Recent Evolution of Large-Value Payment Systems: Balancing Liquidity and Risk

By Antoine Martin

Large-value payment systems have evolved rapidly in the last 20 years, continually striking a balance between providing liquidity and keeping settlement risk under control. Changes to the design or to the risk management policies of such systems were needed, in part, due to the growth in the value of transactions on these systems. For example, in the United States the value of transactions on Fedwire, the Federal Reserve's large-value payment system, increased from about 50 times GDP in 1989 to over 62 times GDP in 2003. This value exceeded $704 trillion in 2003. This growth raised concerns that the settlement failure of a large institution could pose severe economic consequences. The disruption in settlements after September 11, 2001, brought new focus to questions such as: How reliable are the payment systems? How should liquidity be provided to system participants? And how can central banks protect themselves from excessive risk?

This article considers the evolution of large-value payment systems in light of the trade-off between providing liquidity and limiting settlement risk. The main changes worldwide in the last 20 years reflect a shift of emphasis toward greater control of settlement risk. Many countries have replaced delayed net settlement systems, which are very

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liquid but vulnerable to settlement risk, with real-time gross settlement systems, which control risk better but are somewhat less liquid. Even the United States, which has had a real-time gross settlement system since the beginning of the Federal Reserve System, has introduced changes aimed at better controlling risk.

The first section of the article provides some background on large-value payment systems and discusses the trade-off between providing liquidity and controlling settlement risk. The second section describes the recent evolution of payment systems and explains how this evolution was spurred by increasing concerns about settlement failure, particularly in the EU, the United States, and Canada. The third section explains some of the differences between three of the major large-value payment systems. The final section describes how technological progress and faster computers are allowing new systems to combine the best features of delayed net settlement and real-time gross settlement systems. These systems could offer a better trade-off between liquidity and risk.

I. THE TRADE-OFF BETWEEN LIQUIDITY AND RISK IN LARGE-VALUE PAYMENT SYSTEMS

Economic transactions that do not involve barter must be settled by a transfer of funds from buyer to seller. The infrastructures that allow such transfers to happen are called payment systems. An important part of most modern payment systems are institutions that allow the transfer of large, time-sensitive payments between banks and other financial institutions. These large-value payment systems, or LVPSs, form the basic structure that allows other parts of the payment system to function better. A key aspect of the design of an LVPS is how this system trades off liquidity with the risk of settlement failure.

Liquidity and risk in an LVPS

A payment system's liquidity is determined by how easy it is to make a payment at any given time. During a trading day, a payment system participant often wants to make an urgent payment when the necessary funds might not be readily available but with the knowledge that these funds will be available later in the day.[1] Since, by the nature of this kind of payment, delay is not an option, a well-designed LVPS should allow participants to acquire funds when necessary through intraday credit. The easier it is to obtain these funds, the more liquid the system. In a completely liquid system, any participant could make a payment at any time, regardless of the participant's current balance with respect to other system participants or the system's settlement institution. The settlement institution is typically the central bank.[2] A completely liquid system could be achieved, for example, by allowing unrestricted intraday borrowing at no cost.

But as it becomes easier to obtain intraday credit, and thus the use of credit becomes more widespread, the risk that some credit will be defaulted on rises. Since system participants may not be able to settle their obligations to the institution extending the credit, this kind of risk can create settlement risk. Settlement risk is generally used to designate the risk that settlement in a transfer system will not take place as expected, either because of credit risk or liquidity risk (BIS 2003). A system's risk depends on how likely a participant is to default on obligations to other participants or to the system's settlement institution. In a completely risk-free system, default would never occur. This could be achieved if no transaction were allowed that created a liability for the system's participants or its settlement institution.

There is a fundamental trade-off between liquidity and settlement risk. A system can become more liquid by making it easier for participants to borrow intraday, but such borrowing increases the potential for default and a failure to settle with the institution extending credit. Conversely, a system can become less risky by eliminating transactions that are most likely to result in default, but curtailing transactions will reduce the liquidity of the system.

Interestingly, two historical examples of settlement systems approximate the two extreme cases of the trade-off. Before 1986, the Federal Reserve had almost no restrictions on the use of intraday credit for payments over Fedwire, the main domestic LVPS in the United States. As a result, the system was extremely liquid, but the Federal Reserve was potentially taking on large risks. Today, as will be discussed below, several restrictions on the use of intraday credit better protect the Federal Reserve, at some cost in terms of liquidity.

At the other end of the spectrum was Swiss Interbank Clearing (SIC), the Swiss system, from 1987 to 1999. During this period, the Swiss National Bank did not provide intraday credit at any price, which made the system immune to settlement risk, but at a potentially important cost in terms of liquidity. Payments on SIC could be delayed for long periods until funds became available for them to be processed. The cost in terms of liquidity probably exceeded the benefit generated by the elimination of settlement risk. Such cost/benefit considerations contributed to the Swiss National Bank's decision to start providing access to intraday credit in 1999.

