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THE NATURE AND MANAGEMENT OF PAYMENT SYSTEM RISKS: AN INTERNATIONAL PERSPECTIVE

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Introduction[1]

Over the last two decades rapid technological change, deregulation and a tendency for asset prices to display greater volatility have all contributed to an explosion in financial activity and hence in the volume and value of payment flows, both within and across national borders.[2] This trend is clearly illustrated by the surge in the value of interbank funds transfers handled by the major systems in the United States, Japan and the United Kingdom in proportion to GNP (Graph 1). As the value of commercial transactions tends to grow in line with GNP, the major rise in the ratio is essentially due to the surge in financial activities.[3] Among these, foreign exchange and cross-border transactions have played a prominent role.

As a result of this spectacular rise, the total value of interbank funds transfers has become very large indeed. For the three countries shown in the graph, it stood at around 80, 115 and 45 times GNP respectively in 1990. Put differently, the interbank funds transfer systems in Japan took just over two business days to turn over the value of the country's annual GNP.[4] In the case of the United States and the United Kingdom, this took

[1] The authors wish to thank members of the Committee on Payment and Settlement Systems (previously called the Group of Experts on Payment Systems) of the central banks of the G-10 countries for some of the data included in the tables in this paper and for the extensive comments received. They would also like to thank Julian Alworth, Joseph Bisignano and Horst Bockelmann for comments and Stephan Arthur, Angelika Donaubauer and Gerhard Randecker for statistical and graphical assistance, and Françoise Glotin for secretarial services. Any errors or omissions are, of course, the authors' sole responsibility. The views expressed are the authors' own and not necessarily those of the Bank for International Settlements or any of the central banks participating in the activities of the Committee on Payment and Settlement Systems.

[2] An overview of the profound changes in the structure of the financial industry during the last decade which can help put those in the payment industry into perspective is contained in BIS (1992a).

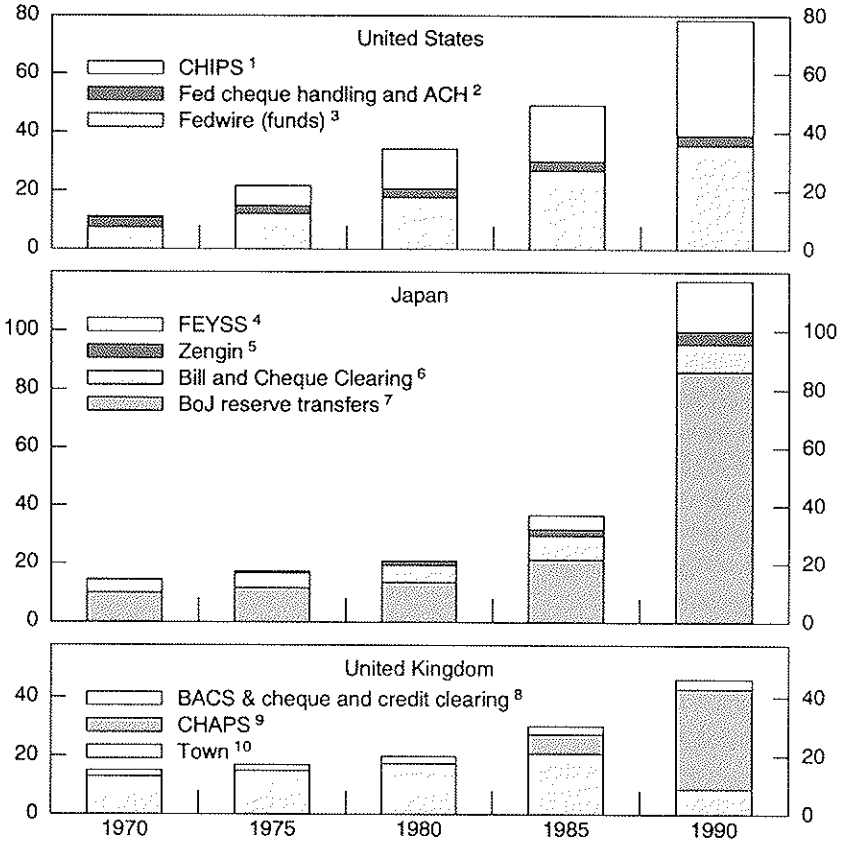
[3] Similar evidence exists for other countries (Borio et al. (1991)).

[4] On the assumption of 250 business days.

Graph 1

Trends in interbank funds transfers

Ratio of transaction value to GNP, at an annual rate



[1] CHIPS is a private clearing system which handles mostly internationally related transfers, i.e. foreign exchange and Euro-dollar transactions. [2] Clearing and settlement of cheques and Automated Clearing House (ACH) transactions by the Federal Reserve System. [3] Fedwire is the Federal Reserve's continuous (gross) settlement system used primarily for wholesale domestic interbank funds transfers. [4] FEYSS (a privately owned system, but operated by the Bank of Japan) is a clearing system for yen interbank transfers relating to foreign exchange and other financial transactions. [5] The Zengin system is a private clearing system used for interbank transfers resulting mostly from customers' credit transfers. [6] The Bill and Cheque Clearing system covers the traditional clearing house operations. [7] Transfers made through the Bank of Japan reserve accounts (including BOJ-NET); mostly related to settlement of interbank money market operations. [8] Private electronic and paper clearing systems for bulk payments. [9] CHAPS is a private electronic large-value funds transfer system. [10] Town Clearing is a private manual clearing system that handles only paper instruments (large-value Town Cheques).

Sources: National data and BIS estimates.

only three and five and a half days respectively. Figures of a similar order of magnitude also apply to other Group of Ten (G-10) countries.[5]

This explosion in the volume and value of transactions has not only represented an important source of revenue for the providers of payment services, particularly banks; against a background of heightened competition, it has also radically altered the dimension of the liquidity and credit risks involved. As a result, payment and settlement systems are now a more important potential source of, and propagating mechanism for, financial crises.[6] Episodes such as the Herstatt bank crisis (1974) and the stock market crash (1987) have helped to raise awareness of these issues.

In this new environment, safeguarding the integrity of the payment system is a goal that acquires particular significance and that calls for the upgrading of risk management procedures through concerted efforts by market participants and the relevant authorities, notably central banks. Moreover, the pursuit of this goal inevitably takes on an international dimension: the spectacular growth in foreign exchange transactions, where settlement brings into contact otherwise largely separate domestic payment systems, has highlighted the issues that arise from the coexistence of different operating, regulatory and legal arrangements.

The objective of this paper is to clarify the nature of the risks connected with payment systems, to consider possible arrangements for their management and to review briefly recent policy initiatives. These issues are illustrated with reference to the G-10 countries and primarily from the perspective of central banks.

Section I sets out the key elements of a stylised payment system. It also briefly describes the main characteristics and recent evolution of payment arrangements in the G-10 countries as well as the international linkages. The main focus is on the structure of interbank funds transfers and on the role of the central bank. Section II analyses the nature, magnitude and distribution of the credit and liquidity risks associated with payment systems. Section III considers the rationale for public intervention in risk management before analysing in more detail three areas where significant policy initiatives have been taken: large-value interbank funds transfer

[5] On the basis of 1990 figures published by the BIS (1991), the total value of cashless payments was about 190 times GNP in Switzerland, 70 times in Germany, 40 times in the Netherlands and Belgium, 30 times in Canada, 20 times in Italy and 10 times in France and Sweden.

[6] For a discussion of the impact of changes in the macroeconomic and financial environment on financial instability, see Bockelmann and Borio (1990) and BIS (1992a).

systems, the settlement of securities transactions and the settlement of foreign exchange transactions. Finally, the conclusions summarise the key points emerging from the analysis.

I.
Structure and evolution of payment systems[7]

The general framework

The payment system may be defined as the set of arrangements for the discharge of the obligations assumed by economic agents whenever they acquire real or financial resources. In non-barter economies such obligations are discharged through the transfer of title of ownership of a narrow set of claims which, by virtue of their wide acceptability, are known as "money" (the "settlement medium"). The payment system, therefore, is a set of mechanisms for the transfer of money among agents. Its constituent elements comprise the institutions providing payment services, the various forms of money, the means of transferring them, including message instructions and communication channels, and the contractual relationships linking the parties concerned.

The history of payment systems has been driven by the pressures to facilitate the execution of transactions. These pressures have dictated the evolution of barter into monetary economies and subsequently the progressive abandonment of "commodity money", such as gold, in favour of "fiat money", which is a claim on (liability of) the issuing institution.[8] Although payment systems differ considerably from country to country, the major participants as well as the key features of the settlement media and transfer mechanisms are quite similar.

