The Rise of Electronic Payments Networks and The Future Role of the Fed With Regard to Payment Finality

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Most participants in the U.S. economy can identify with Goethe's observation that "one goes through life with more credit than money." There is a universal need to carry out economic transactions without tapping scarce cash reserves, a need that is met by various forms of credit from credit cards to corporate bonds. Even most economists would agree that a well-functioning credit market is essential for a successful market economy.

An equally important, though less discussed, aspect of credit concerns the settlement of debt with minimum delay, inconvenience, and legal uncertainty. A successful system of credit clearly depends on the ability of debtors and creditors to agree on terms under which debts are considered paid. Uncertainty surrounding payment finality could make potential lenders overly cautious in their extension of credit.

The settlement of credit-based transactions usually involves exchanging a temporary form of payment (otherwise known as credit) for another, final form of payment (money). In this sense, the issue of payment finality is inextricably linked to the larger issue of monetary policy. Consequently, the Federal Reserve System has historically taken a leading role in formulating the laws and regulations involving payment finality. This article considers the Fed's role with respect to the finality or "moneyness" of a fairly new form of payment, namely, large-value or wholesale electronic payments networks. In the United States, the two largest and best known of these networks are Fedwire, operated by the Federal Reserve System, and the Clearing House Interbank Payments System (CHIPS), operated by the New York Clearing House Association.[1]

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This discussion argues that the current payment practices on Fedwire, CHIPS, and similar networks amount to the creation of intraday money, by means of either an explicit or perceived guarantee of payment finality. Though the intraday money created in this fashion is very short-lived, it is being produced in larger and larger amounts, a phenomenon that has been of much concern to researchers and regulators alike. The position taken here is that the recognition of certain forms of intraday "credit" as money is the key to successfully understanding and regulating the large-value payments networks. The discussion includes a policy proposal that would place an overall cap on the amount of intraday money created via electronic payments networks. Because it explicitly recognizes the monetary role of these networks, the proposal would be likely to result in a more efficient electronic payments environment than would alternative policy regimes.

Money and Credit Defined

A useful first step toward analysis of any monetary system is a precise definition of terms. The definition of money that is used below is that proposed by Peter M. Garber and Steven R. Weisbrod (1992). According to their definition, *money* is "an asset that promises to maintain its value in terms of the unit of account and therefore becomes generally acceptable in market transactions." In the discussion below, *credit* will consist of the transfer of some commodity (possibly including money) from one economic agent to another, conditional on the promised future repayment of money.

The Historical Development of Money

While there are many operational difficulties associated with monetary systems, one of the most persistent of these has been the lack of any lasting agreement about exactly what is generally acceptable as money.

From ancient times to the early twentieth century, money was commonly defined as a certain amount of a precious commodity, which was often but not always gold. A system of pure commodity money suffers from a number of problems, however, the most common being what happens to local economic activity in areas where the monetary commodity is scarce. Peter Spufford (1988), for example, documents how the economies of medieval Europe, which were largely based on the use of commodity money, repeatedly spent themselves into recession by running trade deficits with the Middle East. To settle their trade accounts, European countries were constantly exporting precious metals. Despite all government efforts to the contrary, this situation led to the reduction of the stocks of precious metals to the point that monetary exchange could not be sustained, barring the discovery of new sources of gold or silver.[2]

The economies of western Europe eventually managed to break out of this destructive pattern, thanks in part to an influx of precious metal from the New World and in part to the development of institutions that could provide credit. Credit enabled a given amount of commodity money to support a larger measure of economic activity. Two of these credit-providing means are especially relevant for the analysis of electronic payments networks: the banknote and the clearinghouse. The banknote represented the promise of the issuing bank to pay, upon presentation, a certain amount of the accepted commodity currency.[3] These notes, originally a form of credit, gradually became accepted as money (final payment) for most transactions. With banknotes, payments often could be effected without incurring the risks and costs of moving large amounts of precious metal. Banks were able to economize further on the movements of precious metal by establishing clearinghouses.[4] The role of clearinghouses was to calculate, on a daily basis, each member bank's net obligation vis-à-vis all other members. Net obligations would then be settled at the end of the day, using gold or some other mutually acceptable form of payment.

In the United States, late-nineteenth-century restrictions on banknote issue accelerated the development of yet another type of money—checkable bank deposits.[5] The widespread use of checks allowed banks even greater economies on the use of precious metals or banknotes. The movement toward check money was assisted by the further development of private clearinghouses, and later by the Fed's campaign to establish nationwide par (face-value) check clearing.[6]

The Economics of Electronic Payments Networks

The evolution of money is a continuing process. Today, the vast majority of transactions are still carried out via the monetary "inventions" discussed above—that is, by currency or check. Increasing numbers and amounts of transactions are taking place in pure electronic form, however, particularly on the large-value or wholesale wire transfer networks. For example, the overall transactions volume for large-value wire transfers in the United States (primarily Fedwire and CHIPS) has been conservatively estimated at approximately 100 million transactions for 1990. While this number represents only 0.1 percent of all transactions in the United States for 1990, the total value of these transactions represents about $421 trillion—83.7 percent of the value of noncash transactions for that year and roughly thirty-five times the total value of U.S. gross domestic product.[7] Most of the payments over these systems are associated with either the domestic financial markets or markets for foreign exchange.

The emergence of electronic payments networks poses both great opportunities for market participants and great challenges to present or potential regulators. The current state of computer technology is such that the time between the initiation of a transaction and settlement could, from a purely technical viewpoint, be reduced to a matter of minutes in most instances. However, this ongoing type of settlement (known as gross settlement) has not become the accepted norm for payments networks, either domestically or abroad. Instead, many electronic payments networks have opted for once-a-day net settlement. Under such an agreement, at the end of the business day a bank or another payments network participant pays to (receives from) the network reserve funds equal to their total net debit (credit) position vis-à-vis all other network participants. This "clearinghouse" type of arrangement is often referred to as multilateral netting.[8]

Strong economic incentives operate in favor of such an arrangement. Suppose, for instance, that six banks are organized into an electronic payments network. On a certain day each bank wants to transfer $1 million to each of the other five banks. Under gross settlement, a total of thirty transactions would have to occur, and a total of $30 million would change hands. Under a multilateral netting scheme, no money would actually be exchanged. At the end of the day, each bank's net obligation to the other banks would be zero, and no payments would be necessary.[9] Given this opportunity to economize on transactions balances, it is hardly surprising that most electronic payments networks have not tried to further reduce the interval between payment initiation and settlement.

In an era of electronic payments systems, a payments network with multilateral netting serves one of the same functions that banknotes, clearinghouses, and checks served in the pre-electronic era—that is, economizing on costly transactions balances. In the uncertainty of the real world such multilateral netting arrangements also help to reduce the credit risk associated with the payments network. Risk is reduced because, other things being equal, the amount of funds that each participant must "front" to settle is typically smaller, thereby making it less likely that a participant would not have access to sufficient funds to settle.

A potential disadvantage of multilateral netting is that it requires a high degree of mutual trust and cooperation among participating institutions. In practice, this problem is not insurmountable, however, because a major purpose of electronic payments networks is to facilitate payments among firms that are accustomed to doing business with one another. And electronic payments networks of any type require a high degree of cooperation on matters such as computer formats, security procedures, provisions for backups, and so forth. The cooperation necessary for a multilateral netting agreement seems only a natural extension of that already required for the existence of a given payments network.

Both of the major large-value payments networks in the United States—Fedwire and CHIPS—carry out their operations under rules that, to some extent, embody the multilateral netting principle discussed above. However, the details are quite different across the two systems. Fedwire is nominally a gross-settlement system: under Fedwire rules, payments made through the Fedwire network are in almost all instances final and irrevocable. Finality of payment is guaranteed by the Fed, and reserve funds are made available immediately to the receiving institution. De facto multilateral netting can still take place by means of "daylight overdrafts."[10] A daylight overdraft occurs when an institution sends an amount of funds over the network that exceeds its operating reserve balance plus the sum of any incoming transfers. Fed regulations require that any such overdrafts must be repaid by the end of the business day, either by additional incoming transfers or deposits of additional reserve funds. Fedwire overdrafts are also subject to other restrictions, which are discussed below.[11]

In contrast to Fedwire, CHIPS operates on an explicit net-settlement basis. Payment messages sent during the day are not final until end-of-the-day settlement occurs. Normally this settlement occurs around 6:00 P.M. via special Fedwire accounts at the Federal Reserve Bank of New York. Because CHIPS is not a bank and has no bank accounts, there are no daylight overdrafts per se. The equivalent of daylight overdrafts on CHIPS is the credit that participants are willing to extend to one another. As with Fedwire, the allocation of such credit is subject to certain rules and limits.[12]

Is It Really Money?

Are daylight overdrafts over Fedwire and intraday "credit" over networks such as CHIPS really money or simply a convenient form of credit? By sending payments orders over EFT networks, banks and their customers can de facto expand banks' intraday balance sheets in a process that closely resembles the creation of traditional, overnight bank deposits. The details of this process are spelled out in Appendix 1.