Delayed net settlement and real-time gross settlement systems

Historically, the two main types of LVPSs have offered different trade-offs between liquidity and settlement risk. These two types are delayed net settlement (DNS) systems and real-time gross settlement (RTGS) systems.[3] To understand the differences between the two, a brief review of how payment systems work is useful. When bank A wants to make a payment to bank B over an LVPS, it typically sends a message to the settlement institution. Once the message has been received, the settlement institution can make the transfer of funds on its books. Depending on the nature of the system, this transfer will happen either immediately or with a delay. Also, the settlement institution can process payments individually, on a gross basis, or by offsetting several payments before they are processed. In the latter case, the payments are said to be netted. Netting has the advantage of reducing the need for liquidity since only the net balance of the value of a set of payments needs to be transferred. In an RTGS system the settlement institution transfers funds on its books immediately (in real time) and on a gross basis (each payment is processed individually). In contrast, in a DNS system the settlement institution makes the transfer of funds with a delay (usually at a prespecified time such as the end of the trading day) and nets all payments.[4]

Although many countries used DNS systems until the mid-1980s, these systems have been gradually abandoned, leaving very few DNS systems still in operation in G-10 and other developed countries today. In the United States, CHIPS, a system privately owned and operated by the Clearing House Interbank Payments Company L.L.C., was a DNS system until 2001. The Large-value Transfer System (LVTS) in Canada is an example of a net settlement system still in operation today.[5] Examples of RTGS systems include Fedwire in the United States, TARGET in the euro area, and SIC in Switzerland.

These two types of LVPSs offer different trade-offs between liquidity and risk. DNS systems are typically more liquid than RTGS systems, but also more vulnerable to settlement risk. In DNS systems, participants implicitly provide each other credit at a zero interest rate until the time settlement occurs. Indeed, at that time only the balance of payments made and received matters, not the order in which these payments were made and received. For example, consider a bank that makes a payment of $10 million and subsequently receives a payment of equivalent value before the next settlement time occurs. In a DNS system the values of the payments offset each other so that at the time of settlement the bank does not need any reserves for the two payments to settle.[6] In an RTGS system, in contrast, the bank must have access to $10 million in reserves to make the first payment. This example illustrates how net settlement systems economize on settlement balances. Access to this kind of implicit credit may be limited by restrictions on the size of participants' positions or by collateral restrictions. Nevertheless, DNS systems are typically very liquid because there are few impediments to payments being made.

The drawback of DNS systems is that they are vulnerable to settlement risk. A bank could become bankrupt between the time a payment message is sent and the time the payment is settled. Hence, DNS systems must specify a set of rules or procedures that describe how transactions are handled in case of settlement failure. One frequently adopted procedure is called unwinding. If a payment system participant fails to settle, all transfers involving that participant are deleted from the system, and the settlement obligations from the remaining transfers are then recalculated (BIS 2003). The risk of financial loss associated with this procedure is called unwinding risk. Unwinding risk is a concern because it could potentially create a cascade of failures. Indeed, the failure to receive expected payments from one payment system participant could force other participants into bankruptcy. With each institution that fails, new institutions would fail to receive expected payments. This, in turn, could lead to additional failures.

An RTGS system essentially eliminates settlement risk by eliminating any delay between the time a payment message is sent and the time it is processed and settled. However, because an institution must have access to enough reserves at the time it wants to make a payment, RTGS systems are potentially much less liquid than DNS systems. Participants in RTGS systems do not have automatic access to free intraday credit.

To improve the liquidity of RTGS systems, the central bank typically provides participants some access to intraday credit. Such credit can reintroduce some risk since an institution may become bankrupt before it has repaid its debt, but this risk is now borne by the central bank rather than other participants in the system.

Providing liquidity at what cost?

As noted above, liquidity in DNS systems is implicitly available at no cost until the next time settlement occurs. This is not the case in RTGS systems, in which the central bank typically provides liquidity by allowing participants to overdraw their accounts. One striking feature of RTGS systems is that intraday liquidity is often provided at no charge, or at a fee of only a few basis points.

The low cost of intraday borrowing might appear surprising when compared to the cost of overnight borrowing. In the United States, the cost of overnight loans, which have only a slightly longer maturity, has rarely been below 3 percent since World War II—an order of magnitude higher than intraday rates. Even in the current environment of historically low overnight rates, intraday rates are much lower, leading some economists to argue that intraday credit should be priced at a higher rate (Mengle, Humphrey, and Summers; Lacker 1997).