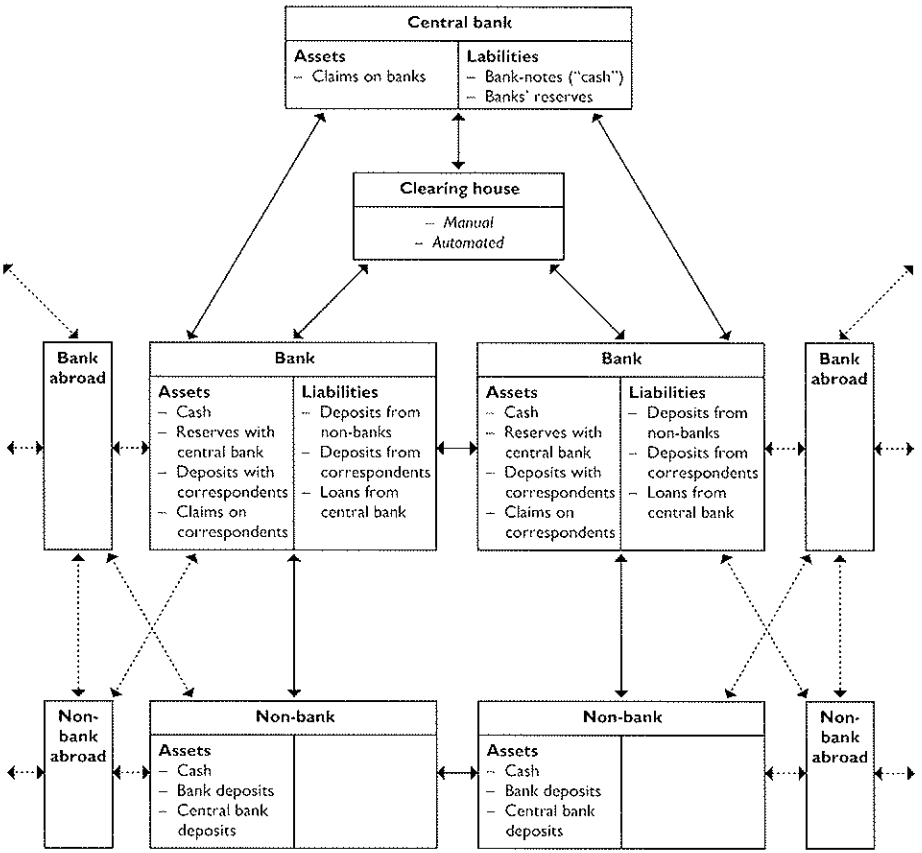
The settlement media are claims on the government (coin) and the central bank (notes and bank reserves) or on other banks (bank deposits) (Diagram 1). The general acceptability of claims on the government and the central bank as settlement media is reinforced by legal provisions (e.g. legal tender clauses) and, ultimately, by the power to tax, which underpins their value in terms of real resources. The acceptability of bank deposits,

[7] This section draws extensively on Borio et al. (1991).

[8] For a review of these issues see, for instance, Giannini (1988), Goodhart (1989) and Goodfriend (1990).

Diagram 1

Payment system participants, message flows and funds transferred



while backed by legal arrangements, depends primarily on the ability of the issuers to convert the deposits into legal tender at the request of holders.[9]

The most common and direct means of settling retail transactions between non-banks is through the physical transfer of bank notes ("cash"). Cash transactions are typically not intermediated ("two-party transfers"). Because of their dominant role in retail transactions, cash

[9] These statements refer to "normal" conditions, in which the legal tender commands confidence.

payments generally account for the bulk of the volume of all payments, but only for a negligible proportion of their value.

The transfer of ownership of any other settlement medium takes place by book entry on the accounts of the issuing institution ("cashless payment"). In this case the payment is performed by intermediaries, which receive and execute instructions to debit the account of the payer and credit that of the payee (customer or "third-party" transfers). Furthermore, whenever the counterparties do not hold deposits with the same institution, the execution of a payment order calls for a transfer of funds from the payer's to the payee's bank in order to allow the latter to cover the new liability incurred vis-à-vis the payee ("interbank funds transfer").[10] These funds, which need to be acceptable to both banks, take the form either of a liability of a third party (the "settlement agent") or of reciprocal accounts ("reciprocal correspondent balances"). Most often the settlement agent is the central bank, but it may also be another financial intermediary with which the banks hold deposits ("common correspondent bank").

The interbank funds transfers relating to the payment instructions can be settled individually on a continuous basis ("real-time or continuous gross systems"). However, in order to reduce the need for settlement balances and the number and size of portfolio adjustments, banks have traditionally relied on multilateral netting arrangements which settle at discrete-time intervals ("clearing or net settlement systems"). In this case, commitments to transfer funds at settlement accumulate over time and each bank finally transfers only its net balance vis-à-vis all other participants in the scheme, i.e. the difference between all its incoming and outgoing transfers ("net net balance").[11] Transfer orders are matched and net balances calculated, manually or electronically, in or by the clearing house, an institution which may or may not have an independent legal identity (Diagram 1).[12]

[10] Obviously, an interbank transfer is also involved when the counterparties are themselves banks. Moreover, interbank transfers can also arise from the relocation of deposits by agents, in which case the payer and beneficiary are the same.

[11] See Appendix I for a detailed illustration of possible structures of net and gross settlement systems.

[12] In many cases clearing houses are still little more than a meeting room where banks physically exchange transfer order instructions, register the resulting debits and credits on clearing accounts and agree on each participant's bilateral and multilateral net positions at the end of the day ("manual clearing houses"). In other cases, the transfer order instructions are delivered on magnetic media or through telecommunications and the corresponding bookkeeping and the calculation of each participant's net settlement position are performed by a central computer ("Automated Clearing Houses" and electronic large-value funds transfer systems).

Banks are of course the payment intermediaries par excellence. But a good proportion of total payments involves banks as the original counterparties of the transactions and as the customers of other banks in the funds transfer chains. This is particularly common, for instance, in the case of money market and foreign exchange transactions.

Characteristics of interbank funds transfer arrangements[13]

The structure of interbank funds transfer arrangements and the flows which they handle are partly dependent on certain characteristics of the economy and, more particularly, of its banking system. Highly developed and internationally integrated financial markets, such as those of the major international financial centres, tend to generate a greater volume of transactions and hence a greater flow of interbank transfers. By contrast, a high degree of size concentration in the banking system reduces the likelihood that customers' transfers will involve shifts of deposits between different institutions.[14] The existence of different categories of institution providing payment services has encouraged the development of intragroup clearing and/or settlement arrangements, as exemplified by those associated with the post office circuit in a number of European countries or with the savings and cooperative banks in Germany. A certain degree of geographical segmentation exists in most countries, typically in the form of local or regional clearing houses, and reflecting primarily the cost advantages of processing transactions in the area in which they occur.

Despite the structural differences in interbank funds transfer arrangements across countries, the evolution of the systems has tended to be common to all, under the impetus of technological advances and the spectacular rise in the volume, value and average size of transactions. Growing automation has gone hand in hand with greater de facto specialisation in the transactions handled by individual systems (Table 1) and a shortening of settlement lags. Although manual clearing houses still tend to be non-specialised, nowadays Automated Clearing Houses (ACHs)

[13] A more detailed comparison of the payment systems of the G-10 countries can be found in Borio et al. (1991). For individual country descriptions, see BIS (1989a) and BIS (1990a) and Committee of Governors of the Central Banks of the Member States of the EEC (1992a). BIS (1991), a regular publication, contains statistical updates.

[14] In France, for instance, where concentration is relatively high, it has been estimated that about 30% of credit transfers and 17% of cheques connected with third-party transfers are intrabank (BIS (1989a)).

Table 1

Examples of the various forms of interbank funds transfer systems[1]

Operational characteristics	Underlying type of transaction			
	Commercial/customer transactions	Money market transactions	Foreign exchange/ international transactions	Securities market transactions[2]
Paper-based (netting)	– Manual clearing houses	– Manual clearing houses – Central bank cheque system – DVP systems[3]	– Manual clearing houses	– Manual clearing houses – Central bank cheque system – DVP systems[3]
Electronic/automated				
Small value (net)	– Automated clearing houses (ACHs) – ATM and POS networks – Credit card systems		– International credit card systems – Eurocheque system	
Large value				
Net	– Large-value funds transfer system	– Large-value funds transfer system – DVP systems[3]	– Large-value funds transfer system[4] – Cross-border or multicurrency netting schemes	– Large-value funds transfer system – DVP systems[3]
Gross	– Large-value funds transfer system	– Large-value funds transfer system – DVP systems[3]	– Large-value funds transfer system	– Large-value funds transfer system – DVP systems[3]

[1] In many countries interbank funds transfers are also effected through a variety of purely correspondent banking channels. [2] Excludes systems used by banks for the transfer of securities. [3] DVP, or delivery against payment, is a mechanism for the settlement of money market and securities transactions which ensures that delivery occurs if and only if payment occurs. The (gross or net) payments may be executed through an existing (large-value) interbank funds transfer system or within a specific sub-system. [4] Specialised systems in a number of countries.

generally process bulk small-value payments related to commercial and retail transactions. In addition, in each country there is now at least one wholesale (large-value) electronic interbank funds transfer system, providing same-day final settlement.

Large-value interbank funds transfer systems[15] were established, or profoundly modified with the introduction of information technology, during the 1980s (Table 2). Most handle transfers relating to both commercial and financial transactions, but the latter account for the bulk of the activity in value terms. While the systems provide settlement for a variety of financial operations, an increasing number have been designed specifically to support payments related to international transactions, such as the domestic currency counterpart of foreign exchange and Euro-market dealings (CHIPS in the United States, IIPS in Canada, SAGITTAIRE in France, BCH-S.W.I.F.T. in the Netherlands and SIPS in Italy).

Most large-value transfer systems settle on a multilateral net basis. Real-time gross settlement systems, however, are also now in operation in most G-10 countries. The exceptions are Belgium, the United Kingdom, Canada and France, although France is planning to introduce such a system in 1993. All large-value systems settle on the books of the central bank, which is also directly or indirectly involved in their operation in view of their crucial role in domestic payment arrangements (see below).

The number of banks participating in these systems varies greatly, depending partly on the structure of the local banking industry and the degree of specialisation of the arrangements (Table 3). For instance, it is relatively lower in systems designed predominantly for foreign exchange related transfers. Five systems have a so-called "tiered structure": a small core of banks settle on the central bank's books and act as correspondents and settlement agents for the other participants (C.E.C. in Belgium, IIPS in Canada, Zengin System in Japan, CHAPS in the United Kingdom[16] and CHIPS in the United States). This may to some extent be dictated by reasons of efficiency, as it saves on non-interest-bearing settlement balances.[17] It may also be the result of restrictive membership criteria based on risk management or other considerations. In a few cases,

[15] While all large-value transfers are channelled through these systems, some of them may also handle small transfers.

[16] In Town Clearing any banks, corporations or service providers wishing to use the system must do so through an account with the Town Clearing branch of a member bank.

[17] See Appendix I.