Not every expansion of banks' balance sheets constitutes money creation, however. To qualify as money, a bank liability should pass a standard test of its "moneyness." That is, how close an approximation is this liability to final, irreversible payment? In the case of Fedwire, the Fed's explicit guarantee of payment finality clearly qualifies daylight overdrafts as money. For CHIPS and other private networks with multilateral netting, the money/credit question is more subtle. The fact that finality of payment is not guaranteed over CHIPS by the Fed or any other governmental entity raises the issue of systemic risk.[13] Over a payments network, systemic risk refers to the risk that some network participants may not be able to settle their net obligations at the end of the business day, thereby forcing other participants to come up with funds to cover incoming transfers expected from the failing participant. If this requirement, in turn, caused other participants to fail to meet their obligations, the integrity of the network or of other parts of the payments system could be compromised.

Although such a crisis has never occurred over CHIPS, the CHIPS system has taken a number of steps to limit its participants' exposure to systemic risk. These include limiting the net credit and debit positions of each participant (bilateral credit limits and overall net debit caps, respectively) vis-à-vis other participants. More recently, CHIPS has adopted a loss-sharing arrangement, which is backed by collateral requirements and is designed to ensure that the losses from one participant's failure are borne by more than one other participant. The total amount of collateral required, however, is small (estimated at $3 billion to $4 billion) relative to the average amount of intraday credit extended via CHIPS (approximately $20 billion to $30 billion). Studies performed by CHIPS indicate that these measures probably would cover losses induced by one member's failure to settle but that the simultaneous failure of two or more members could easily exhaust these provisions. As a last resort, CHIPS rules allow for its governing committee to take any measures necessary to complete the settlement process. However, the committee is limited in its ability to impose additional loss-sharing obligations on other CHIPS members.[14]

Despite the fact that the Fed does not guarantee payment finality over CHIPS, it can be argued that for purposes of economic analysis payments over CHIPS and similar networks should be considered "approximately" final and that CHIPS intraday credit should be considered money. The first reason is that the "settling" members of CHIPS and similar networks are U.S. banks, which would in most cases have access to the Fed discount window. A second reason to consider payments over many private networks de facto final has been advanced by David L. Mengle (1990), among others. Even though there is no guarantee of finality over these networks by the Fed, or by any other regulatory agency, it can be in the best interests of participants in these networks to act as if such a guarantee were in place. By pursuing this course of action, Mengle explains, network participants are in effect betting that the network will be "bailed out" by some sort of governmental intervention should a crisis develop that could cause a settlement failure. The odds may favor this bet if regulators have strong incentives to prevent settlement failures and their negative consequences.

The viewpoint that CHIPS is too big to fail appears to be widespread. Marcia Stigum quotes one bank officer who is responsible for his bank's CHIPS operation as saying, "If CHIPS fails to settle, I jump out of my window. CHIPS cannot not settle because, if it were to fail to do so, it would destroy confidence in the money market internationally" (1990, 903). The view that the Fed "stands behind" private payments systems is apparently shared by a large number of private-sector observers of the payments system, including officials of the American Banking Association (Philip S. Corwin and Ian W. Macoy 1990, 11) and quite a few academics (for example, Robert Eisenbeis 1987, 48; Andrew F. Brimmer 1989, 15; Ben S. Bernanke 1990, 150; Hal S. Scott 1990, 187).

As long as this perception prevails in the private sector, it makes little difference whether or not the Fed explicitly guarantees payment finality. In other words, the market has its own view of what policies the Fed would pursue in the event of an impending systemic crisis, and such views are not under Fed control. The bottom line is that payments over many private networks in effect constitute money because they are perceived as such.

The Policy Problem and Some Real-World Complications

The above discussion shows that the process of netting payments over electronic networks represents a rational private-sector response to the problem of how to economize on costly transactions balances. By exchanging payments messages during the business day and settling net positions at the end of the day, payments network participants economize on their need for costly reserve balances. In the jargon of monetary economics, these savings result from the substitution of "inside" money (money created by the private sector, in this case the payments messages or daylight overdrafts) for "outside" money (in this case, electronic reserve funds held with the Fed).[15]

The ability to create this new form of inside money has certainly been of benefit to the institutions that have been able to do so, and its creation has likely been of net benefit to society as a whole. At the same time, there is evidently a limit to a good thing. The willingness of the Fed to absorb systemic risk associated with electronic payments systems is large but surely not infinite. As is the case with traditional, overnight bank deposits, the economy achieved by the private sector's substitution of inside money for outside money should be offset by a calculation of the costs of the Fed's guarantee of liquidity in the event of a systemic crisis. It is worth noting that the Fed's total liability in the event of such a crisis would not be bounded by the net amounts due to settle but by the gross amount of payments messages entered into the various networks (see Appendix 2). Maintaining a credible (though perhaps implicit) guarantee against systemic risk in electronic payments networks cannot be consistent with unlimited growth in the number of such networks or indefinite growth in the volume of potential liabilities created via these networks.

Thus, the essential policy problem associated with electronic payments networks is how to contain the systemic risk associated with the creation of intraday money via these networks without imposing undue costs on the private sector. It needs emphasizing that the scope of this particular problem goes beyond the confines of domestic bank regulation. On the international front, several multicurrency payments systems are currently in the planning stages. The advent of cross-border payments networks poses some noteworthy complications for policy concerning electronic payments networks.[16]

The first potential complication lies in the sheer size of the international currency markets, whose daily volume is now close to $900 billion.[17] Because the gains from netting arrangements are proportional to the volume of payments over a given network, the incentives for netting cross-border payments are strong. Also, for a given dollar volume of payments, cross-border payments networks can offer stronger incentives for netting than domestic networks, especially if a substantial number of these obligations have to be converted to another currency before settlement. In other words, it is highly likely that a large volume of inside money will be created over these networks and that much of this money will be dollar-denominated.

A second potential problem is the temporal separation of markets in various currencies. This complication should be of particular concern to U.S. policymakers, given that Western Hemisphere financial markets close (and settle) after Asian and European markets have closed for the day. As a result, for certain foreign exchange transactions there is a risk associated with the fact that payment in the foreign currency will have been finalized before the offsetting payment in dollars becomes final.[18] According to Bruce J. Summers (1991, 85), an average daily volume of as much as $400 billion in foreign exchange transactions is settled (on the dollar end of these transactions) by CHIPS at the end of the U.S. East Coast business day. The time delay between initiation and settlement for some of these transactions can be as long as fourteen hours.

On the domestic front, there are incentives for private, nonbank firms to organize themselves into payments networks, including those that allow for bilateral or multilateral netting of obligations. Such networks, known as delivery-versus-payments systems, already exist for U.S. government securities, mortgage-backed securities, and commercial paper. In principle, there is no reason why such arrangements would not be extended to any heavily traded commodity.[19]

The operation of domestic, nonbank payments networks raises policy concerns similar to those listed above, and particularly the issue of ultimate responsibility for the integrity of the network. The settlement of nonbank obligations will, in all probability, continue to be effected via the banking system (that is, through Fedwire). If there is a market perception of a de facto Fed guarantee against systemic risk in these networks, it would be difficult not to recognize the intraday credit extended over the nonbank networks as intraday money.

Possible Policy Responses

The discussion to this point has attempted to show that strong incentives exist for the extension of intraday credit, which in many cases is regarded as intraday money via electronic payments networks. Given these incentives and continued technological improvements, the volume of such credit can be expected to grow over time.

The intraday credit extended over these networks, particularly over Fedwire and CHIPS, has hardly escaped the attention of U.S. policymakers. However, the development of the legal and regulatory framework for electronic payments networks has proceeded at a relatively slow pace. The measured pace of regulation in this area reflects a fundamental dilemma of regulating payments systems. Because the critical characteristic of a free-market economy is voluntary, mutually beneficial exchange, policymakers are reluctant to burden payments networks with restrictions that would unnecessarily hinder such exchanges.

At the same time, there is a widely recognized need to provide safeguards for payments network participants against systemic risk. Some such protection is afforded by the Fed discount window. However, there are certain disadvantages associated with a reliance on the discount window as a means of protection against systemic crises. One potential drawback is that the size of discount window loans necessary to avert a systemic crisis could be quite large, potentially conflicting with monetary policy objectives. Another drawback is the set of restrictions imposed on the use of the discount window by the Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA).[20] Section 142 of FDICIA limits discount window lending to undercapitalized banks to sixty days within any 120-day period unless the Fed or the undercapitalized bank's primary federal bank regulator certifies that the bank is viable. In the case of critically undercapitalized banks, FDICIA instructs the Fed to demand repayment of discount window loans within five days. If the 5-day limit is violated, the Fed must share with the FDIC in any resulting increase in costs, and Congress must be notified of any payments to the FDIC under this provision.

Larry D. Wall (1993) reports that a major objective of FDICIA was to limit the extent of the too-big-to-fail doctrine. Wall notes that although FDICIA allows for "systemic risk" exceptions to its restrictions, invoking this exception requires approval of the FDIC, the Fed, and the U.S. Treasury (Section 142). Thus, while recognizing the importance of a lender of last resort in averting systemic crises, Sections 141 and 142 of FDICIA mandate a clear set of incentives that discourage excessive reliance on the discount window as protection against systemic risk.