Recent research, however, supports the provision of liquidity at a very low cost. One argument is based on the idea that central banks can provide insurance against the risk of incurring large intraday overdrafts. Since the timing of payments received and sent by payment systems participants is highly uncertain, two participants with identical reserve positions at the opening and the closing of the market may have very different liquidity needs throughout the day. For example, one institution might make a lot of payments early in the morning before it receives offsetting receipts. Another institution might receive many payments before it needs to make any. If intraday borrowing is costly, these otherwise identical participants face potentially very different costs. The central bank has the ability to temporarily expand settlement balances at essentially no cost. By charging a very small price for intraday credit, it guarantees that payment system participants with high liquidity needs will not bear a heavy cost. Hence, it provides insurance against the risk of having high payment needs (Green; Kahn and Roberds 2001b; Martin; Zhou).[7]

Another argument is based on the fact that charging less for liquidity reduces the incentives to strategically delay sending payments. If it is costly to borrow intraday, participants will try to minimize the risk that they may have to do so. One way to do that is to delay sending payments as much as possible. The hope is that such delay will make it more likely that payments from other institutions will be received before payments are sent. But since all participants have the same incentives to delay payments, this strategy can create gridlock (Angelini; Bech and Garratt; Kahn and Roberds 1999).

However, the cost of intraday liquidity can be too low. For example, if that cost is literally zero, payment system participants may have an incentive to overuse intraday credit because it is less expensive to borrow than to better coordinate payment inflows and outflows. For this reason it is probably desirable for central banks to charge a small fee or require collateral. One advantage of collateral is that it also protects the central bank from settlement risk, as is discussed in the next section.

Controlling settlement risk

Two different approaches control settlement risk in LVPSs. Most systems require collateral for intraday credit. In RTGS systems, the collateral protects the central bank, which typically provides intraday liquidity. In DNS systems, the collateral protects the participants, who are implicitly lending to each other. Requiring collateral should, in principle, eliminate settlement risk. In case of a settlement failure, the central bank can recover the funds it is owed by selling the collateral. One potential problem could arise if the value of the collateral can change quickly. Thus, a central bank could be exposed to some settlement risk if it finds out, after a settlement failure, that the collateral it holds is no longer worth as much as when the collateral was accepted.

The Federal Reserve uses a different approach to protect itself from settlement risk. Each institution receives a cap limiting the amount of uncollateralized credit it can have and is charged a small fee for intraday credit. By making intraday credit costly, the Federal Reserve provides incentives for payment system participants to reduce their daylight overdrafts.

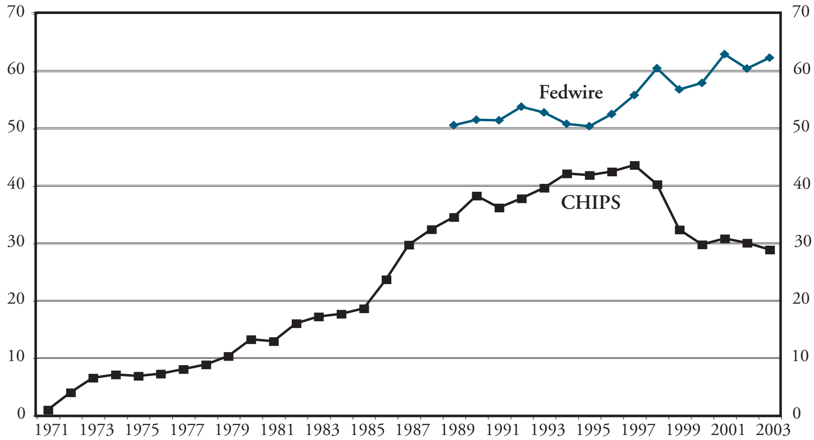
Whether posting collateral or charging a fee is preferable depends on the cost to payment system participants of each option. If collateral is readily available at low cost, posting collateral might be preferable to paying a fee. In addition, the desirability of one system or another may depend on the volatility and predictability of payment patterns.[8] In a collateralized system, an institution making payments must tie up some assets as collateral, either because it needs to post this collateral at the central bank at the beginning of the trading day or because it must make sure that the collateral will be available in case it is needed. Thus, to the extent that collateral is costly, it can be associated with a fixed cost. In contrast, in a fee-based system, the cost is variable since the fee is paid only if credit is actually needed.[9]

II. THE RECENT EVOLUTION OF LVPS

In the last 20 years, LVPSs throughout the world have changed dramatically to better control settlement risk. Perhaps the most visible change is that DNS systems, which are very liquid but subject to settlement risk, have been extensively replaced by RTGS systems, which control risk better.[10] A number of the G-10 countries have adopted RTGS systems since 1985, including Germany, Japan, the United Kingdom, and France. Fedwire, which was already an RTGS system, has also experienced important changes in its risk management policy since the mid-1980s. The few remaining net settlement systems have also evolved to reduce the potential for settlement failure. This section

Chart 1

VALUE OF TRANSACTIONS RELATIVE TO GDP



Sources: Board of Governors, CHIPS

summarizes the events that led to the desire to better control settlement risk and describes three different payment systems: Fedwire, TARGET, and LVTS.