Table 2

Salient features of selected large-value interbank funds transfer systems

	Gross (G) or net (N) settlement	Underlying transactions				Automated (A) or manual (M)	Launch date	Daily average transactions (1990)	
		Commercial	Money market	Foreign exchange and international	Securities market			in billions of US$	as a ratio to GNP[1]
Belgium									
C.E.C.	N	*	*			A	1986[2]	1.1	1.5
Canada									
IIPS	G[3]	*	*	*		A	1976	33.5	14.7
France									
SAGITTAIRE	N	*	*	*		A	1984	26.0	5.5
Germany									
Daily Clearing	N	*	*	*		M	1990	212.4	35.5
CB Express System	G	*	*	*		A	1987	44.5	7.4
Italy									
BISS	G	*	*		*	A	1988	0.1	0.3
ME	N	*	*	*	*	A	1989	17.3	4.0
SIPS	N		*	*		A	1989	18.9	4.4
Japan									
BOJ-NET	G[4]	*	*		*	A	1988	963.3	81.4
FEYSS	N			*		A	1989	203.0	17.2
Zengin System	N	*			*	A	1987[5]	52.5	4.4

Table 2 (continued)

Salient features of selected large-value interbank funds transfer systems

	Gross (G) or net (N) settlement	Underlying transactions				Automated (A) or manual (M)	Launch date	Daily average transactions (1990)	
		Commercial	Money market	Foreign exchange and international	Securities market			in billions of US$	as a ratio to GNP[1]
Netherlands									
CB Current Account	G		*			A	1985	22.3	19.9
BCH - S.W.I.F.T.	N	*	*	*	*	A	1982	11.6	10.3
Sweden									
RIX	G	*	*	*	*	A	1986	23.4	10.3
Switzerland									
SIC	G	*	*	*		A	1987	87.1	92.7
United Kingdom									
CHAPS	N	*	*	*	*	A	1984	145.7	34.0
Town Clearing . .	N	*	*	*	*	M	1946	39.5	9.2
United States									
Fedwire	G	*	*	*	*	A	1982[6]	796.4	36.1
CHIPS	N	*	*	*		A	1970[7]	888.8	40.2

[1] Annual rate. [2] 1974–75 for the exchange of magnetic media; 1986–87 for telecommunication. [3] The receiving bank creates a paper document called an inter-member debit voucher for each credit transfer received. These vouchers are delivered to the sending bank in batches, for which value and volume counts are entered into the Automated Clearing and Settlement System (ACSS), a netting scheme operated by the Canadian Payments Association. [4] The system has been designed to allow participants to enter funds transfer instructions continuously, in which case settlement takes place on the central bank's books immediately. The system is, however, also used to settle on a net basis. [5] Originally 1973. [6] Date of the latest upgrade of the communications system. The system was originally set up in 1914 and the first fully automated system was implemented in 1973. [7] Same-day settlement introduced in 1981.

Sources: BIS (1990a) and various national sources.

Table 3

Participation in selected large-value interbank funds transfer systems (1989)

	Total number of participants	Domestically owned banks[1]	Foreign-owned banks[2]	Non-bank participants[3]	Number of non-settlement participants
Belgium					
C.E.C.	124	58	66	–	64
Canada					
IIPS	68	8	58	2	46
France					
SAGITTAIRE	65	65	–	–	0
Germany					
Daily Clearing	5,061	5,061	–	–	0
CB Express System	14,696	5,061	–	9,635	0
Italy					
BISS	169	160	9	–	0
ME	142	133	9	–	0
SIPS	42	41	1	–	0
Japan					
BOJ-NET	332	216	77	39	0
FEYSS	146[4]	87	59	–	0
Zengin System	4,917	4,914	3	–	4,751
Netherlands					
CB Current Account	286	90	18	178	0
BCH - S.W.I.F.T.	57	57	–	–	0

Table 3 (continued)

Participation in selected large-value interbank funds transfer systems (1989)

	Total number of participants	Domestically owned banks[1]	Foreign-owned banks[2]	Non-bank participants[3]	Number of non-settlement participants
Sweden					
RIX	28	14	10	4	0
Switzerland					
SIC	163	101	60	2	0
United Kingdom					
CHAPS	317[5]	316[6]	1[6]	–	303
Town Clearing	14[7]	13	1	–	0
United States					
Fedwire	11,435	11,398	–	37	0
CHIPS	139	41	98	–	118

[1] Including, where applicable, the central bank. [2] Branches and subsidiaries. [3] Securities dealers: BOJ-NET (Japan) and CB Current Account (Netherlands); non-financial corporations: CB Express System (Germany) and CB Current Account (Netherlands); government entities: CB Express System (Germany), BOJ-NET (Japan), CB Current Account (Netherlands), RIX (Sweden), SIC (Switzerland) and Fedwire (United States); money market/bill brokers: BOJ-NET (Japan) and CB Current Account (Netherlands); and clearing houses: RIX (Sweden) and SIC (Switzerland). [4] An unidentified number of domestic and foreign financial institutions and corporations have access to the FEYSS system as indirect participants. [5] An unidentified number of other banks and institutions have access to CHAPS as customers of the fourteen settlement members. [6] The total number of participants in CHAPS changes quite frequently. Close to half of them are foreign-owned, although there is only one foreign-owned member with responsibility for settlement. [7] Any banks, corporations or service providers wishing to use the Town Clearing system must do so through an account relationship with the Town Clearing branch of a member bank.

Source: BIS (1990a).

non-banks also participate in the arrangements, for example securities and other financial intermediaries (Japan and the Netherlands), government entities (many countries) and even non-financial corporations (Germany and the Netherlands).

In many G-10 countries two or more large-value funds transfer systems coexist (Diagram 2). When the systems settle only on a multilateral net basis at different times during the day, as in the United Kingdom, settlement procedures are clearly not linked. By contrast, in many countries the multilateral balances due for payment in net settlement systems are finally settled through a real-time gross settlement system. That is the case, for instance, in Italy, the United States and Japan. As more countries equip themselves with continuous settlement arrangements, this pattern may become the standard in the future.

International transactions

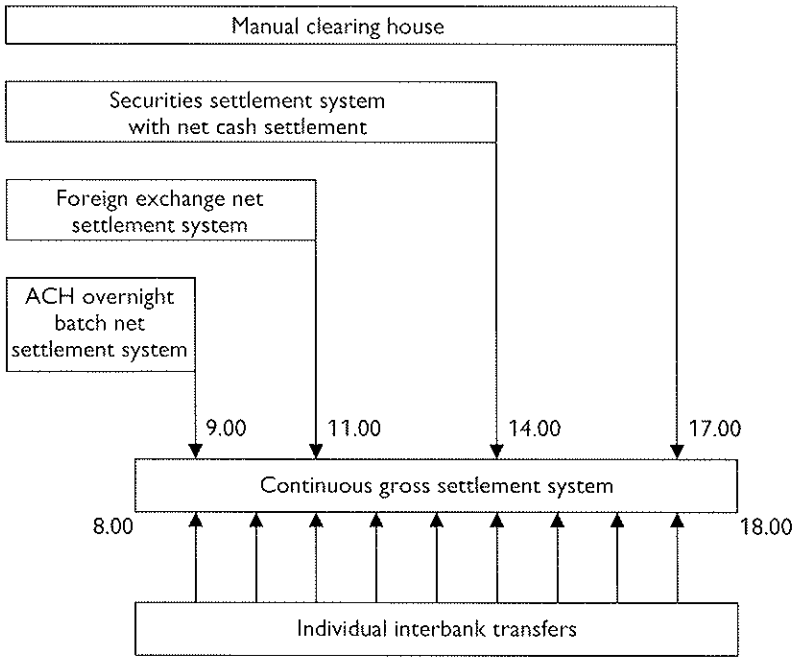
The distinguishing feature of international funds transfers is the tendency for payments denominated in particular currencies to involve funds transfers in the country of issue. The main reason is that even when the payment between ultimate counterparties takes place through funds held outside the country, any induced interbank transfer often does not. Banks prefer to hold transaction deposits in the country of issue in order to obtain the full benefits of domestic clearing and settlement arrangements underpinned by central bank money and by the liquidity of local money markets. Access to these systems may be direct, through branches and subsidiaries in the issuing country, but most often is indirect, through correspondent balances held with other domestic banks (Diagram 1).

At the same time, as a result of technological change, the growing internationalisation of financial markets and the rapid increase in foreign exchange and offshore financial transactions in many currencies, some new types of interbank circuits have been developed to provide for the netting of contracts, resulting in a reduction in settlement flows in country of issue. These include various types of bilateral and multilateral schemes (e.g. FXNET and ICSI).

All the financial institutions involved in executing cross-border payments are linked by a series of communication networks carrying funds transfer instructions to the respective domestic or offshore payment systems. The networks may be operated by the PTT authorities (telex), by large international banks or by other suppliers of telecommunication

Diagram 2

Hypothetical example of linkages between settlement systems



services. Among the private message carriers, the Society for Worldwide Interbank Financial Telecommunication (S.W.I.F.T.), a specialised non-profit cooperative company owned by banks, is the most important. Given its widespread use, many electronic interbank funds transfer systems, such as CHIPS, SAGITTAIRE and the ECU clearing, have been designed to allow messages sent between two or more banks via S.W.I.F.T. to be reformatted electronically and channelled through the clearing without further intervention. This significantly reduces the possibility of errors or delays and makes S.W.I.F.T. an integral part of many interbank funds transfer systems.

