both exchange-sponsored systems and also systems that function as brokers. An electronic communications network for securities trading can be structured either as an exchange or a broker. These new execution systems fit well with the U.S. regime of securities ownership and transfer that has just been described. In fact, the improvement that the revised UCC Article 8 has made in the legal foundation of this regime may well have been one of the factors that has promoted the development of electronic trade execution.

Electronic execution of trades will make it more common for trades to be executed across national borders, for a security to be listed on several exchanges, and so forth. Such circumstances can create some problems of coordinating disparate industry practices and

[21] A current (as of August 2000) example is the proposed amendment of 17 CFR Part 35 of the rules of the Commodity Futures Trading Commission (CFTC 2000), which is intended to help resolve legal uncertainty noted by the President's Working Group on Financial Markets (1999) about the availability of clearing for financial derivatives that are not traded on exchanges.

regulations, such as differences across jurisdictions regarding how promptly settlement must occur after a transaction. Industry participants and policymakers need to harmonize such practices and regulations, as has characteristically been done through a process of consultation when such needs have arisen.

Electronically executed transactions often exemplify transactions in which the parties do not know one another and find it costly or difficult to assess the risks to which they expose themselves by trading with one another. Parties to such transactions benefit especially from various risk-management measures in the clearing process, which are discussed below.

Electronically executed trades can be quickly and accurately matched. For this reason, electronic execution may eventually facilitate a reduction in the time lag between execution and settlement.

Clearing as Risk Management by Contract Alteration

Clearing is often defined as computation of the obligations to be settled. This definition does not explicitly recognize the important risk-management activities that are characteristically performed at the clearing stage of a transaction. These often include economically significant rearrangement of the obligations themselves by means that may include obligation netting, the creation of new contingent obligations in the form of mutualization of losses, settlement guarantee (or substitution of counterparty), and posting of collateral or margin. These four practices are classic examples of a general risk-management technique of contract modification employed today in many forms. [22]

Netting. The most familiar clearing operation is netting. For each asset (including money) and each trader, all quantities of the asset due to the trader and from the trader are added, and the total of the due-from quantities is subtracted from the total of the due-to quantities. If that difference for a particular asset is positive, then the difference is the amount of that asset that the counterparty (or counterparties in cases of multilateral netting) should transfer to the trader. If the difference is negative, then the absolute value of the difference is the amount of the asset that the trader should transfer to the counterparty.

Consider an example of bilateral netting. If A has sold B 2,000 shares of stock in a particular corporation for $70,000, and B has sold A 1,000 shares of stock in that corporation for

[22] BIS (1997a, 1998) provides some further detail regarding the topics discussed in this section.

$50,000 (with the price evidently having changed between the times when the two contracts of sale were negotiated), then the transactions between A and B can simultaneously settle by A transferring 1,000 shares to B and B paying $20,000 to A.

The cancellation of offsetting transfers may be only a convenience to reduce the number of transfers of securities and funds required to achieve settlement. It is called payment netting in that case. However, netting may take a more consequential form, called obligation netting or position netting, in which the legal relationship between A and B is modified. Specifically, if obligation netting has occurred, then the original, separate contractual claims for gross amounts of securities and money between the parties to a set of transactions are voided. They are replaced by new contractual claims for the netted amounts.

The numerical example above illustrates the general fact that bilateral netting reduces the amount of each asset that a trader needs to possess in order to settle. Bilateral netting also reduces the exposure of a trader to default by the counterparty. Suppose that the equity traded in the example becomes worthless after the transactions have been netted but before settlement has occurred. Suppose A becomes insolvent, is put into receivership, and the receiver attempts to obtain $70,000 from B in return for 2,000 shares of now worthless stock. (Note that, while B could attempt to obtain $50,000 in return for 1,000 shares of worthless stock, such an attempt would be futile unless B were a sufficiently senior creditor of A.) If payment netting is all that has taken place, then this is a valid, legally enforceable claim. However, obligation netting involves A and B having figuratively torn up their original contracts and substituted a new contract for a 1,000-share transfer in return for a $20,000 payment. Thus, $20,000 is the most that A's receiver will be able to obtain from B. Obligation netting involves a genuine amendment of legal obligations between the parties, and in this case the amendment has reduced B's exposure to A from $70,000 to $20,000.