Against this background, the Board of Governors of the Federal Reserve System acted in 1990 to strengthen restrictions on daylight overdrafts incurred over Fedwire. A major objective of these restrictions is to limit the amount of systemic risk borne by the Fed in its operation of Fedwire. The most substantive restrictions cap the intraday credit granted to any Fedwire participant, limiting the amount of this credit to a fixed percentage of the participant's risk-adjusted capital.[21] Beginning in 1994 the Fed will also start phasing in interest charges for overdrafts that exceed a deductible, which is also a fixed percentage of risk-adjusted capital. These charges will gradually rise to a level of 25 basis points at an annual rate.[22] These restrictions, together with the new regulations adopted by CHIPS (discussed above), have no doubt helped to restrict the potential for systemic crises in these two large-value payments networks.

Given the increasingly diverse use of electronic payments networks, however, it is questionable whether existing regulation of intraday netting over Fedwire, or even domestic interbank payments networks more generally, will be sufficient to eliminate the possibility of systemic risk. Commenting on the 1990 changes in the rules regarding Fedwire overdrafts, Corwin and Macoy note that "[i]ronically, the result of . . . Federal Reserve policies seeking to limit the growth and totals of daylight overdrafts on Fedwire is to shift them to private wire systems" (1990, 10).[23] In view of the various reforms recently adopted on CHIPS, Corwin and Macoy's statements could probably be applied to some degree to that system as well. To be effective over the longer term, any scheme for minimizing systemic risk over electronic payments networks will have to address the presence of this type of risk on all networks that make use of intraday netting of payments.

At one end of the policy spectrum, a suggested remedy to this situation would be the elimination of intraday netting in favor of real-time gross settlement, that is, gross settlement without daylight overdrafts. While this policy ignores the potential gains from netting arrangements, it has modern technology on its side. That is, if technological improvements make it possible for gross settlement to proceed on a virtually real-time basis, the cost of a gross-settlement system could be reduced vis-à-vis netting arrangements with daily settlement. A real-world approximation to such a system is the Swiss Interbank Clearing (SIC) system. Christian Vital and Mengle describe SIC as "a centralized gross settlement system created to process interbank payment transactions with no daylight overdrafts and therefore no systemic risk" (1988, 23). However, even on this system, the time from initiation of a transaction to settlement often exceeds the technologically feasible minimum of thirty seconds. Vital and Mengle note that as of November 1988, 55 percent of transactions were executed within two hours of initiation, and 85 percent, within five hours.

Could such a system work in the United States? Certainly the introduction of gross settlement to U.S. payments networks would pose a larger, though hardly insurmountable, technical challenge. In 1989, SIC had 163 members versus 139 for CHIPS and 11,435 for Fedwire. (The total number of participants for Fedwire is somewhat deceiving because only about 2,000 high-volume participants maintain direct computer-to-computer links to the Federal Reserve Banks.) The 1989 average volume of transactions over SIC was comparable to that of Fedwire: daily averages were 223,000 for SIC versus 238,000 for Fedwire and 146,000 for CHIPS. However, the average daily value of the transactions over SIC was much less than for the U.S. networks: $73 billion for SIC versus $730 billion for Fedwire and $761 billion for CHIPS.[24] The higher value for the U.S. networks means that sustaining similar volumes under a gross-settlement system would raise the probability of a situation known as "payments gridlock," whereby numerous network participants would each be waiting for other participants to make the first payment. The elimination of net settlement could also contribute to payments gridlock by encouraging network participants to wait until the last possible moment to enter payments messages into the network so as to economize on intraday reserve balances. Prevention of payments gridlock would require installing additional hardware to handle the last-minute volume or the introduction of peak-hour pricing of settlement services.

A constraint even more limiting than any operational difficulty associated with gross-settlement systems would be the reluctance of current users of intraday netting to move to gross settlement. In fact, history favors continued development of intraday credit as a form of money. Once a form of credit—for example, banknotes or checks—has become accepted as a form of money, attempts to regulate that form out of existence have ultimately been unsuccessful. And in at least one case in which stringent regulation was successfully introduced—a tax on banknotes by a congressional act of 1865—the ultimate effect of this regulation was the accelerated development of bank account money, an alternative form of inside money.

A Monetary Alternative

There have been numerous studies and proposed policy responses to the problem of "daylight overdrafts" or "intraday credit."[25] Generally speaking, these studies are of high quality, and most of the suggested policy responses represent sensible approaches to this issue. However, a common failing in this literature is a general reluctance to admit that the extension of intraday credit via electronic payments networks is equivalent to the creation of money.[26] The fact that "electronic intraday money" comes in a form different from currency or bank accounts does not affect the validity of this generalization. Paper currency and check money both developed as claims to a different, more widely accepted form of money. Electronic payments, which began as a form of claim on check money, are coming to be more widely used as money. A reasonable first premise of an effective policy on payments networks would be that once something is used as money, it should be viewed as such for purposes of policy.

A distinguishing feature of electronic intraday money, as it currently exists, is that it is all inside money. By contrast, more traditional forms of money consist of a combination of inside money (transactions accounts at depository institutions) and outside money (currency plus bank reserves with the Fed). Traditionally, the amount of inside money held by a depository institution is limited by reserve requirements to be no greater than a fixed multiple of its holdings of outside money. With electronic intraday money, no such requirements exist. Abstracting from such restrictions as bilateral or multilateral "caps," the sole restriction on the creation of this kind of money is the requirement that it disappear by the end of the trading day. The second premise of an effective payments system policy, in the framework of this proposal, would be the institution of some mechanism analogous to a reserve requirement for all forms of electronic intraday money.

In calling for the institution of a reserve-like requirement for intraday money, it should be pointed out that the institution of such a requirement would not be a panacea for all of the regulatory issues associated with the operation of payments networks that allow for netting of intraday payments. In particular, the institution of reserve requirements is not seen as a substitute for risk-limiting measures such as capital and/or collateral requirements, real-time monitoring of net debit positions, and so forth. Rather, the establishment of a reserve-like mechanism for intraday money creation would serve some of the same purposes as imposing reserve requirements on ordinary, overnight deposits in transactions accounts: delimiting the Fed's liabilities as lender of last resort and supplying a means of pricing the protection provided by the Fed against systemic crises (which may currently be seen as an implicit, rather than explicit, guarantee).

The third and final premise of an effective payments system policy would be recognition of the principle that the successful operation of a payments system, particularly one with multilateral netting arrangements, requires the existence of an institution analogous to a central bank. In the case of the U.S. banking system, the function of a central bank is carried out by the Federal Reserve System; similar institutions exist in most countries today. Although in the late nineteenth and early twentieth century no such institution existed in the United States, many of the present-day functions of the Fed were carried out by private clearinghouse arrangements. Concerning the role of these private clearinghouses, Gary Gorton has noted that "by the early twentieth century clearinghouses looked much like central banks. They admitted, expelled, and fined members; they imposed price ceilings, capital requirements, and reserve requirements; they audited members and required the regular submission of balance sheet reports. . . . [T]hey issued money and provided a form of insurance during panics" (1985, 283).

The fact that such institutions were created voluntarily suggests that some analogous regulatory organization, be it public or private, will inevitably be associated with any electronic payments network.

Reservable Electronic Intraday Money: Some Details

How could reserve requirements be imposed on the intraday money created by electronic payments networks? It seems that currently available payments technology could be used to create a sort of tradable electronic certificate, as follows.

The certificates would be called something like "electronic intraday cash creation rights" (EICCR) and could only be created by the Fed. An EICCR would confer on its owner the right to create intraday money via an electronic funds transfer system with a netting arrangement, up to some prespecified limit. A network participant placing a payments order over a certain network would deposit the required EICCR "collateral" with the relevant network until settlement. Because EICCR would be created in a limited amount, it would have positive value. After its creation, EICCR would be available for purchase by any depository institution with its reserve funds.[27] EICCR not held as collateral by a payments network could be resold to other depository institutions. Nonbank firms could buy EICCR from a depository institution at which they maintained a transactions account.

The term collateral as used here does not mean that EICCR constitutes collateral in the usual sense of "an item of sufficient value such that its liquidation would provide funds necessary to cover any default on a particular debt." In practice, it would be highly unlikely that EICCR liquidation would cover more than a fraction of the funds necessary to cover the obligations of a failed network participant. EICCR might be better described as proof of payment on an insurance policy, under which the proof of payment could be traded among different network participants provided that it was not currently in use.

There are several details of the EICCR plan not described above that would need to be specified in practice. The first such detail would be a way to decide on an initial allocation of EICCR—the amount of EICCR to be created and who would be entitled to it. The question of how much EICCR to create would pose difficult but not insurmountable problems of the same nature as those faced in determining the optimal rate of growth for the Fed's open market portfolio. From a standpoint of economic efficiency, the initial allocation of EICCRs would be essentially irrelevant. One possible candidate for an initial allocation would be to "grandfather in" participants in existing networks by providing them with EICCRs equal to, say, their average maximum intraday exposure over some specified time period.

Another detail that would have to be worked out would be a mechanism for intraday transfer of EICCR. An obvious candidate for such a mechanism would be real-time delivery of EICCR against payment over Fedwire. To be effective, however, such a mechanism would require a "daylight overdrafts" policy of sufficient stringency so as to prevent the widespread substitution of Fedwire overdrafts for intraday money creation over private networks.

Proposals such as the one described above have not been given serious policy consideration in part because of the perception that a mechanism such as EICCR would pose insurmountable technical difficulties. For example, Edward C. Ettin states that "the sheer mechanics of calculating deposit and reserve balances second by second make this approach impossible" (1988, 290). It is not necessary to delve into the technical details to find such claims difficult to support, given the current technological capabilities in the banking industry. With the availability of debit cards and point-of-sale (POS) terminals, consumers are able to purchase electronically such items as gas and groceries on a real-time basis.[28] If everyday retail items can be bought in such a fashion, then it seems reasonable to assume that currently available technology could allow for the real-time purchase of the right to create intraday money.