Reasons for change

The emphasis on the trade-off between liquidity and risk has changed over time for two major reasons. One reason was that the use of LVPSs, as measured by the value of daily transactions on these systems, grew rapidly in the 1970s and 1980s. A greater value of transactions implied greater risk of settlement failure, as more participants were using intraday credit, explicitly on Fedwire or implicitly in DNS systems. Concerns also arose that, due to the growing use of payment systems, a settlement failure or some other problem could harm the broader economy. Chart 1 shows the growth in the value of transactions on CHIPS and Fedwire relative to GDP.[11] This growth illustrates the increasing use of payment systems.

Another reason was the failure of Bankhaus Herstatt in 1974, which provided a vivid example of settlement risk and its potential consequences. Bankhaus Herstatt, a medium-size German bank, was very active in the foreign exchange market. Herstatt's counterparties in New York had irrevocably paid deutsche marks to Herstatt through the German payment system, anticipating that they would be paid later the same day in New York. When German authorities removed Herstatt's banking license, the counterparties were left exposed to the full value of the transactions, which was estimated at $200 million (BIS 1996).[12]

While all systems have evolved toward better control of settlement risk, they have done so in different ways. These diverse experiences could be due to the history of the systems or might reflect different financial structures. It is difficult to assess whether one system is better than another or if each system is optimally designed to fit a particular country's specific needs. It is indeed possible that, despite their differences, each system provides a similar trade-off between liquidity and risk. The remainder of this section describes the evolution of three systems—Fedwire, TARGET, and LVTS.

Fedwire

Starting in the mid-1980s, the Federal Reserve instituted important reforms aimed at controlling the use of Federal Reserve intraday credit by depository institutions. These reforms did influence settlement risk on Fedwire because Fedwire users need intraday credit whenever the value of a payment exceeds the reserves the user holds.[13] The Board of Governors imposed quantitative limits on account overdrafts at Reserve Banks in 1986 and a small fee on intraday credit in 1994. As a general matter, the majority of account overdrafts at Reserve Banks are uncollateralized. This section reviews the main measures adopted by the Federal Reserve to limit credit risk to Reserve Banks.[14]

Since 1986 the Board has imposed a quantitative limit—or cap —on the size of intraday overdrafts by depository institutions with accounts at the Reserve Banks. Caps protect the Federal Reserve by limiting the risk posed by any given institution. Most institutions choose to obtain an exempt-from-filing cap. Institutions that expect to incur large overdrafts can request a larger cap. In such cases, the size of the cap is determined largely by a self-assessment undertaken by the depository institution requesting the cap. These institutions have considerable flexibility in setting the cap, provided they can convince the Federal Reserve that their internal risk-management procedures will allow them to safely handle such a cap. Self-assessed caps are obtained mainly by heavy users of daylight overdrafts. To the extent that some institutions with self-assessed caps can demonstrate that their cap is too constraining, the Reserve Banks may authorize a level of additional collateralized daylight overdraft capacity (Coleman).

To have access to intraday credit, Fedwire participants must also satisfy regulatory criteria designed to ensure they are adequately capitalized.[15] This allows only relatively safe institutions to borrow. However, the value of assets held by a financial institution such as a bank can fluctuate rapidly. Hence, there is a small risk that a payment system participant could have access to uncollateralized credit before the Federal Reserve realizes how much this institution's financial condition has deteriorated. This risk is partially mitigated by the fact that the Federal Reserve has banking supervisory authority and thus can acquire information about the financial health of the institutions that have accounts on its system. Most other central banks, including many which do require collateral against intraday credit, do not have such authority.

In practice, caps have not constrained most institutions. The Board of Governors reviewed its daylight credit policies in 2000. The review found that approximately 97 percent of depository institutions use less than 50 percent of their daylight overdraft capacity for their average daily peak overdraft. However, a small number of healthy institutions did find themselves regularly constrained by their caps, causing them to delay sending some payments (Coleman).

Since 1994 the Federal Reserve has also charged a small fee on intraday overdrafts. This rate was set at 24 basis points (annual rate) and raised to 36 basis points in 1995. By making intraday credit more expensive, the Federal Reserve aimed to provide some incentive for payment system participants to reduce their credit use. A decrease in the value of overdrafts after the introduction of the fee suggests that this indeed happened. One year after the introduction of the fee, average intraday overdrafts had decreased 40 percent (Richards, Coleman).[16]

There is some evidence that the introduction of a small fee for daylight overdrafts in the United States has led to some delay in making payments. Such delays reduce the efficiency of the payment system.