The mathematical formula for netting stated above is a general formula that can be applied multilaterally. That is, it can be applied when there are more than two traders whose transactions are being netted together. For each trader and each asset, the liability of the trader to transfer the asset to others is no greater after netting than was the largest liability specified by any of the original contracts. This mathematical fact might seem to suggest that netting always mitigates risk for all traders in the way indicated by the preceding example. However, such an impression is misleading because, in the case of multilateral netting, the mathematical formula

does not completely characterize the netting arrangement. Suppose, for example, that bilateral contracts between A and B, B and C, and C and A are netted and that the formula determines that A should pay $100,000 and should receive 2,000 shares of stock. As before, suppose that the stock becomes worthless and that A becomes insolvent after netting, but before settlement. From an ex post perspective, B and C are collectively worse off by $100,000 than they would have been if no trades had occurred. Who is how much worse off, though? Should the entire burden of A's insolvency fall on B, or on C, or should it somehow be apportioned between them? If A's payment obligations had not been netted, there would have been clear answers. After netting, however, the sharing of the burden is indeterminate unless a loss-sharing arrangement has been specified. For this reason, a fully specified netting agreement must incorporate such an arrangement.

Mutualization. When they commit themselves to a loss-sharing arrangement from an ex ante perspective, risk-averse traders may unanimously prefer to mutualize, or commit to sharing, their losses from default of counterparties. Specifically, mutualization makes sense when three conditions are satisfied: (1) traders are risk averse; (2) traders have little ability to monitor or control the propensity of their respective counterparties to default (making moot the "free-rider" problem that mutualization would erode incentives to monitor, control, or warn other traders about counterparties' default propensities); and (3) a pattern of widespread, relatively small losses among the traders who do not initially default would be less likely to produce a chain reaction of defaults than a pattern of concentrated, large losses suffered by the counterparties of whichever traders initially defaulted.

Rules for trade execution can affect the extent to which these conditions are salient and hence the desirability of loss-mutualization arrangements. In particular, if an exchange requires acceptance of the highest bid or lowest offer for a security, then traders do not have the option to deal preferentially with the counterparties viewed as less likely to default. That is, an exchange that adopts such a best-execution rule is likely to satisfy the second condition regarding inability to monitor and control risk.

The structure of a loss-sharing arrangement matters for two reasons. The obvious reason is that it determines the allocation of losses that would result from a given set of gross trades. If there is a particular trader who tends to be selected to absorb a large fraction of the losses from many other participants' defaults, then that trader can be at high risk of default as a consequence.

Because of such a potential to concentrate losses in a way that might set off a chain reaction of defaults, it is conceivable that an inappropriately designed multilateral net settlement system could be more liable to widespread default than a gross settlement system would be in the same market environment.[23]

A second, more subtle reason why the structure of a loss-sharing arrangement matters is that mutualization—a form of insurance among the participants in the arrangement—can erode the participants' incentives to control risk. This problem is analogous to the classic problem of a group of owners of lumber warehouses who agree to mutualize their losses from fires. If a warehouse so insured does burn down, then its owner will individually suffer a loss smaller than the cost of installing a sprinkler system to extinguish fires. Thus, no warehouse will have a sprinkler system if losses are mutualized, and therefore many warehouses will likely burn down. Because of this unfortunate incentive effect, the owners will all be worse off than if they had been required to bear the full losses from fires at their respective warehouses. Without any mutualization, each would have installed a sprinkler system at fairly low cost and very few fires would have grown to a costly scale. In a clearing arrangement, the analog of installing sprinkler systems is for traders to avoid exposure to risky counterparties, to make efforts to acquire sufficient information about counterparties to determine which ones are risky, and to share that information with other participants so that they, too, can use it to control their risks.[24]

Settlement Guarantee. Not only can new contracts replace old ones as in netting, but a new party to contracts can be introduced. The entity that conducts clearing operations, typically called a clearinghouse, can become the counterparty to all of the newly issued contracts.[25] By being substituted for the counterparty in this way, the clearinghouse guarantees settlement to

[23] Yamazaki (1996) studies this problem. On the other hand, Kahn, McAndrews, and Roberds (1999) formulate and analyze a model of collateralized payments in which net settlement is less liable to occurrences of strategic default than gross settlement under some conditions. Their key idea is that available collateral may be worth less than the value of netted payments but more than the value of the gross payments that are netted. In circumstances where buyers would have incentive not to make payments that would exceed the value of collateral, net settlement would avoid such strategic default.

[24] Fujiki, Green, and Yamazaki (1999) study the influence of mutualization rules on incentives to provide information about the riskiness of a counterparty. They show that there can be incentives either to understate or to overstate the level of risk, depending on the specific circumstances of the market in which the arrangement will function and the intended allocation of benefits from the arrangement to the various participants. Thus, the design of a loss-sharing arrangement to control these incentives must take such specific circumstances into account.