As a method of managing the aggregate amount of systemic risk associated with the payments system, an EICCR-based limit on the creation of electronic intraday money would have several advantages over more direct regulation of electronic payments networks. A requirement that intraday money creation be "collateralized" by EICCR would place an effective aggregate limit on the amount of intraday electronic money outstanding at any given time. An advantage that an EICCR-based constraint would have over simple quantitative caps is that it would encourage the development of a market for intraday funds, particularly intraday EICCR. With such a market, an EICCR-based constraint would be more efficient than quantitative caps in the sense that electronic intraday money would be created in the largest amounts in the networks associated with the highest demands for funds. An obvious and beneficial side effect of the EICCR market would be the availability of a market price for intraday "credit"—that is, a price reflecting the true value of the Fed's safeguards against systemic risk in these markets. An operational difficulty associated with policies that advocate the ad hoc pricing of daylight overdrafts is that such policies provide no direct measure of the appropriate price of intraday money. Incorrect pricing, in turn, would amount to levying an unintended tax on, or providing an unintended subsidy to, the creation of intraday money.

The EICCR proposal outlined above bears a strong resemblance to the idea of marketable emission permits in the area of environmental policy. Under such a policy, firms emitting a harmful pollutant into the environment must purchase a permit to do so. The permit allows for emission of the pollutant up to a specified amount. By limiting the number of permits for a given pollutant, the government can control its total emissions. The permits can be freely traded between polluters at market prices. Although the available evidence on the overall efficacy of such permits is mixed, there is a good deal of evidence to suggest that the use of permits represents a more cost-effective approach to pollution control than does direct regulation (explicit quantitative caps on emissions by each producer).[29]

Under the EICCR proposal, the analog of "pollution" would be systemic risk. That is, in the course of producing a desirable commodity—intraday money—participants in electronic payments networks would create an undesirable by-product, systemic risk, most of which would be borne by the Fed as a lender of last resort. As in the case of pollution permits, it is possible to limit the amount of this risk outstanding by requiring permits for creation of such risk (via the netting of payments) and limiting the total amount issued.

The pollution analogy is also useful for illustrating the key difference between the EICCR proposal and a system of explicit, fixed charges for daylight overdrafts or intraday credit. The equivalent of overdraft charges in terms of environmental economics would be a per-unit pollution tax. Overdraft charges attempt to limit the extent of something undesirable—systemic risk—by fixing the price of the risk and letting the market determine the quantity of the risk that would be incurred, a policy that economists term *price rationing*. In contrast, the EICCR proposal would limit the quantity of risk and let the market determine the price, an approach known as *quantity rationing*. In the case of intraday money, quantity rationing (and the systemic risk associated with creating intraday money) would possess an important advantage over price rationing because the closest substitute for intraday money—overnight reserves or federal funds—is already effectively price-rationed by the Fed by means of daily interventions in this market. To fix prices successfully in the markets for two close substitutes (overnight and intraday money), one would to have to possess precise information on the relative price of the two forms of money. Otherwise, one form of money would be overpriced relative to the other, causing market imbalances as market participants try to convert their funds from the more expensive to the cheaper form of money. Under a quantity-rationing scheme for intraday money, the informational demands on the Fed would be less stringent. The Fed would simply set a cap on the maximum amount of intraday money that could be created on a given day. The market would then decide the appropriate price for this money, a price that would be consistent with the going rate of federal funds.

A proposal for reserve requirements on intraday money, similar in some respects to the EICCR proposal outlined above, has been advanced by E. Gerald Corrigan (1987) and put forth in more detail by Kausar Hamdani and John A. Wenninger (1988). In the case of Fedwire daylight overdrafts, Corrigan and Hamdani and Wenninger propose that overdrafting banks hold supplemental overnight reserves at a level that is the average of these overdrafts. Supplemental balances would earn interest at a rate lower than the overnight fed funds rate. While the basic idea of the Corrigan and Hamdani-Wenninger approach—making intraday money reservable—is the same as that behind the present approach, there are some noteworthy differences. The Hamdani-Wenninger proposal is limited to overdrafts on Fedwire, whereas this proposal suggests that an EICCR-based "reserve requirement" be applied to all electronic payments networks that allow for intraday netting of obligations (Corrigan also suggests that reserve requirements be widely applied). For the reasons outlined above, imposition of a reserve ratio on Fedwire, without imposing similar requirements on private networks, would have the undesirable side effect of encouraging the creation of additional intraday money and thereby additional systemic risk on the private networks.[30] Both the Hamdani-Wenninger and the Corrigan approaches also propose reserve requirements (clearing balances) based on average levels of overdrafts, with the averaging taking place over some specified period. On the other hand, an EICCR-based reserve requirement would effectively place a continuously administered reserve requirement on the creation of intraday money. Because intraday money is created on a continuous basis, a true reserve-based market for such funds would have to reflect the continuous changes in the availability of reserves to be held against such funds. A continuously applied reserve requirement would therefore seem preferable, abstracting from technical difficulties, to reserve requirements based on a time average.

By serving as a uniform international standard for electronic payments networks, an EICCR-reserve-based limitation on the creation of intraday money could serve to lessen the risk associated with cross-border payments networks. Such limits could also help to reduce Herstatt risk (see note 18), for example, by means of a uniform international requirement that cross-border payments network participants granting credits to be settled in foreign currencies hold EICCR reserves in the settling currency. Any such requirements would necessitate that EICCR for each currency be made available on an around-the-clock basis.

Potential Problems

Aside from technical difficulties, one could foresee other potential difficulties with the introduction of intraday reserve requirements, based on either EICCR or more traditional reserve accounts. One of the most troubling from a regulatory viewpoint would be the blurring of the distinction between banking and commerce. Any statutory recognition of intraday electronic exchanges between nonbank firms as a reservable form of payment would come close to conferring on these firms the legal authority to create money, a right currently reserved for depository institutions that are regulated, examined, and insured by governmental agencies. If nonbank firms are to be involved in the production of intraday money, their involvement raises the question of what kind and degree of regulation would be appropriate for these firms.

The inherent difficulty of such public policy issues does not mean that an EICCR requirement or a similar limitation should not be placed on electronic intraday money. The unfortunate legacy of historical policy toward intraday money has been the encouragement of an unsustainable "bielectronic" monetary standard. That is, current policies allow for a dual standard whereby one form of money (transactions funds held overnight at depository institutions) is reservable, yet another form (electronic intraday payments) is not, and the result is a situation reminiscent of the late nineteenth-century U.S. experiments with bimetallism. Theoretically, bimetallism was supposed to allow for the simultaneous maintenance of gold and silver commodity standards, plus the maintenance of a strict mint ratio of convertibility between the two metals. The fate of such schemes is well known: in practice, because the mint ratio between the two metals rarely equals their relative market prices, the cheaper of the two metals circulates while the more expensive metal is converted to a nonmonetary commodity.[31]

In the present-day situation, the existence of reserve requirements on overnight money means that inside money created in the form of traditional checking accounts is more costly to produce than inside money created via intraday credit over electronic payments networks because the latter is currently nonreservable. If there were a private market for the exchange of the two forms of money, intraday money would probably trade above par with overnight funds.[32] Yet par convertibility of electronic intraday money is maintained by the daily settlement of electronic accounts via the exchange of reserve funds—that is, via Fedwire. Par settlement of electronic intraday money in effect causes this money to be underpriced relative to the usual, overnight bank funds.[33] The imposition of an EICCR collateral requirement on intraday money could rectify this situation while maintaining par valuation of intraday money in terms of overnight money.

The foregoing discussion assumes the continued existence of reserve requirements on transactions accounts at depository institutions. However, many economists question the need for reserve requirements, and any policy designed to regulate the creation of intraday money must contend with the possibility that these requirements could be abolished.[34] In the case of EICCR, it can be argued that the efficacy of an EICCR collateral scheme need not depend on the existence of explicit legal reserve requirements for overnight money.

For example, suppose that explicit reserve requirements for overnight funds were abolished. Even in this case, reserve accounts would still be of value for the liquidity they provide. Most banks would almost certainly continue to hold positive reserve balances for clearing purposes. If these "clearing balances" paid no interest or paid interest at a rate below the market rate on overnight funds,[35] in the absence of EICCR or a similar collateral requirement there would still exist a positive cost differential between the cost of overnight and intraday money, a differential that would reflect the cost of holding liquid, but low-yielding, reserve funds. Hence, the right to create intraday money, which would be conferred by posting of EICCR collateral, would still be of positive value. The price of EICCR would reflect the value of intraday money in reducing the need for costly reserve balances.

A more fundamental objection to placing reserve requirements on electronic intraday money is implied in, for example, the views expressed by Lawrence H. White (1984, 1989). White argues that governmental regulation of the money supply has been at best inefficient and that free market forces would, over time, deliver better monetary institutions. Those sharing White's views might object to imposing reserve requirements on electronic intraday money as precluding the development of efficient private-sector mechanisms for regulating the supply of intraday money.