Central bank involvement

In all countries the central bank takes an active interest in payment systems in view of its overall responsibility for the soundness and smooth

Table 4

Selected features of the role of the central bank in the payment system

	BE	CA	FR	DE	IT	JP	NL	SE	CH	GB	US
Statutory responsibility for payment system		*1	*	*	2	3	*	*4	*		*
Settlement agent for interbank payments											
resulting from payment clearing operations	*	*	*	*	*	*	*	*	*	*	*
on a gross/continuous basis			p[5]	*	*	*	*	*	*		*
resulting from securities transactions	*		*	*	*	*	*	p		*	*
internal network available to banks	*		*	*		*	*	*			*
Involvement in payment clearing systems											
setting/enforcement of rules	*		*	*6	*	*		*	*	*7	*
auditing system(s)	*		*		*	*		*	*		*
owns system(s)	*		*	*	*	*		*			*
operates system(s)	*		*	*	*8	*		*	*		*
Involvement in securities transfer system											
for government securities	*		*	*9	*	*		p[10]		*	*
for other types of securities	p		*	*	*		*	p[10]		*	
Provision of daylight overdraft facility			*	*11	*11	*11	*11	*	*11, 12		*
subject to quantitative limits			p	*	*	*	*		*		*
collateral required			p	*	*	*	*	*	*		13
Provision of standing credit facilities	*		*	*	*	*	*	*	*	14	*
subject to quantitative limits	*			*	*	*	*	*			
collateral required	*		*	*	*	*	*	*	*		*
Restrictions on banks' use of reserve holdings											
reserve requirement in force	15	*16	*	*	*	*	*	*	*	*17	*
averaging provisions for required reserve holdings		*	*	*	*18	*			*		*

Table 4 (continued)

Selected features of the role of the central bank in the payment system

	BE	CA	FR	DE	IT	JP	NL	SE	CH	GB	US
Involvement in prudential supervision											
of individual banks			*	*	*	*	*	*19	*20	*	*
separate auditing of banks' EDP systems					*	*	*			21	*
of other payment system participants					*	*					*22

* = yes; p = planned; blank = no.

Here, and in subsequent tables, BE = Belgium, CA = Canada, FR = France, DE = Germany, IT = Italy, JP = Japan, NL = Netherlands, SE = Sweden, CH = Switzerland, GB = United Kingdom, US = United States.

[1] The role of the Bank of Canada in the payment system is largely based on its statutory role in the Canadian Payments Association, which was created by a federal act (the Bank of Canada chairs this Association). [2] The banking law stipulates that the Banca d'Italia shall operate the clearing houses. [3] The role of the central bank in the payment system is governed by a private agreement between the Bank of Japan and the participants in the various interbank funds transfer systems. The Bank of Japan has no explicit statutory power to supervise payment systems. Article 1 of the Bank of Japan Law defines the objective of the Bank as maintaining and enhancing the stability of the credit system, which has been the basis for its supervision of financial institutions and payment systems. [4] The central bank has responsibility for the safety and the efficiency of the payment system. [5] TBF (Banque de France Transfer System) to be introduced in 1993. [6] Only for the use of its own network. [7] The Bank of England is directly involved in organising the payment arrangements connected with the Central Gilts Office (CGO) and the Central Money Market Office (CMO). Direct responsibility for other systems rests with the Association for Payment Clearing Services (APACS) and the settlement banks concerned, including the Bank of England as one of the settlement banks. The Bank of England also has a general (non-statutory) role in monitoring and overseeing the operation of all payment systems. [8] The Banca d'Italia Continuous Settlement System (BISS). [9] Cash settlement for Kassenverein. [10] The Money Market Clearing Centre (PMC), a system for settlement against delivery, started operating in 1991. It handles interest-bearing money market securities issued by the Government, banks and housing credit institutions. [11] Arrangements for daylight overdraft facility basically the same as those for standing overnight credit facilities. [12] "Lombard" loans are available to banks in the course of the day but have a minimum maturity of one day. [13] Collateral may be posted by institutions that wish to exceed uncollateralised limits. [14] If a bank with a net net debit position in the final settlement holds insufficient funds with the Bank of England to meet its settlement obligations and is unable to arrange overnight borrowing from other clearing banks to cover the difference, settlement of the clearing can be completed only by the Bank providing an overdraft to the bank concerned. [15] The central bank has the power to impose minimum reserve requirements but does not currently exercise it. [16] The Canadian Government has announced that new banking legislation will phase out the cash reserve requirement. [17] The very low cash ratio imposed on the monetary sector's eligible liabilities is not primarily intended to facilitate the operation of monetary policy and clearing banks are expected, in addition, to hold balances for settlement purposes. [18] Since November 1990 banks have been able to reduce their reserve holdings by up to 5% of the required minimum. [19] Although the main responsibility lies with the Bank Inspection Board, the Riksbank is involved in certain areas. [20] Only SIC participants and for the purpose of the smooth functioning of the interbank funds transfer system. The National Bank does not have supervisory responsibility for individual banks as such. [21] External audits of banks' EDP systems may be carried out at the request of the Bank of England. [22] CHIPS.

Source: Borio et al. (1991).

functioning of the financial system. In a few cases the bank has specific statutory responsibility for payment system matters, which may range from a general mandate to safeguard the system's efficiency and soundness (e.g. in Sweden) to duties in respect of individual arrangements (e.g. the operation of clearing houses in Italy). But central bank involvement typically depends more on historical tradition and the institution's perception of its proper sphere of action than on detailed statutory provisions (Table 4 above). That explains, for instance, the particularly active role played by the Banca d'Italia and the Banque de France, which consider it their task to improve the efficiency and stability of their domestic systems.

In all countries central banks issue currency and perform interbank settlement services. They also typically provide standing credit facilities.[18] Even within these functions, however, some distinctions are apparent. Settlement services can be on a continuous and/or discrete-time basis, depending on whether the settlement system is gross or net. Similarly, gross systems are normally associated with intraday ("daylight") credit facilities, which in most countries are simply an extension of existing overnight facility arrangements (see Section III). Overnight credit is collateralised. In most countries it is also subject to quantitative limits.

Central banks are actively involved in interbank clearing systems at various levels: ownership, operation, auditing, and setting and enforcing rules. They are also playing a growing role in the clearing and settlement of securities transactions. This may include the running of a book-entry system for government or private debt instruments (e.g. in the United States, the Netherlands and the United Kingdom) and/or the settlement of the payment leg of the transfers of securities on their books, normally through one of the domestic large-value funds transfer systems.

In view of their general responsibility for the stability of the financial system, many G-10 central banks are involved in the supervision of banks. But even if they are not, they are in a position to monitor the financial strength of the key providers of payment services and to help manage financial crises whenever they arise. This enables them to reduce the probability of an unexpected failure on the part of an institution and to assist in the management of the timing and resolution of financial distress in such a way as to minimise disruptions to the payment system, thereby

[18] In all countries central banks also have various discretionary means of regulating bank reserve positions. These are excluded from the analysis as they are less immediately connected with the functioning of the payment system.

helping to secure the necessary confidence in its operation. In some countries their responsibility goes even further. In Italy, Japan, the Netherlands and the United States the central bank may conduct separate audits of banks' Electronic Data Processing (EDP) systems; in Italy, Japan and the United States its supervisory role extends to other participants in the payment system (e.g. CHIPS in the United States).

II.
The nature of payment system risks

A taxonomy of risks

The discussion of payment system risks has tended to focus on interbank funds transfer systems since it is there that risks concentrate. It has also centred on the analysis of the risks connected with the execution of transactions at the expense of those related to the properties of the settlement medium. This approach can clearly be justified, because, as explained below, the credit and liquidity risks associated with settlement tend to be more difficult to monitor and control. At the same time, it is not possible to fully understand the various types of risk and their relationship without extending the analysis to the transactions which give rise to the funds transfers and to the risk properties of the settlement medium. It is only in this broader context, for instance, that the distinction between credit and liquidity risks or the significance of delivery-against-payment arrangements are fully apparent.

The transaction leading to a payment is typically a contract calling for some form of exchange between two parties (Diagram 3). One leg of the exchange is the payment itself ("payment leg"). The other can be the provision of a good or service or the transfer of ownership of a financial asset ("delivery leg"). It is also quite common for the other leg to consist of a transfer of (a stream of) funds. For example, two streams of funds are exchanged when the contract is a foreign exchange transaction (i.e. funds denominated in different currencies) or a loan (i.e. funds at different points in time). In principle, each exchange therefore involves risks for the counterparties (X, Y) and for any intermediaries taking part in the payment leg ("payment intermediaries") and in the delivery leg ("delivery intermediaries", such as securities depositories).

The counterparties face two fundamental types of risk: credit and timing risk. Defined broadly, credit risk is the risk of loss on outstanding claims on participants in the transaction. These are the counterparties themselves, the issuer(s) of the settlement medium (payment intermediaries) and, if any, the delivery intermediaries. Timing risk is the risk of the unavailability of *either* of the items exchanged at the time due. When the item in question is the settlement medium, this risk is known as "liquidity risk", which is the typical form of timing risk in payment arrangements.[19]

The distinction between credit and liquidity risk is important. Credit risk refers directly to the possibility of a loss, liquidity risk to that of a cash-flow shortfall.[20] The distribution of credit losses ultimately depends on court decisions which adjudicate between competing claims and take time to materialise. Liquidity shortfalls can appear suddenly and are determined by the technical arrangements for funds transfers. On the other hand, liquidity shortfalls may themselves be costly, resulting in relatively expensive borrowing, unprofitable asset sales or induced defaults on other contracts and even bankruptcy. They are, that is, themselves an important cause of *induced credit risk* (see below).[21] Similarly, while a liquidity shortfall in an exchange may arise because of a technical failure, it can also stem from the unexpected bankruptcy of the counterparty.

In any exchange there are at least three possible sources of risk, viz. any lag between the time the trade takes place and each of its two legs are performed (the two *"settlement lags"),* any lag between the completion of the two legs of the exchange *("asynchronous settlement")* and the possibility of default on the *settlement medium.*[22] All of these sources can give rise to credit risk and, in the absence of an unrestricted supply of funds to the counterparties, also liquidity risk.