[25] Sometimes this state of affairs is described by stating that the clearinghouse has a principal-to-principal relationship with each participant.

each of the original contract parties.[26] By doing so, the clearinghouse assumes the replacement-cost risk in the event that either party fails to perform.

In the simplest case, if A has sold B 2,000 shares for $70,000, then the contract of sale is replaced by two contracts—one for a sale of 2,000 shares by A to the clearinghouse and the other for a sale of 2,000 shares by the clearinghouse to B. A and B each make the same trades as they would have made before, but now they both have the clearinghouse as counterparty (that is, trading partner) rather than having one another. In effect, the clearinghouse has guaranteed to both A and B that the trade for which they have contracted will be settled. This guarantee is beneficial if the clearinghouse is better able or more willing to bear or control risks than either A or B is. This is often the case, as is explained below. In a process analogous to multilateral netting, substitution of the clearinghouse as counterparty to contracts can occur simultaneously between the clearinghouse and several traders. In fact, multilateral netting and substitution of the clearinghouse as counterparty are often done in conjunction.

Posting Collateral. Settlement generally takes place some time after the execution of a trade has concluded. The seller can be required to post collateral to avoid exposing the buyer to replacement-cost risk in the interim. Such a risk-control measure can be regarded as part of clearing. When a clearinghouse is involved, it often acts as a third party that holds the collateral in escrow. Some derivative contracts settle after the passage of a considerable time or, as in the case of swaps of revenue streams (for example, between fixed- and floating-rate interest payments), over a course of time. It is likely that the level of replacement risk of such a contract will fluctuate with market conditions between execution and settlement.[27] This fluctuation can be countered by marking the contract to market, that is, by having the parties frequently pay variation margin in addition to the initial margin or collateral paid at the commencement of the contract. A common arrangement is for the clearinghouse to manage this activity and even to serve as escrow agent for the margin funds.[28]

Mutualization of losses—in the form of loss-sharing arrangements among market participants in the event of default—is exemplified by multilateral netting, as discussed above.

[26] In the case of a participant who is a party to several contracts, the guarantee may be for net settlement.

[27] Of course, the value of a bond also fluctuates with market conditions between the time it is issued and the time it matures. What distinguishes a derivative contract in this respect is exposure to a counterparty whose credit risk is superimposed for an extended period on the riskiness of the asset on which the contract is written.

[28] For further discussion of margining, see BIS (1997a, 1998). The choice between paying variation margin directly to the counterparty or holding it in an escrow account has some implications for risk management.

Guarantee of settlement by a clearinghouse provides further ways to accomplish this. For example, losses can be indemnified from a clearinghouse fund that is capitalized by dues assessed on clearinghouse members. Moreover, clearinghouse membership may be structured to involve a contractual obligation to pay an ex post assessment to recapitalize the fund if a large loss exhausts or exceeds it. A clearinghouse can also have credit lines with banks in order to manage liquidity risk.

Risk Management

The approaches to risk management discussed here are implemented in a variety of ways in the clearing and settlement arrangements for different assets. Two things particularly should be borne in mind in thinking about the importance of risk management in a particular arrangement. First, risk can be managed by providing incentives that deter undertakings involving disproportionate hazard to the benefit provided by the risky activities (from the viewpoint of the market and the public as a whole). Sometimes, as in the case of moral hazard, there is a trade-off between providing these ex ante incentives and sharing losses as broadly as possible ex post. Thus, it should not be assumed that complete mutualization of losses is always the best strategy for managing risk or that there is a particular degree of mutualization that is the optimum for all markets.

Second, the operational and financial details of risk management operate in the context of the legal relationships among the participants and between the participants and the clearinghouse, and they must be understood in that context. Use of a clearinghouse fund in the event of default is a case in point. If an asset's seller defaults after the clearinghouse has guaranteed settlement, then the clearinghouse simply settles with the buyer by purchasing the asset from the clearinghouse fund. If the asset has appreciated since the contract of sale was executed so that the purchase costs the clearinghouse more than the buyer pays it, then the clearinghouse absorbs the loss. The clearinghouse has standing to sue the seller for breach of contract to recover the loss. The buyer no longer has any contractual relationship with the seller in connection with the transaction since the clearinghouse has been substituted as the seller's counterparty, so the buyer has no cause for legal action against the seller. It would appear that the buyer has lost legal recourse against the seller even if the loss exceeded the resources of the

clearinghouse. In that case the buyer could only sue the clearinghouse (to compel it to levy an assessment on members to reimburse the full loss, for instance).