This criticism is difficult to answer, given how little the economics profession really knows about the workings of money. Because there is currently no widely accepted theoretical framework for money, it is difficult to rank systematically the "efficiency" of various monetary arrangements. Furthermore, the historical evidence concerning private banking systems is decidedly mixed. Richard H. Timberlake, Jr. (1984), Gorton (1985), and Gorton and Donald J. Mullineaux (1987) have argued that the central-bank-like features of nineteenth-century bank clearinghouses represented a spontaneous private-sector response to the various risks typically associated with banking, including the sort of systemic payment risk inherent in multilateral clearing arrangements.[36] Thus, one could argue that something akin to reserve or collateral requirements would be imposed on intraday money by the private sector.

There are several arguments that could be made in favor of increased public-sector regulation of the electronic intraday money, however. The first is the argument made above concerning the CHIPS network—that if participants in a given network expect the Fed (and other central banks) to bear the systemic risk associated with intraday netting schemes, these participants may act as if the risk were covered, irrespective of the Fed's actual policy stance on the issue. If these expectations are backed by similar ones on the part of the general public, there would be greater difficulty in dissociating Fed policy from any implied guarantee against systemic crises. In other words, simple disclaimers of responsibility for systemic risk are not likely to be credible if such disclaimers run against the grain of public expectations. Any credible transfer of the Fed's responsibility as lender of last resort to the private sector would likely require an unambiguous statutory backing and widespread political support.

Another argument in favor of governmental, as opposed to private, regulation of these payments networks concerns the allocation of regulatory responsibility. Under a system of private regulation, would one payments network bear any responsibility for a systemic crisis on another network? In the historical example of the pre-Fed clearinghouses, it is well known that these private clearinghouses provided effective safety nets (from systemic liquidity crises) for their member banks. During the 1907 panic, however, these carefully planned private arrangements were unable to prevent a systemic crisis from developing within the closely allied but relatively unregulated trust companies.[37] If a similar "contagion" of systemic crises were to develop over more than one private payments network, questions would certainly arise about how to allocate the responsibility for managing such a crisis. It is conceivable that these allocations could be governed by private contracts, but the scope and extent of such arrangements would be unprecedented. In addition, this approach would require a credible commitment on the part of the U.S. government to limit the scope of the Fed's control over the intraday money supply.

A related problem with pre-Fed clearinghouse arrangements had to do with the distributional effects of systemic crises. During pre-Fed money panics, clearinghouse member banks would often protect themselves from bank runs by resorting to suspensions of payment (of specie or its equivalent). These suspensions constituted a reasonable (though, strictly speaking, illegal) mechanism for protecting the banking system against liquidity crises. However, the suspensions also imposed significant costs on bank depositors who were unable to convert their bank deposits into hard cash, effectively removing political support for this mechanism. Similar considerations would afflict any private arrangement for dealing with systemic crises over electronic payments networks. If it imposed large costs on a considerable segment of the population, even an economically efficient mechanism could prove politically untenable.[38]

Conclusion

The history of money is one of ever-increasing sophistication in the technology for economizing on transactions balances. The latest milestone in this historical trend is the advent of electronic intraday money. This money is in effect created by the extension of intraday "credit" over electronic payments networks, networks whose integrity is often seen as either de jure or de facto guaranteed by the Fed or by foreign central banks.

The development of electronic intraday money is a natural outgrowth of the development of computer and communications technology necessary for electronic payment. These payments technologies offer the potential to economize on the use of scarce bank reserves and to increase payments system efficiency. Unfortunately, the legal and regulatory framework of the payments system has not kept pace with the rate of technological innovation. In particular, current technologies allow for virtually continuous payments while the laws, regulations, and conventions regarding settlement are still largely oriented toward settlement on a once-a-day basis.

An unforeseen consequence of this disparity has been the encouragement of a "bielectronic" monetary standard. That is, money in overnight transactions accounts is reservable while intraday money is not reservable but is convertible to overnight money at par. As a result, the existing regulatory framework has favored the creation of the less costly electronic intraday money in ever larger amounts. The creation of intraday money carries with it a certain amount of systemic risk. A number of policy measures have been aimed to limit the amount of such risk borne by the Fed, and it is likely that the legal and regulatory framework in this area will see additional changes. This discussion has argued that a major step toward containing the systemic risk associated with electronic payments networks would be to eliminate the artificial cost advantage associated with intraday money by creating tradable "intraday money creation rights." By encouraging the development of an intraday money market, this step would lead to more efficient allocations of intraday funds than would the continuing imposition of ad hoc limits on the creation of such funds.

The literature on electronic payments networks has tended to focus on the very complex institutional and technological characteristics of such systems. Without minimizing the complexity of such issues, it is this author's opinion that such analyses have failed to emphasize the fundamental truth that electronic payments are increasingly being used as an efficient form of money. Conceptually, electronic payments are no more innovative than were other devices that allowed for the creation of inside money: banknotes in seventeenth-century Sweden, clearinghouses in eighteenth-century London, or checks in the nineteenth-century United States. The introduction of marketable rights to the creation of electronic intraday money would be a useful first step toward moving electronic payments systems away from the realm of technocracy and into the mainstream of the marketplace.

Appendix 1
The Mechanics of Money Creation: Some Simple Examples

The process by which banks can create money is covered in most college courses on money and banking. However, the notion that banks can create money remains a foreign one to many people. The first example describes how a theoretical banking system can create traditional, overnight money.

Suppose that a small, closed economy has only two banks. In this simple economy, banks hold liabilities in the form of demand deposits and assets in the form of loans to customers and reserves in an account held with a central bank. There is a 10 percent reserve requirement, meaning that each bank must end the banking day with a ratio of reserves versus deposits of at least 10 percent. No interest is paid on reserves.

Suppose further that the two banks' initial balance sheets are the following:

Bank A's Initial Balance Sheet

Assets		Liabilities	
Loans	$900	Deposits	$900
Reserves	$110	Net Worth	$110

Bank B's Initial Balance Sheet

Assets		Liabilities	
Loans	$900	Deposits	$900
Reserves	$90	Net Worth	$90

Note that the aggregate M1 money supply—the total demand deposits in the economy—equals $1,800. Also note that Bank B is "loaned up," that is, Bank B's reserve holdings equal exactly 10 percent of its deposits. Bank A, however, holds an additional $20 in reserves beyond its legal requirement, or $20 in *excess reserves*. Because these reserves earn no interest, Bank A decides to loan the $20 to a creditworthy customer. When the loan is made, Bank A's assets and liabilities both expand. That is, its assets are increased by the addition of a $20 loan, and its liabilities are increased by the amount of additional funds made available to the borrowers' account, which is also $20. This means that Bank A's balance sheet can now be written as

Bank A

Assets		Liabilities	
Loans	$920	Deposits	$920
Reserves	$110	Net Worth	$110

Note that the money supply has expanded to $1,820. Suppose now that the Bank A customer who received the loan writes a check to a customer of Bank B. The Bank B customer deposits the check in Bank B. Initially, assume that the check clears instantaneously through a clearing system run by the central bank. In the clearing process, Bank A's balance sheet is contracted by $20, and Bank B's balance sheet is augmented by a corresponding amount. The new balance sheets for both banks are as follows:

Bank A

Assets		Liabilities	
Loans	$920	Deposits	$900
Reserves	$90	Net Worth	$110

Bank B

Assets		Liabilities	
Loans	$900	Deposits	$920
Reserves	$110	Net Worth	$90

Note that after clearing the check, the money supply has remained constant at $1,820, and that both banks continue to meet their legal reserve requirements.

While the example is highly stylized, it is relevant because it demonstrates some salient features of banking under a fractional (less than 100 percent) reserve requirement. First, it shows that the banking system can create money in the form of demand deposits. Second, it can be used to exemplify how reserve requirements place a constraint on the creation of such deposits. To illustrate, suppose that Bank B wishes to lend out its excess reserves to a creditworthy customer. However, in contrast to the earlier case with Bank A, there are only $18 of excess reserves available for Bank B to lend. If Bank B decides to lend out the $18, then the M1 money supply will expand by $18. If the Bank B customer writes a check for $18 to a Bank A customer, Bank B will lose its excess reserves to Bank A after the check clears. After clearing, Bank A can loan out its excess reserves, in the amount of 90 percent of $18, or $16.20. This process can be repeated over and over again, but the total amount of money in the economy is constrained by the reserve requirement and by the amount of available reserves to be less than or equal to $2,000, which is the amount of reserves available, or $200 divided by the reserve requirement of 10 percent or one-tenth.

Now consider a second example that is exactly the same as the first, except that the two banks decide to eliminate checks and to exchange all payments via a private electronic payments network. The rules of the payments network are as follows.

At the beginning of each business day, the network assigns each member a net debit cap, which is a limit on the amount of intraday net indebtedness to the other bank. For purposes of comparison with the first example, suppose that this limit is given by each bank's initial excess reserves. At the end of the day, the two banks settle by having the bank in the net debit position remit reserve funds via a wire system run by the central bank. Further suppose that it is also the custom of both banks to credit their customers' accounts with good funds as soon as a payment message to the customer's account is received via the EFT network.

At the beginning of a certain business day, suppose that each bank's initial balance sheet is as it was in the previous example. That is, both banks have $900 in loans and deposits, Bank A has $100 in reserves, and Bank B has $90 in reserves. According to the network rules, Bank A's net debit cap is $20, and Bank B's net debit cap is zero.