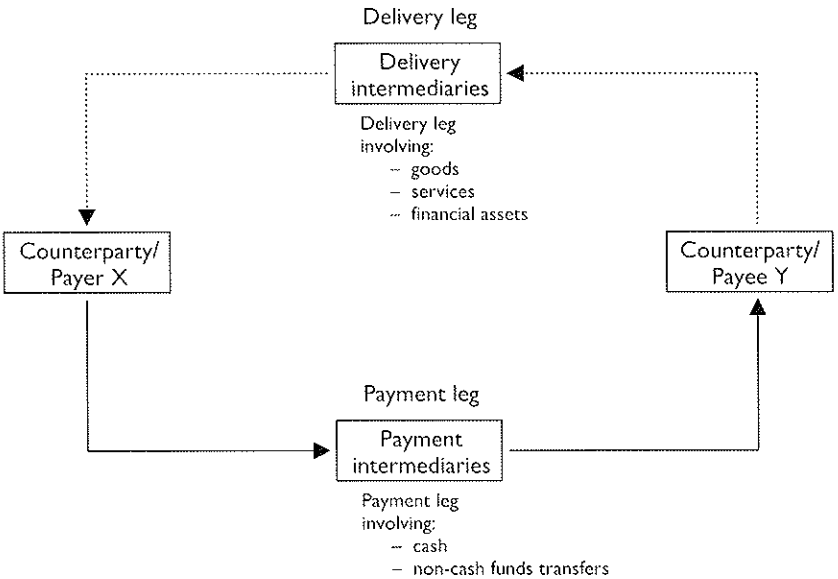
[19] There is no generally accepted term to refer to the timing risk of the non-cash leg of the transaction, although the term "liquidity risk" could in principle apply to it too. Often credit and liquidity risks are defined only in terms of counterparty risks, i.e. excluding risks on holdings of the settlement medium (e.g. BIS (1989b)).

[20] Sometimes credit and liquidity risks are defined as being mutually exclusive. If so, credit risk is defined as the risk that the counterparty may fail to settle for full value and liquidity risk as the risk that settlement of an obligation will be made at some date after the date due (e.g. BIS (1989b)). The definition used here is broader and highlights the fact that liquidity risk and credit risk refer to two quite distinct sources of problems: losses on contracts and disruptions in cash-flow management. This definition seems more appropriate for the purposes of the present analysis.

[21] "Timing risk" can also be quite costly when the shortfall pertains to assets or goods exchanged in the transaction.

[22] For simplicity, the possibility of default on the part of delivery intermediaries is disregarded for the moment.

Diagram 3
The structure of exchanges



The settlement lag creates the risk that the transaction may fail before either party settles its obligation. For example, for some reason the transaction may be cancelled or one of the two parties may default. One of the two parties would then suffer a loss if the terms on which it could replicate the transaction in the market had since moved against it, i.e. if the rate of exchange of the two items had worsened. This form of credit risk is known as *"forward replacement cost"*[23] risk. For example, the non-defaulting party would incur a loss if it was the buyer of a security whose market price had risen since the contract was struck.

When the settlement of the exchange is asynchronous, the party performing its obligation first runs the risk that the counterparty may fail to perform its own obligation. The non-defaulting party may receive only part or none of what is envisaged in the contract, thereby suffering a loss. This form of credit risk is known as *"principal risk"* (or "capital risk").

[23] See, for example, BIS (1989b). Forward replacement cost risk is also sometimes regarded as a form of "market risk" (e.g. OECD (1990)).

Even if the settlement of the exchange is synchronous (on a so-called "delivery-against-payment" (DVP) basis), its execution may simply shift the risk to another contract struck in order to allow the transaction to go through. This occurs when the payer borrows (from the counterparty or another agent) so as to be able to perform his payment obligation under the original contract. The implicit loan which would otherwise be involved in an asynchronous settlement is replaced by an explicit one. Put differently, the original asynchronous transaction is replaced by another asynchronous transaction, i.e. the "exchange" of two streams of funds at different points in time (the loan).

Even if there is no settlement lag and settlement is synchronous, the counterparty receiving payment would still be exposed to credit (and liquidity) risk if the settlement medium is subject to *default risk*.[24] While cash and central bank balances are risk-free in this sense, the liabilities of other payment intermediaries typically are not. Settling transactions in settlement media subject to default is therefore equivalent to an asynchronous exchange or a synchronous exchange supported by explicit borrowing. What varies is the terms on which the credit is extended (i.e. the type of claims exchanged) and, possibly, the distribution of exposures between the participants (Appendix II). The clearest example is that of an interbank transaction in which the payee accepts as settlement an increase in its correspondent balance with the counterparty, which is a kind of loan callable on demand.

The risks faced by the payment intermediary or intermediaries in the settlement of a transaction, including possibly the central bank, are essentially analogous to those run by the ultimate counterparties to the exchange (Diagrams 3 and 4). The reason is that each intermediary is engaged in a type of exchange: it receives funds (its liabilities are reduced) and makes funds available (its assets are reduced), albeit in relation to two different counterparties. As a result, it faces liquidity risk whenever it does not receive funds at the time due. It runs a credit (principal) risk when the settlement of the transfer is asynchronous, i.e. when it makes funds

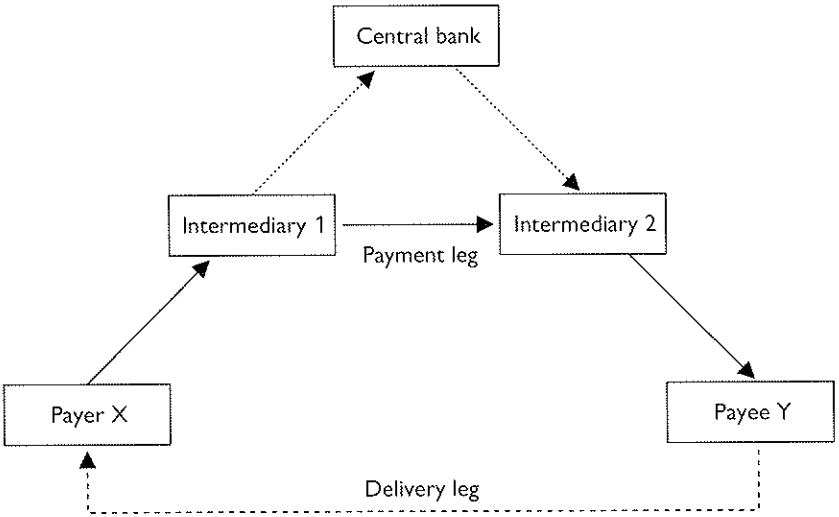
[24] Mutatis mutandis, the counterparty receiving delivery would face credit and timing risk if a delivery intermediary held the item exchanged on his behalf.

[25] This is true regardless of whether the underlying exchange giving rise to the funds transfer is synchronous.

[26] Under normal conditions, however, it would not face forward replacement cost risk as the rate of exchange of the two funds transfers is fixed.

Diagram 4

Risks in intermediated payments



Credit (principal) risk:
X vis-à-vis Y: transfer of funds before receipt of item
Y vis-à-vis X: transfer of item before receipt of funds
1 vis-à-vis X: transfer of funds to 2 without availability of funds in X's account
2 vis-à-vis 1: transfer of funds to Y without availability of funds in 1's account or before receipt of final funds from X on its central bank account
central bank vis-à-vis 1: transfer of funds to 2 without availability of funds in 1's account

Liquidity risk:
1 vis-à-vis X: if X does not make funds available at time expected
2 vis-à-vis 1: if 1 does not make funds available at time expected
Y vis-à-vis 2: if 2 does not make funds available at time expected

available to the next member of the chain (including the ultimate beneficiary) before receiving funds from the previous member (including the ultimate payer).[25] It shifts risk to another party when it borrows explicitly in order to execute the two legs of the funds transfer obligations simultaneously. It assumes credit risk when accepting a risky settlement medium.[26]

The fundamental types of risk involved in the settlement of sets of transactions are the same as those just described with reference to individual transactions. The additional question is how different procedures

for their aggregation and performance affect the risks faced by participants. It is in this context that a number of elements acquire particular significance: whether the underlying exchanges are settled separately in specific sub-systems or, as most commonly occurs, the payment legs of a multitude of transactions converge in certain funds transfer systems; the methods of aggregation and resolution of the obligations in the delivery and payment legs respectively; and, in particular, whether the interbank funds transfer systems settle at discrete intervals on a multilateral net basis or on a continuous gross basis.

Revocability, conditionality, finality and the legal framework

So far the discussion of the distribution of the risks incurred by participants in an exchange has relied heavily on the notion of lags in the transfers of the items concerned. Time is indeed a key element for the analysis of risk, but risk also depends on other terms of the transactions.

Whether the agents facing credit risk in the exchange can obtain collateral is a case in point. Another important consideration is the ability to *revoke* payment or delivery orders before their execution or to make them *conditional* on a particular set of events. For example, a payment intermediary may agree to credit the beneficiary's account only on condition that the funds are received. Similarly, participants in an interbank funds transfer system may retain the right to revoke individual transfers before a cut-off time and the rules may be such as to make all orders conditional on final settlement. This gives rise to the notion of *finality,* often used to denote a payment or delivery which is irrevocable and unconditional. Part of the analysis of payment system risks is devoted to understanding how clauses such as conditionality, primarily aimed at safeguarding individual participants, may in fact have undesirable properties at systemic level (see below).

Finally, the precise allocation of losses among payment system participants and the risks to which they are exposed depend on the legal framework which governs the rights and obligations of the parties to the transactions. There may, however, be considerable *legal uncertainty* surrounding these rights and obligations and the enforceability of the contracts.[27] The revolution in payment services has dramatically enlarged the area of services governed by quasi-legal regulations and private agreements or contracts which are often not backed by a codified legal system

and are untested in the courts. The growing internationalisation of the systems has underlined complex questions of conflict of law.

This lack of clarity in the legal framework can be a source of risk in its own right to the extent that it creates uncertainty about, or leads to incorrect perceptions of, exposures to potential losses. The uncertainties surrounding the implications of bankruptcy law for both credit and liquidity risk are particularly relevant in this context. For example, contract netting schemes which are not legally robust can lead banks to underestimate their mutual exposures, lulling them into a false sense of security (BIS (1990b)).[28] As a result, the actual risks run could be significantly higher than assumed.