However, the small fee appears to have been beneficial by providing incentives for payment system participants to better manage their payments. Some evidence suggests that coordination between different institutions to send each other payments at roughly the same time has increased, thus reducing the potential for overdraft over long periods (McAndrews and Rajan). Such coordination enhances the efficiency of the payment system.

TARGET

TARGET, the main payment system in the euro area, takes a different approach to controlling settlement risk. TARGET is an RTGS system introduced in 1999. It is a decentralized system consisting of the "interlink" of 15 national payment systems, together with the European Central Bank (ECB) payment mechanism.[17] TARGET is an RTGS system because the national payment systems it comprises are themselves RTGS systems.[18] As shown in Table 1, all these countries, except for Greece, adopted RTGS systems from 1981 to 1997. Greece adopted such a system in 2001, when it joined TARGET.

As with other RTGS systems, providing enough liquidity for the system to function smoothly was an important concern for the designers of TARGET. Some of the liquidity needs could be met with required reserves, but more was needed. The solution that was adopted allows system participants to borrow intraday funds at a zero interest rate. In the TARGET system, liquidity is provided by the individual central banks within the European System of Central Banks (ESCB). To protect the central banks from settlement risk, all intraday credit must be collateralized. This requirement raised the fear that the system would be too demanding in terms of collateral. To remedy this potential problem, a wide range of assets is eligible for collateral (BIS 1999).[19]

The design of TARGET appears to work well. Access to liquidity has turned out not to be an issue and the ESCB is protected by the required collateral. But, there is a risk that the value of some assets offered as collateral could fluctuate quickly and leave the ESCB's member central banks exposed to some settlement risk.

An important question for systems such as TARGET, which protect central banks with collateral, is who bears the risk of settlement? In such systems, the creditors of payment system participants are particularly at

Table 1
RTGS IMPLEMENTATION IN SELECTED COUNTRIES

Country	Year
Denmark	1981
Netherlands	1985
Sweden	1986
Germany	1987
Italy	1989
Finland	1991
United Kingdom	1996
Belgium	1996
Portugal	1996
France	1997
Spain	1997
Luxemburg	1997
Ireland	1997
Austria	1997
Greece	2001

Source: Bech and Simonds

risk. Indeed, failure to settle by a system participant is usually caused by the bankruptcy of this institution. In such a case, the owners will lose their equity in the institution, whether or not their intraday credit is collateralized. Creditors of the bankrupt institution, however, are able to recover much less if intraday credit is collateralized than if it is not collateralized. Although their funds are at stake, these creditors may not have much influence on the kind of risk a payment system participant can take. Hence the incentives of owners and creditors of a payment system participant may not be aligned. Owners may have an incentive to take excessive risk with their creditors' money.

In a well-functioning market, creditors would ask institutions that heavily use intraday credit to pay a premium on the funds they borrow to compensate them for the risks they take. Faced with the prospect of having to pay a higher price for their funding, payment system participants would then have incentives not to take excessive risks. This market mechanism might not work, however, if creditors are uninformed about the risk they are implicitly taking on or if they expect to be bailed out in case of a failure.

Whether this kind of concern is important in systems that require collateral is an empirical issue. Interestingly, most TARGET participants pledge substantially more collateral than their payments would require, suggesting that the collateral requirement is very inexpensive. The very low cost of collateral to TARGET participants could be an indication that creditors of these institutions do not ask for a premium on the funds they lend. This might simply indicate that creditors know the borrowing institutions are not taking excessive risk, so no premium is necessary. A less benign interpretation is that creditors are not well informed about the risk they are taking on, and that there is a risk of moral hazard. Distinguishing between these two hypotheses is especially difficult given the lack of data available for empirical analysis.

LVTS

The Canadian payment system offers a third approach to trading off liquidity needs and settlement risk. LVTS is a real-time net settlement system which was introduced in 1999. Before LVTS, payments in Canada were handled by a system which settled payments the day after the clearing process. Because of the delay between clearing and settlement, some institutions were implicitly lending overnight funds to their counterparties. When large sums were involved, this could create substantial settlement risk. Furthermore, unwinding risk was also an important issue, as the failure of one participant to settle might prevent other participants from settling their obligations with a third party. LVTS was designed to improve on this situation.

Although it is not a gross settlement system, LVTS is similar to RTGS systems in two important ways. First, it guarantees the certainty of settlement of all payments accepted by the system and, second, it allows system participants to have full access to funds received through the system in real time. The way it achieves this, however, is different from RTGS systems.