Suppose that when the network opens for business, each bank has twelve extremely creditworthy customers, each of whom would like to send $20 to a customer of the other bank. Suppose that the customers are named C1, C2, C3, . . . , C24 and that odd-numbered customers use the payment services of Bank A and even-numbered customers use Bank B. Each customer i wishes to send customer $i + 1$ the sum of $20 (C24 wishes to send funds to C1). In this very predictable economy, the same set of payments are made every day. However, the order of payments is random.

Suppose that on a particular day, C1 is first in line at Bank A and wishes to wire $20 to C2's account at Bank B. Customer C1 has no deposits at Bank A but has a $20 line of credit against some good collateral. Further, C1 expects a $20 payment sometime during the day from C24, who banks at Bank B. He taps his line of credit and instructs Bank A to send a $20 payment message to C2, after which the banks' balance sheets look like

Bank A

Assets		Liabilities	
Loans	$920	Deposits	$900
Reserves	$110	Due to B2	$20
		Net Worth	$110

Bank B

Assets		Liabilities	
Loans	$900	Deposits	$920
Reserves	$90	Net Worth	$90
Due from B1	$20		

Note that the M1 money supply has expanded by $20. Bank B's net debit position is now –$20. Because it is below its net debit cap of zero, Bank B starts processing its customers' payment orders. The first customer in line is C14, who wants to send $20 to C15, who banks with Bank A. As was the case with C1 and Bank A, C14 has no deposits with Bank B but has a $20 line of credit with Bank B that she taps and uses to send a payment message to C15, knowing that the loan will be repaid sometime later in the day by C13. After C14's payment, the balance sheets of the two banks and the money supply have again expanded by $20, as shown below.

Bank A

Assets		Liabilities	
Loans	$920	Deposits	$920
Reserves	$110	Due to B2	$20
Due from B2	$20	Net Worth	$110

Bank B

Assets		Liabilities	
Loans	$920	Deposits	$920
Reserves	$90	Due to B1	$20
Due from B1	$20	Net Worth	$90

Suppose that on this particular day, the remaining customers in line at Bank A are customers C3, C5, . . . , C23 and that the remaining customers in line at Bank B are C16, C18, . . . , C24, C2, C4, . . . , C12. None of the customers had any funds on deposit with either bank at the beginning of the day, but each had a line of credit for $20. Now consider the balance sheets of the two banks after C1, C3, . . . , C11 have sent payment messages to C2, . . . , C12; and C14, C16, . . . , C22 have sent messages to C15, . . . , C23. These are as follows:

Bank A

Assets		Liabilities	
Loans	$1,020	Deposits	$1,000
Reserves	$110	Due to B2	$120
Due from B2	$100	Net Worth	$110

Bank B

Assets		Liabilities	
Loans	$1,000	Deposits	$1,020
Reserves	$90	Due to B1	$100
Due from B1	$120	Net Worth	$90

At this point in the business day, the money supply has expanded to $2,020, an amount exceeding the upper limit of the first example by $20. As more customers send their payment messages, the intraday loans will start to be paid off. (The example abstracts from the fees and interest that would be charged for such loans in real life.) At the close of the business day, both banks end up with a net debit position of zero and their balance sheets look exactly as they did at the start of the day.

While this second example also is highly stylized, it is again a relevant one because it illustrates two salient features of a private electronic funds transfer system. First, it shows that such an EFT system with a netting arrangement allows for an intraday expansion of balance sheets that closely parallels the traditional process of inside money creation. Second, it shows that this expansion of balance sheets need not be constrained by traditional reserve requirements.

Some Real-World Complications

The simple examples above abstract from several important features of real-world payments systems. While some of these features complicate the logic of the argument that intraday payments amount to money creation unconstrained by reserve requirements, none of them renders the basic point invalid. Some of these complications are considered below.

The first complication is the existence of "check float." Check float occurs when the funds associated with a check simultaneously appear as deposits on two banks' balance sheets. Float occurs as a result of the time lag associated with the check-clearing process. In certain instances, this delay can result in a customer at a payee bank having access to funds before the check for those funds has been presented to the payor bank. In such instances an expansion of bank balance sheets and transactions deposits can occur, in a fashion analogous to that described for the hypothetical wire transfer system in the second example above. Check float is not counted in the official monetary aggregates, however.

The existence of check float means that it is possible for a banking system under a fractional reserve requirement to exceed the theoretical upper bound on inside money creation (provided one is willing to include float in the definition of "money"), at least on a short-term basis. This last fact, in turn, could be interpreted to mean that the creation of intraday money via electronic payments networks is really no more problematic than the creation of check float.

There are at least two key distinctions, however, between the creation of money via check float and the creation of money via the netting of electronic payments. One distinction is a technological one. That is, it is physically much easier to run up a large net debit position on a wire transfer network than it is systematically to write checks that will result in equally large amounts of check float. This first distinction is a direct consequence of a second, more fundamental distinction between intraday EFT netting and the purposeful management of check float—the differing policy stance of the Fed and other regulatory bodies toward these formally similar phenomena.

Simplistic attempts by individuals to exploit lags in the check-clearing process are more popularly known as "check kiting," and such activities carry a criminal penalty in most instances. More subtle and systematic attempts by larger organizations to exploit the lag in check clearing are usually designated by a less ominous term, "remote disbursement." Though widely practiced, remote disbursement is officially discouraged by the Federal Reserve, and some of the more flagrant practices associated with remote disbursement have been effectively prohibited. By contrast, the netting of intraday payments has been generally tolerated (subject to certain risk controls) as a means of introducing greater efficiency into the payments system. Thus, it seems that the expansion of bank balance sheets, and the consequent creation of inside money, enjoys both technological and regulatory advantages when this activity occurs over EFT networks as compared with its occurrence by means of check float.

A second real-world complication is that reserves need not stay constant. As pointed out in Marvin Goodfriend and Monica Hargraves (1983), traditionally the Fed has chosen to accommodate short-run fluctuations in banks' demand for reserves rather than allow these demand fluctuations to affect short-term interest rates. Hence, reserve requirements have not historically posed a barrier to banks' expansion of the money supply, at least in the short run. For this reason, the first example above exaggerates the constraining effect of reserve requirements on money creation. In real life, reserves can be borrowed overnight in the Fed funds market at a rate that changes little from day to day.

It should be noted, however, that the Fed's accommodation of short-run fluctuations in reserve demand have not reduced the marginal cost of adding further reserves (and hence of creating additional reservable deposits) to zero. Further, the real marginal cost of adding reserves—the real Fed funds rate—fluctuates over the course of the business cycle and is typically highest near the business cycle peak. In the case of intraday payments over EFT networks, the marginal cost of additional payments is often negligible, given that preset caps on such payments and their associated net debit positions have not been breached. It seems unlikely, therefore, that such quantitative caps would be as effective as the existence of reserve requirements in constraining the growth of banks' balance sheets.

A third complication is that bank customers may not have free access to lines of credit, as the second example above supposes. However, the same aggregate expansion of banks' balance sheets can be obtained by introducing additional banks to the payments network. As long as each participating bank is willing to credit its customers immediately with funds sent over the network, the example goes through.

A final complication that could affect the validity of these examples is that the electronic payments in the second example could presumably be sent over Fedwire, which would change the accounting somewhat. Because the finality of payment is guaranteed over Fedwire, any overdrafts of banks' reserve accounts would become "due to the Fed," and the "due from's" would be actual increases in each bank's reserve account. These entries would be exactly offset by new entries on the Fed's balance sheet, which would consist of the payor bank's "due from's" on the asset side and increases in the payee bank's reserve account on the liability side, as shown more formally in Appendix 2.

Appendix 2
The Algebra of Netting Schemes

The properties of market clearing have been studied extensively in economic theory (see, for example, Gerard Debreu 1959). However, implementation of market clearing has not been as thoroughly studied. One fairly recent, systematic study is Alfred Lorn Norman (1987). The following discussion uses a framework similar to Norman's to analyze netting schemes.

Example 1: A Domestic Payments Network

The first abstract setting to be considered is a domestic payments network. There are $N + 1$ participants in this network, N participants ("banks") plus a network manager. In the jargon of equilibrium theory, there are $N + 1$ "commodities"—that is, things that will be traded. Each commodity i, $i = 1, \ldots, N$ consists of (reserve account) funds to be held by bank i. The commodity $N + 1$ consists of funds in a settlement account with the network.

Assume that at the beginning of a business day, each bank i knows the total amount of funds that all of its customers need to wire to all other banks $j \neq i$. Denote the amount of this "excess demand" of bank i for commodity j as Z_{ij}. Note that $Z_{ij} \geq 0$ and $Z_{ii} = 0$. It is assumed that transactions costs are negligible and that all banks' funds are valued at par, which in this abstract setting means that all commodities have a price equal to one. Each bank has a large endowment of commodity i that is more than sufficient to meet all demands for commodity i but has no endowment of any other commodity. Three types of clearing schemes can now be considered: gross settlement, settlement with bilateral netting, and settlement with multilateral netting.

Case 0: gross settlement, meaning no netting. In this case, the network manager does nothing other than to verify that the transfers take place. Each bank i will transfer a total of $\sum_{j \neq i} Z_{ij}$ to other banks. The total funds required to clear the market will be

$$F_0 = \sum_i \sum_{j \neq i} Z_{ij}.$$

Under gross settlement, the maximum number of transfers necessary to settle is $N(N - 1)$.