A clearinghouse that does not have a principal-to-principal relationship with its participants might nevertheless provide money or securities to a buyer in the event of the seller's default. Such a transaction could be structured as a loan. Its function would be to protect the buyer against liquidity risk, but not against replacement-cost risk. Because default has occurred on the original contract of sale between the seller and the buyer, the buyer can sue the seller to compel delivery of the security. The terms of the loan from the clearinghouse to the buyer will presumably entail that, at some point, the clearinghouse can also sue the buyer for repayment of the loan.

To say that a clearinghouse may maintain a fund to aid participants against whom default has occurred tells only part of the story. The precise use to be made of the fund and the pattern of legal claims that can arise despite its existence or that can be triggered by drawing on it are also important. Part of the cost of a severe market disruption, from both a public and private perspective, is the uncertainty and cost generated by legal disputes in its aftermath. The outcomes of these disputes may be difficult to predict, and they may be reached only after long delay. It is therefore preferable to manage risks in a way that minimizes the prospect of complex, prolonged litigation. On the whole, making the clearinghouse the counterparty in all transactions is thought to accomplish this. Such a consideration complements one that is more often cited as a rationale for placing the clearinghouse in a principal-to-principal relationship with all participants—that a clearinghouse can be structured in a way that makes it more creditworthy than most individual participants are. Nevertheless, as mentioned above, it would be going too far to suppose that establishing this relationship must invariably be best.

A Clearinghouse's Banking Relationships

Securities settlement involves interaction between a system for transferring securities and one for transferring funds. Because of the need to transfer funds, a clearinghouse must either be a bank or else maintain a very close institutional relationship with one or more banks.[29] Even where a clearinghouse is a bank, participants may prefer to use other banks as intermediaries to

[29] "Bank" is used here in the generic sense of a depository institution. In the United States, the DTC is a New York State chartered member of the Federal Reserve System; several other important settlement arrangements are not chartered as depository institutions. See DTC (1997) and Annex 2 of BIS (1997a).

deal with it. Moreover, in general, the need of the clearinghouse to avoid risk precludes it from providing a full spectrum of corporate banking services.

A clearinghouse typically enters into five types of relationships with banks. In this paper the bank parties to these relationships are called participants' settlement banks, clearinghouse settlement banks, correspondent banks, agent banks, and standby-credit banks. While a bank might play only one of these roles, they are all compatible. Given that providing credit and services to clearinghouses is a specialized line of business and that the competency to engage in this business is applicable to all of the four roles, this economy of scope provides a bank with incentive to play multiple roles. If the clearinghouse is chartered as a bank, then it may play some or all of these roles directly.

A participant's settlement bank is the bank at which a participant holds an account to and from which payments for settlement are made. A clearinghouse may require each participant to hold an account at one of a designated group of banks, and it may place special requirements on those banks. For example, to be designated a settlement bank, a bank might be required to make an irrevocable commitment to make payments on the basis of instructions from the clearinghouse, without regard to whether or not the account holders confirm those instructions.

If the clearinghouse becomes the counterparty to all transactions, then it must also hold an account at a settlement bank. Payment to settle a transaction between two clients of a settlement bank can be accomplished as an on-us transaction. However, payment between clients of distinct settlement banks requires an interbank funds transfer. Such a transfer is typically made on the books of a correspondent bank at which all of the settlement banks hold accounts by means of a funds transfer system of very high integrity and security. A central bank is capable of playing this role. The extent to which it should do so is an aspect of public policy that varies across countries. In some countries the discretion of the central bank to create money to satisfy nominally denominated claims is a decisive consideration in favor of using its services to settle transactions on securities markets that could be loci of systemic risk. In other countries securities brokers are ineligible—on grounds that have been given careful thought—to hold accounts at the central bank, so commercial banks must play the correspondent role.

Whether or not it makes and receives payments to its own account to achieve settlement, the clearinghouse requires various banking and trust services. The holding of participants'

collateral and the investment of the clearinghouse fund are examples of services that a bank can provide as agent of the clearinghouse.

Because holding participants' collateral and clearinghouse assets entirely as cash or in other highly liquid form would have substantial opportunity cost, those resources are typically held partly in forms that could perhaps not be liquidated immediately in the event of a default. Moreover, if the clearinghouse has authority to assess its members to provide further resources, that process cannot be completed immediately. For these reasons, a clearinghouse typically arranges with banks for standby lines of credit against which it is authorized to draw on extremely short notice.