Payments in the LVTS system can be sent through two distinct channels, called tranches. A tranche 1 payment will be accepted by the system provided the net position of the issuer, as a result of all tranche 1 payments, is covered by collateral pledged to the Bank of Canada. This is very similar to the way RTGS systems operate. For tranche 2 payments, each participant is granted a bilateral line of credit by all other institutions in the system. The payments a given institution can send are constrained by a cap, which is proportional to the sum of all bilateral credit lines extended to that institution. In addition, each system participant must post collateral with the Bank of Canada in an amount proportional to the largest bilateral line of credit this participant has been given. This collateral is used to cover the possible losses that would occur if a system participant were to fail. The system is designed so that the amount of collateral pledged by all participants can cover the failure of the institution with the largest net debit cap. If only one institution fails, the collateral will be able to cover any net position of the failed institution. In the unlikely event that two institutions were to fail, the Bank of Canada guarantees settlement of all payments in the system (BIS 1999).

The objective of tranche 2 is to economize on collateral to make the system more liquid. Some collateral is needed to cover the largest net debit position but not every net position is collateralized dollar for dollar, so the collateral requirement is much reduced compared to tranche 1 payments, or RTGS systems such as TARGET. The vast majority of payments over LVTS are tranche 2 payments. For example, economists estimate that such payments accounted for 98 percent of all payments made the first five months of 2003 over LVTS (McPhail and Vakos).

III. WHY ARE LVPSs SO DIFFERENT?

In light of the differences between Fedwire, TARGET, and LVTS, it is natural to ask why the credit risk management designs of these systems are so different. More specifically, since most LVPSs closely resemble the TARGET model, why are Fedwire and LVTS so different? This section provides some answers to this question.

Why is Fedwire different?

Important changes to the Federal Reserve's intraday credit policy have affected Fedwire participants in the last 20 years. However, Fedwire remains different from other payment systems in that the Federal Reserve does not require collateral for some intraday credit and instead charges a small fee and imposes caps. An important reason Fedwire remains different is that the benefits from requiring collateral do not seem to outweigh the costs of such a change.

The Federal Reserve's staff recently studied whether the Federal Reserve should impose full or partial collateralization for intraday credit in its payment systems risks policy review. The review did not recommend full or partial collateralization for two main reasons (Coleman).

First, some of the Federal Reserve's intraday credit exposure is effectively secured by collateral. The Federal Reserve holds collateral pledged by system participants for access to the discount window. This collateral can be used to compensate the Federal Reserve in case of an institution's failure to settle intraday credit. More than 90 percent of payment system participants have sufficient collateral pledged to cover most of their overdrafts.

Second, such a policy would be costly to some institutions which do not hold enough assets that could be used as collateral to cover their intraday overdrafts. Federal Reserve staff tried to estimate the potential cost if institutions were required to provide collateral for their intraday credit. They compared the assets held by payment system participants that could be used as collateral with the collateral that would be required given these institutions' intraday credit needs. Few Federal Reserve account holders would not have enough eligible assets on their balance sheet if collateral were required. However, some of the institutions that would not have enough such assets are among those that incur the largest intraday overdrafts. A policy of full or partial collateralization could have important consequences for these institutions by forcing them either to reduce significantly their intraday credit or to hold more assets that could be pledged as collateral (Coleman).

Federal Reserve staff also estimated that a policy of full or partial collateralization could "significantly reduce and possibly eliminate credit risk to the Federal Reserve" (Coleman). However, at that time the benefits from reduced credit risk apparently did not clearly outweigh the costs of requiring full or partial collateralization.

Why is LVTS different?

The main difference between LVTS and standard RTGS systems such as TARGET is that LVTS can send tranche 2 payments, which require much less collateral. Everything else being equal, this makes the Canadian system more liquid than TARGET. Greater liquidity might come at some cost in terms of settlement risk, since the collateral pledged for tranche 2 payments might not be enough to protect the Bank of Canada from multiple failures. But the balance between liquidity and risk also depends on the range of assets allowed as collateral. As the range expands, the quality of the marginal asset tends to decline. As a result, everything else equal, a system is more liquid, but less protected from settlement risk, if the list of assets that can be pledged as collateral is greater.[20] Hence, to the extent that more assets are available as collateral on TARGET than on LVTS, it is harder to evaluate which of the two systems is more liquid or more risky.

One reason Canada might have chosen to adopt a net settlement system rather than a more standard RTGS system could be that it has very few payment system participants. With only 14 participants in LVTS, setting up and monitoring bilateral lines of credit with all other participants is relatively easy. This would be more complicated in a payment system with many more participants. Hence, because of the small size of its banking system, Canada may be able to achieve a better trade-off between liquidity and risk than it would have been able to achieve with an RTGS system.