Case 1: settlement with bilateral netting. In this case, the network manager still does not play an active role. Instead, each bank i first determines its net debit (credit) position vis-à-vis bank j, $Z_{ij} - Z_{ji}$, where $1 \leq i, j \leq N$. All banks in a net debit position then settle by paying $|Z_{ij} - Z_{ji}|$ to the bank in the net credit position. Under the assumptions of this analysis, half of the transactions that occurred under gross settlement need not occur under bilateral netting. Settlement thus requires a total amount of funds equal to

$$F_B = \sum_i \sum_{j<i} \left| Z_{ij} - Z_{ji} \right|$$

and involves at most $N(N - 1)/2$ transfers.

Case 3: settlement with multilateral netting. In this case, the network manager presents each bank i with its net credit or debit position vis-à-vis all banks in the network, which will be $\sum_{j \neq i}(Z_{ij} - Z_{ji})$. Banks with a net debit position will pay this amount to the network manager, who will use these funds to pay the amounts due net creditors. The total amount of funds needed to clear the market will be

$$F_M = (1/2) \sum_i \left| \sum_{j \neq i} \left(Z_{ij} - Z_{ji} \right) \right|,$$

and settlement will involve, at most, N transactions—that is, settling the network accounts of N banks.

The "economy" of netting schemes derives from the following results.

Lemma 1. The number of transactions involved in multilateral netting ($\leq N$) is no greater than the number of transactions for bilateral netting [$\leq N(N-1)/2$], which is no greater than the number of transactions for gross settlement [$N(N-1)$].

Lemma 2. $F_M \leq F_B \leq F_0$. (This equation represents just the triangle inequality.)

In words, *Lemma 1* means that fewer transactions are needed as a result of netting, and *Lemma 2* means that less cash is needed. In this simple example, if clearing is instantaneous at the beginning of the business day and settlement is made at the end of the day, the amount of daylight credit extended is F_0 for either type of netting scheme.

In the example above, the market is static, meaning that money has no time value, and the excess demands Z_{ij} are considered fixed quantities. In real-world networks, money will have time value, and the granting of costless or underpriced daylight credit will result in an increase in the demands for funds at other banks—the Z_{ij}'s. In a network with bilateral or multilateral netting, a cap on bilateral credit requires that two banks i and j switch to gross settlement when $|Z_{ij} - Z_{ji}|$ exceeds the cap value. In a network with multilateral netting, a cap on overall credit requires that bank i must switch to gross settlement with all other banks $j \neq i$ when bank i's overall net debit position, $\Sigma_{j\neq i}(Z_{ij} - Z_{ji})$, exceeds the specified limit.

The example above also assumes that each bank i has a sufficient endowment of (reserve account) funds to clear exchanges under all settlement schemes. Conceivably, these endowments could be so small as to make gross settlement impossible with only bilateral exchanges, even though settlement could occur under a netting scheme. This situation corresponds to what is known as network "gridlock."

Arithmetic examples. Example 1: A payments network has eleven member banks. On a particular day, each bank owes the other ten banks the gross amount of $10 million each. In this example, F_0 = ($10 million • 10 recipients • 11 banks) = $1.1 billion, whereas $F_B = F_M$ = $0. Under gross settlement, there are 110 settling transactions, but no transactions are required to settle under either netting scheme. *Example 2*: Each bank i owes bank $i + 1$ a sum of $10 million and owes bank $i - 1$ a sum of $5 million. In this case F_0 = ($5 million + $10 million) • 11 banks = $165 million, F_B = ($10 million – $5 billion) • 11 banks = $55 million, and F_m = 0. Under gross settlement, 22 transactions are required to settle; there are 11 transactions under bilateral netting; under multilateral netting, no funds are required to settle.

Example 2: A Payments Network with Different Currencies

Now consider the case of an interbank payments network in which payment may be made in any of K different currencies, where the Kth currency is the "dollar." Let P_k represent the market-clearing dollar price of currency k, where $P_K = 1$. In this network, there are $K(N + 1)$ commodities—that is, accounts in K different currencies at N different banks plus K settlement accounts with the network. Let Z_{ij}^k denote bank i's excess demand for the typical commodity—money in currency k in an account of bank j. As in the previous example, banks do not need to transfer money to themselves, so $Z_{ii}^k = 0$ for all i and k.

Associated with each bank i is a "home currency" $\kappa(i)$. Initially, consider the especially unrealistic case in which each bank is well supplied with funds in every currency. One way to view the operation of the K-currency payments network would be to model this network as the simultaneous operation of K parallel domestic payments networks. A maximum of $KN(N - 1)$ transactions would occur under gross settlement, one-half that number under bilateral netting, and, at most, KN transactions would occur under simultaneous multilateral settlement in all currencies.

While this example is easy to analyze, the assumption that each network participant has access to and wishes to hold a "large" stock of funds in every currency seems particularly unrealistic. In a real-world situation, each bank i would prefer to hold a specialized portfolio of funds in a few currencies. In an extreme example of multilateral netting, each network participant i would only settle their net credit or debit position

$$\left|\sum_k \sum_{j\neq i} P_k\left(Z_{ji}^k - Z_{ij}^k\right)\right| \text{\{expressed in dollars\}}$$

by payment in their own domestic currency $\kappa(i)$. (Recall that the prices P_k by assumption clear the currency market so that no one gets stuck with an unwanted currency.) The total number of transactions involved in settlement would be N while the total dollar value of funds needed to settle would be

$$F_M^I = (1/2)\sum_i \left|\sum_k \left[\sum_{j\neq i} P_k\left(Z_{ji}^k - Z_{ij}^k\right)\right]\right|.$$

The total dollar value of funds needed to clear under gross settlement would be

$$F_0^I = \sum_i \sum_k \sum_{j\neq i} P_k Z_{ij}^k.$$

In such a situation, the overall reduction in the number of transactions required for clearing, by going to multilateral netting from gross settlement, would be from a maximum of $KN(N - 1)$ to N.

Arithmetic example. Suppose, as in the previous example, that there are eleven banks in a payments network, only this time it is supposed that each bank is based in a different currency and that each bank wishes to hold domestic money only at the beginning and end of each trading day. As before, each bank i owes bank $i + 1$ an amount equivalent to \$10 million, and bank i also owes bank $i - 1$ an amount equivalent to \$5 million. To settle a debt with another bank, a given bank has to make two transactions. First, it has to convert the required payment to foreign currency; second, it discharges the debt in the required currency. Under a gross settlement regime, settlement results in forty-four transactions having a total dollar value of $F_0^I = 2 \cdot$ (\$5 million + \$10 million) • 11 banks = \$330 million. Under bilateral netting, settlement requires twenty-two transactions having a dollar value of $F_B^I = 2 \cdot$ (\$10 million – \$5 million) • 11 banks = \$110 million. Under multilateral netting, no payments are needed to settle because $F_M^I = 0$.

Example 3: A Generalized Payments Network for *K* Commodities

The framework for Example 2 can be adapted to payments for K different types of goods (for example, government bonds or mortgage-backed securities). The only difference is that network participants may have endowments of any commodity, but that settlement is always in the Kth commodity—that is, in dollars.

Observational Equivalence of Multilateral Netting (with Guaranteed Settlement) and Gross Settlement with Daylight Overdrafts

Consider a domestic payments network, as in Example 1. Bank i wishes to send payment Z_{ij} to bank j, and the payments will be settled by multilateral netting.

Before settlement bank i's balance sheet looks like the following (showing only intraday changes):

Bank *i*

Assets	Liabilities
$+ \max\{\sum_j Z_{ji} - \sum_j Z_{ij}, 0\}$	$+ \max\{\sum_j Z_{ij} - \sum_j Z_{ji}, 0\}$
Due from network	Due to network
	$- \sum_j Z_{ij}$
	Debits to sending customers' accounts
	$+ \sum_j Z_{ji}$
	Credits to receiving customers' accounts

After settlement, bank i's balance sheet will change as follows:

Bank *i*

Assets	Liabilities
$- \max\{\sum_j Z_{ji} - \sum_j Z_{ij}, 0\}$	$- \max\{\sum_j Z_{ij} - \sum_j Z_{ji}, 0\}$
Net due from erased	Net due to erased
$\sum_j (Z_{ij} - Z_{ji})$	
Change in reserves	

Under a Fedwire-type system, bank i's payments may be covered either by bank i's reserve balance or by overdrafting this balance. Before settlement on such a system, bank i's balance sheet would be

Bank *i*

Assets	Liabilities
$+ \max\{-R_i, \sum_j Z_{ji} - Z_{ij}\}$	$+ \max\{\sum_j Z_{ij} - \sum_j Z_{ji} - R_i, 0\}$
Change in reserve account	Amount of daylight overdraft, if any
	$- \sum_j Z_{ij}$
	Debit senders' accounts
	$+ \sum_j Z_{ji}$
	Credit receivers' accounts

After settlement, the balance sheet of bank i would be

Bank *i*

Assets	Liabilities
$- \max\{\sum_j Z_{ij} - \sum_j Z_{ji} - R_i, 0\}$	$- \max\{\sum_j Z_{ij} - \sum_j Z_{ji} - R_i, 0\}$
Cover daylight overdraft, if necessary	Overdraft obligation erased

There are two principal differences between the "multilateral netting" and "Fedwire" T-accounts. The first is the presence of the initial reserve balance, R_i, in the Fedwire accounts. However, the historical incentives of the Fedwire system have been such that banks would try to minimize R_i. If it is assumed that R_i is "fairly small," then the remaining difference between the two

systems is that under Fedwire, net creditors would be in possession of the reserve funds "due to" them from the network, *before settlement*. By contrast, under an explicit multilateral net-settlement mechanism, net creditors would not receive funds until *after settlement*. If settlement is guaranteed, however, this difference would be inconsequential for the behavior of the network participants.