The ability of a clearinghouse to manage risk depends on the smooth functioning of these banking relationships under conditions of market stress, as well as during normal times. Both market and supervisory pressures limit eligibility for these relationships to highly creditworthy, well-managed banks. Even such banks may face challenges, however, in meeting their commitments during periods of severe market stress. Once again, a precise understanding of the legal relationships incorporated in the settlement system is key to risk assessment. For example, an "irrevocable commitment" from a bank to make a payment on demand from the clearinghouse may not literally force the bank to transfer everything in its reserve account to the clearinghouse if that were necessary to meet an obligation. Description of a contractual obligation in these terms might predispose a court to treat the bank harshly if it refused to do so, however. As was emphasized in the earlier discussion of legal certainty, it is important to design settlement arrangements so that such commitments will be as ironclad as possible, even though absolute certainty will be impossible to attain.

The Clearinghouse as a Provider of Public Goods and its Supervision and Regulation

Certainty of settlement is a public good in a market where the ability of one trader to meet commitments often depends on his or her benefiting from the fulfillment of others' commitments. The role of a clearinghouse as a provider of a public good is particularly evident when the clearinghouse becomes the counterparty to all transactions and provides the protections discussed above. The contracts that result from substitution of the clearinghouse as counterparty to all trades meet a high, uniform standard of insulation from risk that has widespread benefits to traders.

The general argument about why some degree of submission to a central authority is efficient in an environment with a public good therefore applies to settlement of securities transactions. Clearinghouses serve as central authorities in numerous ways, some of which involve exerting regulatory authority over their participants. For example, a clearinghouse may set, monitor, and enforce standards of creditworthiness and fitness on participants. Having done so, the clearinghouse may require participants to transfer securities and funds to one another in reliance on its judgment rather than allowing participants to exercise independent judgment on the creditworthiness of counterparties. The clearinghouse may set and compute participants' margin requirements, hold participants' collateral in escrow, maintain (either directly or by contracting out) the telecommunications and computing equipment that could pose operational risk, manage the liquidation of defaulting participants' positions, and so forth. Participants' willingness to authorize the clearinghouse to perform these functions, conditional on all other participants delegating that same authority, is appropriate in view of the public-goods problem that they collectively face (see Baer, France, and Moser 1996).

It is intrinsically difficult to design institutions that, when their participants make rational decisions in equilibrium, result in the provision of efficient levels (that is, neither insufficient nor excessive) of public goods. Historical experience and economic theory suggest that the molding of such institutions by the forces of either laissez-faire or government fiat is not a panacea. Despite a century of intensive study by economists, the design of effective public-goods institutions can best be characterized as an art that receives some guidance from scientific understanding. The institution that is most effective in a particular environment is likely to have been tailored to make best use of specific, idiosyncratic features of that environment.

In this circumstance common sense recommends a pragmatic, continuous, collaborative effort of market participants and supervisors to monitor and improve clearing and settlement systems. To the extent that a supervisor perceives that such a system does not completely resolve the participants' incentive problems discussed earlier, the supervisor will tend to recommend that it operate in a more risk-averse manner than market incentives alone would dictate. Nevertheless, a wise supervisor respects the generally effective performance that market practices and institutions of long standing have achieved, refrains from imposing requirements that would be so burdensome as to discourage market participants from making use of beneficial risk-management techniques, and supports well-conceived innovations that arise in the market.

Conclusion

Arrangements for the clearing and settlement of financial transactions have improved dramatically and continuously during the past several decades. A quantum leap in the capacity to clear and settle financial transactions and in the integrity with which those operations are accomplished has been part of a radical restructuring of the operation of financial markets in the industrialized countries. Other aspects of this restructuring include the development of financial derivatives and exchanges to trade them, the availability of advanced computing and telecommunication technology to link traders, and the rapid growth of transaction volume. None of these innovations would have been feasible, or commercially feasible, by itself. In particular, the high fixed infrastructure costs for the way that transactions are cleared and settled today would probably have been uneconomical at the transaction volumes typical until the 1970s. By the same token, the development of this way of clearing and settling transactions was a prerequisite for exchanges to handle a volume of transactions beyond those traditional levels. To the extent that one believes that the financial markets transformation has been—and continues to be—among the causes of improvement in the macroeconomic performance of the United States and other economies, the dramatic advances in clearing and settlement deserve a full share of the credit.

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