To summarize, over the last 20 years payment systems worldwide have put more emphasis on controlling settlement risk. Despite this common evolution, important differences remain between payment systems. This article has highlighted differences in the way risk is controlled—by requiring collateral or charging a low fee. And it has discussed who bears the settlement risk—the central bank in the case of

Fedwire or LVTS and creditors of payment system participants in the case of TARGET. It is not clear whether a given design should be preferred to all others. Because each country, or group of countries, has a different set of financial institutions, each system might be particularly well adapted to the needs of the country or countries it serves. Despite the obvious differences in designs and credit policies between the systems, it is also not obvious that they offer very different trade-offs between liquidity and risk. Given historical and institutional differences, each system might be the most efficient way to deliver a similar trade-off in each of these countries or group of countries.

IV. LOOKING AHEAD: THE FUTURE OF LVPSs

The evolution of payment systems can be seen as an attempt to achieve a better trade-off between liquidity and risk in a changing environment. One factor influencing this trade-off at any given time is the level of technology. Greater computing power and faster computers have allowed payment systems to implement finer measures of risk control—for example, by making it possible to keep track of the reserve positions of a large number of institutions in real time.[21] Technological progress is leading to the emergence of new systems that try to combine the best features of DNS and RTGS systems to achieve a better trade-off between liquidity and risk.[22] Faster computers allow complicated algorithms to search quickly through lists of payments to find some that approximately offset each other and can be netted without delay.

Two types of systems have emerged. The first type has evolved from net settlement systems and aims to provide a faster settlement, as "real-time" systems do. As in a netting system, payment participants send their payment messages to the settlement institution throughout the day without having to worry about securing intraday credit. An algorithm searches through the payment messages to see if some set of payments might offset each other. Once such a set of payments is found, the payments are settled. This type of design can greatly reduce the delay between the time a payment message is sent and the time the payment is settled for large numbers of payments, so that many, or most, end up being settled very rapidly. Unwinding risk is thus reduced substantially while the system keeps most of the advantages of netting from a liquidity standpoint. An example of such a system is newCHIPS, the updated version of CHIPS.

The other type of system has evolved from RTGS systems but tries to reduce the need for liquidity by creating a queue to which payments that have not yet been settled are sent. An algorithm searches the queue for offsetting payments. All payments are processed on a gross basis, but the need for intraday credit is reduced since many payments can offset each other at the time they are settled. An example of such a system is RTGSplus, the payment system currently used in Germany.[23]

One might ask what the prospects of such new systems are in the United States. As noted above, newCHIPS provides this kind of service, but newCHIPS is only accessible to a relatively small number of institutions. The large number of participants in Fedwire makes it potentially difficult to operate offsetting systems because of the need to consider a very large number of possible offsetting combinations. On the other hand, given enough computing power, the large number of possible offsetting combinations should improve the performance of a system combining netting with real-time settlement. This suggests that, with the help of new technologies, there may be scope to improve the trade-off between liquidity and risk offered by existing LVPSs.

V. CONCLUSION

This article described the recent evolution of LVPSs as they have tried to balance liquidity and risk. As risk became a bigger concern in the 1980s, DNS systems, which are very liquid but subject to settlement risk, were gradually replaced by RTGS systems, which control risk better. This article discussed three different approaches to controlling risk in payment systems; those of TARGET, Fedwire, and LVTS. The Federal Reserve's intraday credit policy allows Fedwire users to borrow intraday funds without needing collateral while LVTS is one of the few remaining net settlement systems. Despite the differences in their designs and credit policies, it is not obvious that these LVPS systems provide very different trade-offs between liquidity and risk.

Looking ahead, payment systems are likely to continue to evolve as technological progress permits more efficient coordination among payment system participants, allowing them to process more payments with less liquidity, while limiting settlement risk. Whether one system will come to dominate all others, or whether different systems will continue to serve different countries, and sometimes the same country, remains an open question. Whatever the institutional differences, these systems seem to converge toward very similar trade-offs between liquidity and risk.

ENDNOTES

[1]For example, Zhou notes that "In general, a bank has little control over the arrival of its customers' outgoing payment requests, whether they are urgent (time sensitive) requests, and the flow of its incoming funds transfers (which depend on other banks' timing decisions of payments initiation)."

[2]A distinction exists between a settlement institution and the settlement agent. The latter is the institution which manages the settlement process. In many cases, the settlement agent is also the settlement institution.

[3]Shen provides an introduction to these concepts. It should be noted that some settlement systems are neither delayed net settlement systems nor real-time gross settlement systems. An example of such a system is Continuous Linked Settlement (CLS), a system used to settle foreign exchange transactions. Kahn and Roberds (2001 a) provide more information on CLS.

[4]Payments may be netted on a bilateral or a multilateral basis. Payments are netted on a bilateral basis when the payments of only two institutions are netted at a time, before they are settled. If the payments of more than two institutions are netted simultaneously, then payments are said to be netted on a multilateral basis.