Individual risk, aggregate risk and systemic risk

For any given set of final transactions and value of financial and non-financial resources, payment system arrangements would in principle simply *redistribute* the risk of losses among economic agents. In other words, aggregate potential losses ("aggregate risk") would be independent of the mechanisms for the settlement of monetary obligations.[29] In the case of the forward replacement cost resulting from settlement lags, for example, the potential gain of one counterparty would be perfectly offset by the loss of the other.[30] In that of asynchronous exchanges or explicit borrowing in order to execute synchronous exchanges, the lender would simply absorb part of the losses which would otherwise have fallen on the original creditors of the bank. Even in respect of the choice of settlement medium (risky vs. risk-free) the effects would be purely distributional. For

[27] On the general issues, see Revell (1983), the Electronic Banking Committee of the Financial System Research Council (1988) and Vasseur (1989). On the United States, see Mengle (1988) and Scott (1988). For examples of some contentious cases, see Vasseur (1989) and Ballen and Diana (1991). On the legal questions concerning the responsibilities of carriers such as S.W.I.F.T., see Lingl (1981) and Etzkorn (1991).

[28] Depending on domestic legal arrangements, certain forms of netting (e.g. novation) may be legally more binding than others. There may also be a certain lack of clarity regarding the relationship between the obligations in interbank funds transfer systems and those in respect of the underlying contracts giving rise to the transfers. For instance, the interbank contracts may make banks liable only for their multilateral net balances and extinguish all gross and net bilateral positions. That still leaves open the question as to how these obligations stand in relation to those attaching to the gross amounts involved in the original transactions. Another potential source of difficulties is the application of "zero-hour rules" in certain jurisdictions, whereby all transactions entered on the day of the failure may be considered void.

[29] Appendix II analyses these issues in more detail.

[30] Moreover, the surviving party may in fact even stand to gain at the expense of outstanding creditors of the defaulting party since the market may move in its favour.

example, the counterparties to the transaction would reduce their exposure to credit risk at the expense of the issuer of the riskless claim (e.g. the central bank) to the extent that the latter increased the supply of riskless claims to participants by augmenting its holdings of risky assets, e.g. lending to the participants. If this lending was granted against collateral, risk would in turn partly be shifted to the general creditors of the borrower(s).

In practice, however, the conditions necessary for aggregate potential losses to be independent of the payment mechanisms do not hold. The real world is characterised by imperfect information regarding the parties involved in the process of exchange, both original counterparties and payment intermediaries. This limited information typically relates to their general financial condition, the quality of their investments, the use they make of the resources obtained through the process of exchange and even their identity. It is, after all, precisely this lack of information that lies at the origin of the acceptance of a specific settlement medium in the payment process, otherwise promises to transfer future real resources would do just as well.

Under these conditions it is no longer a matter of indifference how the process of exchange is organised. The form that counterparty exposures take, their degree of concentration within the system, how they are generated and controlled, who faces them and the mechanisms for the resolution of unexpected cash-flow shortfalls and defaults are all factors having a bearing on the aggregate losses incurred by participants. It is in such a world that even temporary failures to obtain funds can lead to permanent losses as agents act on the limited information available, that is, liquidity risk can generate credit risk.

The typical mechanisms are familiar. The difficulties in ascertaining the underlying creditworthiness of a counterparty that, for whatever reason, has problems in meeting or is unable to meet its payment commitments can increase total losses and possibly lead to its insolvency: rationing or the withdrawal of funds on call and an unwillingness to enter into further transactions may force the disposal of assets at distress prices, for less than what they would have earned if they had remained on its books. The financial linkages that exist between institutions and agents can spread localised shocks more widely, as other participants may in turn find themselves short of funds or face a decline in the value of their assets. Uncertainty regarding the size and distribution of the exposures compounds the problem as it tends to encourage the withdrawal from transactions.

The risk of the scenario just described, where the chain reaction through the system leads to a general financial crisis, is commonly known as *"systemic risk"*. It is primarily the real costs associated with a systemic crisis that explain public concern for the safety and soundness of the financial system in general, and the payment system in particular. And certain structural characteristics of payment systems suggest that the risks incurred in them could have particularly serious implications.

Firstly, payment system arrangements concentrate liquidity risk and typically also credit risk on a set of participants, viz. the providers of payment services.[31] Their task is precisely that of absorbing liquidity pressures by committing themselves to effect funds transfers. In the process, they also normally take on credit risks which would otherwise have been absorbed by their customers. This results in sizable intrasectoral exposures, which raise the potential for chain defaults among payment intermediaries.

Secondly, a good part of the risks involved in payment systems is associated with failures to *settle* transactions *("settlement risk")* i.e. with settlement lags and asynchronous settlement rather than with defaults on the contracts outstanding after settlement. The counterparties vis-à-vis which risks are incurred, therefore, are typically more unpredictable and information about them more incomplete and imperfect. An agent would normally know less about the creditworthiness of a counterparty in a market trade than about his own bank. Similarly, the credit risk run by a bank under competitive pressure to make funds available to the beneficiary before interbank settlement would be incurred vis-à-vis the sending bank with which the agent entering into the transaction with its customer happened to hold his account, an event hardly controllable by the receiving bank. As a result, the risks associated with settlement failures are as a rule more difficult to control than those outstanding after settlement. This is one important reason why much of the analysis of payment systems focuses on settlement risk.

Finally, disturbances that disrupt the payment system can have profound ramifications across the economy. Payment arrangements represent the connective tissue of all financial and real economic activity, as it is the ability

[31] The central bank can, of course, eliminate liquidity risk from the system by standing ready to supply the settlement medium without limit. This would, however, shift credit risk to the central bank, to a degree which would depend on the terms on which its funds were granted.

to settle transactions, and confidence that the counterparties will do likewise, that underpins it. Inevitably, therefore, payment arrangements can be a key channel for the transmission of shocks across institutions and markets even when they are not the original source. From this perspective, interbank funds transfer systems deserve particular attention, given that they lie at the heart of the settlement process.

III.
The management of payment system risks

The policy issues

As the fundamental policy concern in connection with payment arrangements is systemic risk, the rationale for the prudential supervision and regulation of payment systems is essentially the same as that for the prudential supervision and regulation of financial markets in general and of institutions providing liquidity services in particular.[32] For the same reasons, the overall impact of any policy specifically directed at payment arrangements partly depends on the other "lines of defence" set up to limit systemic risk.

The basic principle behind intervention in payment arrangements is that its benefits in terms of lower systemic risk should outweigh any possible costs in terms of an increase in the resources needed to provide payment services or output forgone as a result of a reduction in the overall volume of transactions. The degree of intervention by the authorities, notably central banks, is largely country-specific, depending on perceptions of costs and benefits which vary according to structural factors and historical experience.[33] However, the profound changes observed in financial markets around the world over the last two decades have raised the priority of risk reduction policies in many countries.

Three key structural developments explain this trend. Firstly, the rapidly increasing volume of transactions has put existing payment arrangements under growing strain. It has significantly raised the risks run by payment

[32] See, for example, Goodhart (1987), Marquardt (1987), Corrigan (1987), Guttentag and Herring (1988) and, specifically on payment arrangements, Board of Governors of the Federal Reserve System (1988).

[33] For different perspectives see, for instance, Padoa-Schioppa (1990) and Summers (1991).

system participants and shortened the time span in which they are incurred, often exposing the inadequacy of existing monitoring and risk control systems. Secondly, the spectacular growth of foreign exchange transactions in particular has highlighted the problems arising from the coexistence of separate sets of arrangements for the settlement of the two legs of the transactions, each governed by its own rules and legal framework. Arrangements which might otherwise have appeared to be adequate for purely domestic transactions have come under closer scrutiny. Thirdly, the increase in competition in the financial industry and in the provision of payment services, both within and across national borders, coupled with more sophisticated cash management by customers, has heightened the pressure on banks to accept risks. For example, banks have increasingly provided credit facilities as part of their payment services while customers now routinely expect to have funds available within the course of the day regardless of whether interbank settlement of the related transfers has been completed.[34] Against this background, episodes of financial distress such as the "Herstatt" crisis in 1974 and the stock market crash of 1987 have highlighted the importance of payment arrangements in the propagation of a financial crisis.

The policy response to these developments has proceeded primarily in four directions: raising private agents' awareness of payment system risks; reducing those forms of intervention which may provide perverse incentives for risk-taking while encouraging private sector arrangements designed to contain risks; adapting the legal framework to the new payment practices;[35] and strengthening international coordination with a view to dealing with the increasing internationalisation of financial markets.

The complexity of payment arrangements in modern-day economies has contributed to a selective approach to risk reduction. Attention has focused on areas where risks concentrate and where the potential

[34] Moreover, as the structure of domestic markets has become more heterogeneous because of greater freedom of entry, there has been a greater need to review traditional supervisory approaches based on relatively informal practices.

[35] For example, in the United States a Uniform Commercial Code has recently been adopted explicitly covering wholesale wire transfers (Article 4a); in the United Kingdom, a White Paper identifies a number of areas in which the law could be clarified and tightened (United Kingdom Treasury (1990)); at the international level, the United Nations has recently finalised a model law for international credit transfers (Heinrich (1991a)). For a summary of various international initiatives, see Heinrich (1991b).

systemic implications of payment disruptions have become more forcefully apparent. The rest of this paper considers three such areas: large-value interbank funds transfer systems, settlement of securities transactions and settlement of foreign exchange transactions.

In the case of large-value interbank funds transfer systems, the focus of the analysis is the payment leg of the transactions only i.e. the bottom half of Diagram 3, regardless of the type of underlying transaction giving rise to the payment. Particular attention is paid to the risks incurred by the payment intermediaries (box in Diagram 3 or Diagram 4). In the case of the settlement of securities or foreign exchange transactions, the focus of the analysis is the transaction itself. Particular attention is paid to the relationship between the delivery and payment legs and the risks incurred by the counterparties.

Large-value interbank funds transfer systems[36]

The key concern in large-value interbank funds transfer systems is the risk of a settlement failure (settlement risk). A settlement failure implies a liquidity shortfall for other participants (liquidity risk). It also typically involves a loss on outstanding contracts (credit risk), whose size and distribution depend on the structure of underlying obligations, the methods of dealing with the liquidity shortfall and legal arrangements.

The form that the settlement failure takes as well as the methods employed to prevent and manage it differ considerably between systems that settle at discrete times and on a continuous basis. Nevertheless, the conceptual framework outlined above points to a number of general observations that can help in guiding the assessment of risk management procedures in both types of arrangements.