Notes

1. According to Juncker, Summers, and Young (1991), the Fed provides settlement for more than 160 private, small-value payments netting arrangements involving checks, Automated Clearing House (ACH) transactions, and so forth. To date, the relatively small amount of intraday credit extended via these networks has not been a major policy concern. Besides CHIPS, other domestic large-value payments networks include those operated by Participants Trust Company (PTC) and by Depository Trust Company (SFDS). See Juncker, Summers, and Young (1991) for more details on the PTC and SFDS networks.
2. Of course, monetary exchange could have been carried out with fiat money (legal tender), which was unknown in Europe at the time.
3. Clough and Cole (1941, 276-77) attribute the first widespread issue of banknotes to the Bank of Stockholm in 1661. The popularity of this note issue is at least partly explained by the fact that Sweden was on a copper standard at the time.
4. Clough and Cole (1941, 493) and Braudel (1984, 606-607) date the founding of the first clearinghouse for banks, the London Clearing House, to 1773. As noted by Braudel, nonbank clearing organizations were in existence centuries before this date.
5. See for example, Timberlake (1978, 87).
6. Timberlake (1984), Gorton (1985), and Gorton and Mullineaux (1987) each provide descriptive accounts of the workings of nineteenth-century clearinghouses in the United States. Duprey and Nelson (1986) describe the Fed's efforts to introduce par checking.
7. Figures are from Bank for International Settlements (1991, 47).
8. Two excellent glossaries of terms commonly used in the literature on electronic payments are provided in Bank for International Settlements (1989) and Gilbert (1992).
9. Similar examples can be found for domestic clearinghouses in Juncker, Summers, and Young (1991) and for cross-border clearing arrangements in Gilbert (1992). Readers interested in the mathematical details are referred to Appendix 2.
10. "De facto multilateral netting" means that the behavior of Fedwire participants is essentially the same as if Fedwire were a multilateral net settlement system, which it is not. Garber and Weisbrod (1992, 300-302) discuss the behavioral equivalence of "daylight overdrafts" and multilateral netting. A more formal discussion of this equivalence is given in Appendix 2.
11. The vast majority of daylight overdrafts (on a value basis) are incurred by large banks in the business of clearing financial-markets transactions. One recent estimate attributed 60 percent of daylight overdrafts to only three money-center banks.
12. A useful summary of basic information on Fedwire and CHIPS is provided in Bank for International Settlements (1990a).
13. There are types of risk other than systemic risk associated with private payments systems such as CHIPS. From a public policy point of view, however, systemic risk is the most important for at least two reasons. First, a truly widespread or "systemic" crisis would be the sort of risk that the private sector is least able to either control or insure against. Second, existing rules covering EFT netting arrangements typically do not provide a complete set of contingent rules in the event of a systemic crisis. See, for example, Federal Reserve Bank of New York (1991) for a more complete description of the CHIPS risk management procedures or Stehm's (1992) description of risk management on the Participants Trust Company network.
14. See Federal Reserve Bank of New York (1991).
15. The classification of Fedwire overdrafts as inside or outside money is somewhat problematic. The accepted definition of outside (inside) money is money that does (does not) represent a *net* claim of the private sector against another party outside the private sector (see, for example, Sargent 1987, 103, or Gurley and Shaw, 1960, 73). Any Fedwire payment that is funded by a daylight overdraft causes the instantaneous creation of a claim by the payee bank against the public sector (the Fed). In this sense, Fedwire overdrafts resemble more traditional forms of outside money such as overnight reserves. Under normal circumstances, however, the claim against the Fed caused by a daylight overdraft is exactly offset by a claim of the Fed on the payor, a claim that must be paid at par by the end of the business day. In this "expectational" sense, no net liability has been created, and daylight overdrafts more closely resemble inside money. Another "inside" feature of daylight overdrafts is that they are automatically created (up to the amount of any quantitative cap) at the behest of banks and their customers, at a negligible marginal cost. By contrast, the more traditional Fed liabilities commonly equated to "outside money," such

as overnight bank reserves, are under explicit control of the Fed. The Fed may choose to accommodate fluctuations in the demand for overnight reserves, but it also exerts a high degree of control over both the amount of the accommodation and the (typically nonnegligible) price charged. On balance, Fedwire daylight overdrafts seem more "inside" than "outside."

16. More detailed treatments of the issues surrounding cross-border networks can be found in Bank for International Settlements (1989, 1990b) and Gilbert (1992).
17. Estimate by Bank for International Settlements (1993).
18. This risk is referred to as Herstatt risk, after the 1974 failure of a German firm, Bankhaus Herstatt. A detailed study of Herstatt risk in the foreign exchange markets is presented in Kamata (1990).
19. McAndrews (1992) presents a more detailed treatment of delivery-versus-payments systems.
20. The discussion of FDICIA below draws heavily on that of Wall (1993).
21. For a summary of the restrictions enacted in 1990, see Board of Governors of the Federal Reserve System (1991, 79-80).
22. For a summary of the pricing scheme for Fedwire daylight overdrafts, see *American Banker*, October 1-2, 1992.
23. A very rough estimate of the magnitude of such a shift, provided in an unpublished Federal Reserve System study, is calculated to be no more than one-third of the value of all Fedwire transfers. More precise estimates must await full implementation of pricing of daylight overdrafts.
24. Figures are from Bank for International Settlements (1990a).
25. Some representative studies from this rather large body of literature include Board of Governors of the Federal Reserve System (1988), Faulhaber, Phillips, and Santomero (1990), and Flannery (1988).
26. The "Angell" report notes that "systems for the binding netting of . . . financial obligations provide a service that is a very close substitute for the function of money as a medium of exchange" (Bank for International Settlements 1990, 7). The recognition of electronic payments as money is at least implicit in the discussions of electronic payments systems by Corrigan (1987) and Flannery (1988). In a footnote, Ettin (1988) characterizes electronic payments as money and attributes this characterization to Jeffrey Marquardt.
27. Note that EICCRs as described here are not "reserves" in the traditional sense, nor do they confer a right to borrow at the discount window. Rather, EICCRs confer on their owner the right to create intraday money, which is a close substitute for reserves.
28. Several readers of early drafts of the paper have correctly pointed out that debit card and POS transactions are currently not settled on a real-time basis. It seems likely, however, that if the float associated with the settlement on these transactions were appropriately priced, then real-time settlement would become the norm.
29. The idea of marketable emission permits was suggested by Dale (1968). Baumol and Oates (1988, chap. 12) provide a discussion of these permits and a survey of the literature that analyzes them.
30. Note that this proposal does not claim that the imposition of compensating balances on Fedwire would increase the aggregate level of systemic risk in the payments system. The claim is that imposition of reserve requirements (via compensating balances) on Fedwire would shift such risk from a network in which finality is explicitly guaranteed by the Fed to other networks. As argued above, participants in such systems may well see themselves as protected from systemic risk by an implicit Fed guarantee.
31. See, for example, chapters 10 and 11 of Timberlake (1978) for an account of the U.S. experiments with bimetallism. In a nutshell, these experiments consisted of repeated, unsuccessful attempts by the U.S. government to circulate silver coinage at a mint value above its market value. For a history of earlier experiments with bimetallism by various European countries, see Kindleberger (1984, chap. 4).
32. The validity of this statement does not require that the (market) relative prices of the two types of money equal the ratio of their production costs. As long as the market price of each type of money increases as its production cost increases, intraday money would trade above par with overnight money.
33. A notable difference between the current situation and nineteenth-century bimetallism is the direction of the mispricing of the newer form of money. The introduction of silver money was a flop because the mint, or official, value of the new money was above its market price in terms of gold. Presently, electronic intraday money has succeeded at least partly because of its official valuation at par with ordinary overnight bank money. This value is below its market price, which would be above par, as discussed above.
34. For example, Goodfriend and Hargraves (1983) offer an in-depth assessment and critique of the performance of reserve requirements as a component of monetary policy. For another treatment of the costs and benefits of reserve requirements, see chapter 13 of Garber and Weisbrod (1992).
35. Currently the Fed is required by law to pay interest on any such balances on a quarterly basis, at a rate corresponding to the average rate of return on the Fed's open market portfolio for the previous quarter. A reduction in this rate would require statutory authorization.
36. It should be mentioned that the member banks of the nineteenth-century clearinghouses were hardly unregulated institutions. In other words, one does not have to endorse a system of pure laissez-faire banking to believe that private mechanisms could deal with some of the risk associated with electronic payments networks.
37. See Tallman and Moen (1990) for an account of the trusts' role in the 1907 panic.
38. For example, Donaldson (1992, 78) contends that a common pre-Fed mechanism for dealing with bank panics, that is, suspension of payments and issue of clearinghouse certificates, often resulted in abnormally large profits for the members of the clearinghouses.

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