[5]However, as will be pointed out below, LVTS is considered a real-time net settlement system and not a delayed net settlement system.

[6]In some systems, such as Euro 1, a private system operating in the EU, the value of payments can offset before settlement.

[7]It is possible to offer intraday liquidity at a low price only because an intraday loan cannot be rolled over into an overnight loan. Otherwise, the low price of intraday liquidity could conflict with other monetary policy goals.

[8]The predictability and variability of payment patterns could depend on a number of factors. One such factor could be institutional differences between countries. Another factor may be the size of the institution considered. These factors would thus be important in order to assess which system is more desirable for a particular country or a particular institution. Unfortunately there is currently not enough data available to determine what factors influence patterns of payments. Several papers consider the benefits and costs of requiring collateral or charging a small fee. See, for example, Bech; Mills; and Martin.

[9]This can be illustrated by an example. Consider an institution that wants to borrow a perfectly known amount of funds from the beginning to the end of the trading day. If the opportunity cost of collateral is smaller than the fee charged by the central bank, this institution would prefer to post collateral and get access to free credit. Now suppose instead that this institution has a 50 percent chance of needing credit throughout the day and a 50 percent chance of not needing credit at all. Assume further that the decision to post the collateral must be made before it is known whether credit is needed. In this example, if collateral is required, half the time the institution pays the opportunity cost of collateral even though it does not use any credit. This institution would prefer a system with collateral only if the opportunity cost of collateral is half of the fee. Otherwise, it would be preferable to pay a positive fee half the time rather than the cost of collateral all the time.

[10]Bech and Simonds provide an interesting study of this evolution.

[11]Because CHIPS is not, properly speaking, a domestic payment system, it is not emphasized in this article. Access to CHIPS is limited to a few major banks representing about 20 countries. CHIPS plays a particularly big role in cross-border payments in U.S. dollars, processing over 95 percent of such payments. The decrease in the value of transfers originated on CHIPS relative to GDP after 1998 could be due to a decrease in fees per payment charged in Fedwire. These fees were reduced from $0.45 in 1997 to $0.40 in 1998 to a range of $0.21 – $0.34 in 1999 and a range of $0.17 – $0.33 in 2000. It could also be influenced by the decrease in the number of participants in CHIPS, from 104 in 1996 to 53 today.

[12]Other settlement failures have occurred since Bankhaus Herstatt including: Drexel Burnham Lambert Group, BCCI, and Baring Brothers. A more recent illustration of the problems that can arise in the payment system is the disruption in settlement after September 11, 2001 (McAndrews and Potter, Lacker 2004).

[13]Note that several factors other than Fedwire activity can influence a depository institution's reserve position.

[14]Coleman and Richards provide more detailed accounts of these policies.

[15]The criteria to be considered adequately capitalized, as defined by the FDIC, are: Total Risk-Based Capital Ratio equal to or greater than 8 percent, Tier 1 Risk-Based Capital Ratio equal to or greater than 4 percent, and either Tier 1 Leverage Capital Ratio equal to or greater than 4 percent or this ratio equal to or greater than 3 percent and the bank rated composite 1 under the CAMELS rating system in the most recent examination and not experiencing signifigant growth.

[16]The reduction in overdrafts was mainly observed in securities transfers and not in funds transfers.

[17]The 15 countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Luxemburg, the Netherlands, Portugal, Spain, Sweden, and the UK. The ECB payment mechanism is a payment system which is not open to commercial banks but only to public organizations, such as central banks, and specialized payment organizations.

[18]The current TARGET system is evolving into an improved system called TARGET2. One of the main objectives of TARGET2 is that all central banks in the system share a common technical platform to process payments. This should allow for economies of scale and harmonize the level of service between the different central banks in the system (ECB).

[19]For example, payment system participants can use their commercial loans as collateral for intraday credit.

[20]Note that it is possible to reduce the risk associated with a particular asset accepted as collateral by increasing the haircut associated with that asset. A haircut is the difference between the market value of a security and its collateral value. Haircuts are taken by a lender of funds in order to protect the lender, should the need arise to liquidate the collateral, from losses owing to declines in the market value of the security (BIS 2003)

[21]For example, on Fedwire the reserve position of each participant is updated every minute (Coleman).

[22]McAndrews and Trundle provide an introduction to such systems.

[23]There are many open questions about the design of hybrid systems and how these systems might affect payment system participants' incentive to delay payment. One interesting question is whether the ability to see what payments are placed in the queue of a hybrid system matters. Some recent work suggests that it might not, at least when banks know what payment other banks must make, but do not know which payments are time critical (Willison). However, it appears that whether or not the offsetting facility operates throughout the trading day or only during a certain time during the day might matter.

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