One dimension along which to consider the systems is the extent to which they *concentrate credit exposures* on participants. Ceteris paribus, greater concentration can raise the disruptive potential of a failure.

A second, vital dimension is the extent to which the systems deal with the *problem of uncertainty* that lies at the heart of many of the systemic repercussions of a settlement failure: uncertainty about the extent to which cash-flow difficulties reflect latent solvency problems, about the

[36] An overview of the large-value interbank funds transfer systems of the G-10 countries can be found in BIS (1990a), which also includes further references for individual countries. Other useful sources of information are listed in the bibliography.

size and distribution of the underlying credit exposures, and about the impact of the failure on the transactions to which the funds transfers relate.

Three types of mechanism are important in this context. The first is information and monitoring systems aimed at identifying the exposures. The second comprises procedures which tend to reduce the volume of transactions affected by a settlement failure. The third, and most important, consists of those arrangements for decoupling the settlement failure of individual participants from that of the system as a whole. Such arrangements have the additional merit of permitting the de facto separation of pure liquidity from underlying solvency problems: the liquidity shortfall at settlement is resolved, leaving the underlying loss on contracts to be allocated at a second stage.[37]

A third dimension concerns the extent to which participants are provided with the necessary *incentives to monitor, limit and control the risks* they incur. Particularly important in this context is the extent to which the arrangements have inbuilt mechanisms for the resolution of a settlement failure or else rely on external support from the central bank.

Discrete-time settlement on a multilateral net basis

In systems settling at discrete intervals funds transfer orders accumulate until they are executed at a particular point in time. Settlement then takes place on a multilateral net basis, which means that for each participant incoming funds transfers are treated as cover for outgoing ones. The systems relieve banks of the need to have intra-settlement cover for their running transfer orders and concentrate liquidity pressures at the end of the cycle.

The credit risk involved in these systems results primarily from the existence of *settlement lags*.[38] Given a set of ultimate transactions, implicit intra-settlement borrowing and lending occurs between participating banks, their customers and the central bank. The precise distribution of the resulting credit risk depends on the timing and other terms of the funds

[37] This mechanism can be thought of as mimicking the effects of a closure of the institution outside trading hours.

[38] Consistently with the previous analysis, the term settlement lag is here used to refer to the lags involved in the settlement of the underlying transactions. This contrasts with much of the existing analysis of interbank settlement systems, where the term often denotes the lag between the transmission of the interbank funds transfer order and its completion (settlement).

transfers as well as on their relationship to the underlying contracts giving rise to the economic exchanges.

As might be expected, the evidence indicates that the credit risk tends to concentrate on participating banks. When the interbank transfers relate to transactions that the banks enter on their own behalf, the funds transfers are often one leg of an asynchronous exchange (e.g. the purchase of an asset or foreign exchange, the extension or repayment of a loan). When they relate to the provision of payment services to customers, banks have come under growing competitive pressure to make funds available to the beneficiary prior to interbank settlement. This practice is quite common, for instance, in CHIPS[39] and FEYSS.[40] More generally, banks often grant credit lines to major customers without apparently monitoring their intraday exposures because of the costs involved. In particular, standing credit lines are a typical feature of correspondent balances.[41]

The conjunction of the underlying credit exposures between banks with the concentration of liquidity needs at the end of the day underscores the potentially disruptive effects of a settlement failure. This is confirmed by simulation exercises, which, though mechanical, provide a rough quantitative idea of the repercussions. The simulations estimate the change in participants' net balance positions induced by the inability of one of them to settle. Knock-on effects can then be calculated given some assumptions regarding a critical deterioration that would in turn leave other participants unable to settle.

In one such exercise applied to CHIPS, the results suggest that failure to settle on the part of a large participant could have sizable and unpredictable effects (Humphrey (1986)).[42] On balance, even on relatively conservative assumptions, close to half of all participants could in turn be unable to

[39] In CHIPS, however, availability is conditional on final settlement. In general, the intermediary may of course be able to obtain a claim on an alternative asset to reduce its exposure.

[40] In CHAPS the rules make it inevitable that the intermediary will incur credit risk, since the banks have an obligation to make funds available to customers as the orders are sent through the system.

[41] There is ample anecdotal evidence that payment orders sent over the S.W.I.F.T. network are often automatically accepted, before the corresponding funds have been received.

[42] The analysis was specifically designed to deal with the method of resolution of settlement failures then used in CHIPS, i.e. deletion (see below). Nevertheless, it is also indicative of the kind of knock-on effects that might be expected on the basis of the original set of transfer orders. A recent study, following a similar methodology, found that in the case of the Italian netting system ("Compensazione Nazionale dei Recapiti"), the potential systemic problems were significantly smaller. See Angelini et.al. (1992).

settle, with as much as one-third of the total value of transfers remaining unsettled. The results tend to be insensitive to whether the institution assumed to fail is a settlement or non-settlement participant. They also indicate that the institutions affected can vary substantially depending on the day chosen for the exercise and that, because of the knock-on effects, even banks having no deals with the failing institution or in a net debit position vis-à-vis it could be affected. The significance of indirect exposures highlights the difficulties involved in, and the limitations of, credit assessments based on bilateral exposures.

One way of limiting settlement risk is through appropriate membership criteria and supervisory arrangements. In virtually all G-10 countries membership is limited to credit institutions (Table 5). In some cases, as in Italy, France and the United Kingdom, eligibility is also based on additional criteria such as specific capital and technical requirements. In certain cases, notably in CHIPS, a degree of discretion is retained so as to ensure that access is restricted to participants regarded as financially sound. In at least one country, the United Kingdom, restrictive membership criteria coupled with regular supervision have long been the main safeguard against settlement risk.

A second mechanism is real-time monitoring facilities. These can help in the early identification of potential problems and facilitate liquidity management, particularly when they permit the centralised monitoring of all the participants' positions. Real-time monitoring is possible in about half of the systems considered.

A third mechanism consists of bilateral and multilateral caps on the participants' net positions, which automatically limit the interbank settlement exposures incurred within the systems.[43] Such caps are relatively rare, being operative only in CHIPS, FEYSS and, since late 1992 and purely on a bilateral basis, CHAPS (Table 5). Their main drawback if that they may either be circumvented, via settlement instructions sent through other systems, or lead to delayed or refused execution of customers' orders, which generates litigation risk for banks and may have knock-on effects elsewhere in the financial system.[44]

[43] Caps may be somewhat misleadingly referred to as "credit limits", as in CHIPS. As discussed earlier, and explained in more detail in Appendix III, there is no necessary correlation between participants' net balance position and their credit exposures. The net balances can serve as a proxy under certain conditions.

[44] From this perspective, they can generate problems akin to those of gross settlement systems (see below).

Table 5

Risk management in selected discrete-time net settlement systems

	Belgium		Canada	France				Germany
	C.E.C.	Manual clearing	ACSS	Clearing house	SAGITTAIRE	Ordinateur de compensation	SIT (planned)	Daily clearing
Membership criteria								
type of institution	*	*	*	*	*	*	*	*
other[1]			*		*	*	*	
Control of net balances								
real-time monitoring							p	*
bilateral debit caps							p	
multilateral debit caps								
Resolution of settlement failures								
no rules								
conditional orders:								
unwind[2]	*	*	*	*	*	*	*	*
unconditional orders:								
loss-sharing								
collateral								
central bank guarantee								

Table 5 (continued)

Risk management in selected discrete-time net settlement systems

	Italy			Japan		Nether-lands	United Kingdom		United States
	National clearing	ME	SIPS	Zengin	FEYSS	BCH - S.W.I.F.T.	Town clearing	CHAPS	CHIPS
Membership criteria									
type of institution . . .	*	*	*	*	*	*	*	*	*
other[1]	*						*	*	
Control of net balances									
real-time monitoring .	*	*	*	*	*			*	*
bilateral debit caps . .					*			*	*
multilateral debit caps	p							p	*
Resolution of settlement failures									
no rules							*	*[3]	
conditional orders:									
unwind[2]	*		4	5		*			
unconditional orders:									
loss-sharing				*	*[6]				*
collateral				*					*
central bank guarantee				*					

* = yes; p = planned; blank = no.

[1] Including specific capital and technical requirements. [2] The banks can repeat the clearing process (partially or totally) by re-entering orders until the resulting balances can be settled. [3] All orders are unconditional and irrevocable. [4] The application of bilateral novation at the end of the day allows banks to consider their end-of-day bilateral positions as final. [5] Unwind is not possible because the contracts are novated, i.e. gross and net bilateral obligations extinguished. [6] Any credit losses on uncollateralised credit are covered by the loss-sharing agreement.

Ultimately, the best safeguard against settlement risk is mechanisms aimed at ensuring that the systems can settle even in the face of failure to do so by individual participants.[45] These arrangements typically pool the liquidity risk, allocating the unsettled balances according to a pre-established rule ("loss-sharing arrangements"), and generally involve the pre-posting of collateral and/or a central bank liquidity guarantee.

At present, only three systems include these safeguards: CHIPS, Zengin and FEYSS (Table 5). The systems rely on loss-sharing agreements,[46] which in the case of CHIPS[47] and Zengin are backed by pre-posted collateral. In addition, in Zengin the central bank stands ready to ensure settlement on the understanding that any losses in excess of the posted collateral will subsequently be reimbursed by surviving participants.

The rest of the systems are "open-ended", in the sense that none has inbuilt mechanisms to ensure that the original orders are settled. Town Clearing and CHAPS do not lay down any specific rules for the resolution of a settlement failure. The remainder rely on clauses making transfer orders conditional on successful settlement and allowing the order flows to be adjusted ex post until sufficient funds are available to complete the recalculated settlement ("unwinding"). These procedures can take many forms: the cancellation of the excess orders of the defaulting bank, the exclusion of its orders from settlement ("deletion") and, in principle, the repetition of the daily clearing process ex novo, possibly after its postponement.

Open-ended systems, even those relying on conditional orders, leave unresolved the basic problem of the resolution of the original transfer instructions and do little to tackle the uncertainty that is at the root of systemic difficulties. The protection afforded by the conditionality clause, for instance, is largely illusory. The clause may encourage banks to be less inclined to operate on the assumption that the orders will indeed be

[45] Systems with this property are sometimes said to provide "settlement finality". This is because, if the mechanisms are successful, all the original transfers are irrevocably executed.

[46] The FEYSS rules state simply that the shortage of liquidity should be absorbed by the banks with a bilateral net credit balance vis-à-vis the defaulting party in order to avoid an unwinding. There is, however, no clear pre-established rule regarding the distribution of the burden (Kamata (1990a)).

[47] Specifically, in the event of a participant's default, each CHIPS participant is required to pay an additional settlement obligation (ASO) based on its maximum exposure to the failed institution on the day the failure occurs. Coverage is provided through the pre-posting of collateral by each participant equal to its largest potential ASO. The rules are thus designed to ensure settlement in the event of the default of the participant with the single largest net debit position.

completed, and hence to be more careful about their liquidity management. It may also be of some use to individual institutions. Yet, it still implies a liquidity shortfall at the level of the system and leaves banks open to the risk of litigation for any cancellation or delays in executing customers' orders. Above all, it does not help to decouple liquidity from underlying solvency concerns and provides little assurance as regards the final outcome of the process and the resolution of the transactions that underlie the funds transfers. Indeed, the unwinding of a large-value funds transfer system can in turn lead to the unwinding of some of those transactions and disrupt other settlement systems, such as those for securities transfers (see below).

Settlement systems which are open-ended also appear to be inadequate from the point of view of providing incentives for prudent risk management. The reason is that they tend to shift the risk onto the central bank – which may feel under inordinate pressure to grant the necessary liquidity to ensure settlement – without providing it with the means to control its exposure: the exposure does not take the form of an actual extension of credit on specific terms but, rather, of a potential extension of uncertain size and distribution.[48] The problem exists regardless of whether orders are conditional or, as in the case of CHAPS, unconditional and irrevocable (Allsopp (1990)).

Awareness of the limitations of existing risk management procedures in net settlement systems has been increasing in recent years. The history of risk reduction policies in CHIPS is perhaps the best illustration: in 1981 the system moved from next-day to same-day settlement, largely to reduce risks associated with third-party transfers; in 1984 bilateral caps on net debit positions were introduced; in 1986 multilateral caps were implemented; and finally in October 1990 loss-sharing arrangements were set up with a view to ensuring settlement. Steps are also envisaged or being studied in the other G-10 countries. For example, caps are planned in the National Clearing in Italy, in CHAPS in the United Kingdom and in SIT, the planned system in France. Moreover, in Canada work is under way to introduce a system which would include all the key risk management mechanisms, notably those aimed at ensuring settlement of uncovered orders. Finally, in some countries the introduction of gross settlement

[48] This pressure may be particularly strong when settlement occurs at the end of the day, when other markets may be closed.

systems is seen as obviating some of the problems associated with discrete-time net settlement.[49]

Continuous gross settlement systems

In continuous gross settlement systems funds transfers can be completed at any time during operating hours. They can be settled individually and sequentially on a gross basis. In contrast to discrete-time net settlement systems, settlement is therefore spread over the day and incoming payments are not treated as cover for outgoing ones. As a result, settlement lags can be shortened at the cost of greater intraday pressures on the liquidity position of participants.

The higher intraday pressure on cash-flows can in principle be resolved in four ways. First, the traffic of transactions executed through the system may be reduced. Second, the amount of *explicit* borrowing may be increased. When the additional borrowing is from the central bank rather than from other banks, as is generally the case, the value of available settlement balances in the system is raised commensurably.[50] Third, interbank settlement may be slowed down by delaying the entry of the transfer orders. Fourth, the lag between advance fund availability to customers and interbank settlement may be shortened.

Continuous gross settlement systems may lead to a reduction in the concentration of credit risk on participating banks. Part of the intraday credit risk is transferred to the central bank to the extent that participants as a whole increase their holdings of settlement balances.[51] Part is shifted onto customers to the extent that the transmission of customer transfers is delayed during the day until sufficient funds are available for their execution.

The more important potential benefit of these systems, however, is that they can help to make a part of the credit exposures more transparent and to reduce the volume of transactions subject to the uncertainty of unwinding provisions. They can thereby contribute to a better

[49] There are plans to implement the changeover from next-day to same-day settlement in the Zengin system in Japan in March 1993. This would, inter alia, reduce the inevitable credit risks incurred by banks vis-à-vis their customers given that banks are under an obligation to make funds available to customers as the interbank orders are transmitted.

[50] Additional settlement balances can also be acquired through the sale of assets to the central bank.

[51] As mentioned above, the use of collateral by the central bank in turn shifts the risks to general creditors of the bank.

management of risk. At the root of the potential benefits is the shortening of the settlement lag and the sequential completion of transfers.

The shortening of the settlement lag imposes a need for intraday cover for funds transfers. In the absence of unlimited credit availability, this calls for the installation of appropriate monitoring facilities which would otherwise be unnecessary. Banks should be able to track their credit facilities vis-à-vis the central bank or other banks to make sure that sufficient funds can be obtained to effect the transfers. In contrast to discrete-time settlement systems, real-time monitoring is essential (Table 6). This can contribute to a better awareness and identification of intraday credit risks by all the parties concerned.

The shortening of the settlement lag also permits the substitution of explicit lending for implicit lending: continuous systems, for instance, can more easily underpin DVP mechanisms, which eliminate the lag between settlement legs of trades (see below); they can also limit advance funds availability to customers by speeding up interbank settlement. As examined above, this substitution tends to shift credit risk to those parties that are in a better position to manage it: the agent entering into the original trade need not be concerned with the identity of the occasional counterparty; the receiving bank need not consider the identity of the sending bank, which is largely outside its control. In both cases credit risk is taken on by those parties with presumably better information about their borrowers, i.e. those deciding to arrange the necessary credits to the trader and sending bank respectively. This may be one reason, for instance, why membership in continuous gross systems is typically wider than in discrete-time systems (Table 6).

Since transaction settlement is individual and sequential, continuous systems make it easier to ensure the unconditionality and irrevocability, i.e. finality of settlement during the processing cycle. This stands in sharp contrast to open-ended discrete-time settlement systems, where the resolution of all the transfers is interlinked and uncertain, as there can be no guarantee of their completion until settlement. It also removes the lingering doubts that attach to discrete-time arrangements designed to ensure settlement, as they cannot generally do so under all circumstances. The disruptive implications of a settlement failure can thereby be circumscribed. For example, continuous settlement systems can be particularly useful in avoiding unwinding in securities settlement. As a result, forward replacement cost risk is significantly reduced.

Table 6

Risk management in selected continuous gross settlement systems

	FR	DE	IT	JP	NL	SE	CH	US
	TBF (planned)	CB Express	BISS	BOJ-NET	CB Current Account	RIX	SIC	Fedwire
Membership								
banks	*	*	*	*	*	*	*	*
others		*		*	*	*	*1	*1
Control on orders								
real-time monitoring	*	*2	*	*	*	*	*	*3
revocability				*4	*4		*	
Resolution of uncovered orders								
rejection		*	*	*	*5			3
queuing to end of day	*						*	
Standing central bank daylight credit facility[6]								
available	*	*7	*7		*7	*7	*7	*
ceiling	*		*		*			*
collateral:								
full		*	*8		*		*	
partial	*					*		3
priced	9	9	9		9		9	p[10]
Intraday interbank credit market				*				

* = yes; p = planned; blank = no.

[1] Only government entities. [2] System facility only for the central bank. [3] Real-time monitoring is used only if the sending institution is considered to be in financial distress. In this case payment instructions that would exceed the caps are rejected. At each Reserve Bank's discretion institutions experiencing financial difficulties may be extended central bank credit if it is fully collateralised. Compliance with net debit caps by healthy institutions is monitored ex post. [4] Only for the subset of orders which is settled at the designated times of the day. [5] Orders which are settled at a pre-designated time can be rejected only at that time. [6] In many countries central banks may supply bank reserves on a routine basis during the day through their money market operations. [7] Arrangements for daylight overdraft facilities are basically the same as those for standing overnight credit facilities. See also footnotes to Table 4. [8] Although the cover is defined in terms of non-negative reserve balances, banks can borrow to replenish these balances during the day. [9] Borrowing charges are typically calculated on the debit balance at the end of the business day. See also footnotes to Table 4. [10] In October 1992 the Federal Reserve announced the introduction of a fee for daylight overdrafts that occur in the reserve and clearing accounts of depository institutions. The first phase of pricing – 10 basis points of an annual rate – will go into effect on April 14, 1994. The fee will rise to 20 basis points one year later and to 25 basis points one year after that.

All this in no way implies, however, that settlement risk is absent. Unsettled balances can accumulate during the day if banks delay the entry of transfers or are unable to execute them as expected.[52] Sufficient settlement balances, well-developed intraday borrowing facilities and procedures for the management of the traffic of orders[53] are indispensable for the smooth running of the systems and in order to avoid bottlenecks. Otherwise, failure by a large participant to carry out its payments because of a lack of funds could have knock-on effects on other participants, possibly leading to a generalised payment gridlock with potential systemic consequences. This would be true regardless of whether the failure to settle reflected cash-flow mismanagement or underlying solvency problems.

Awareness of such potential settlement risk was an important factor behind the inclusion of a queuing mechanism in the SIC system in Switzerland. In this case payment orders which cannot be settled immediately when entered are not rejected but held pending in a queue file until sufficient funds have accumulated in the sending bank's account. Although there is no queue management facility since all transactions are processed on a first in, first out basis, banks can manage their queue of outgoing payments by cancelling queued orders and resubmitting them. The major advantage in terms of liquidity risk control stems from the fact that each participant has real-time access to all data relating to its account, including settled and queued incoming and outgoing funds transfers. The disadvantage is that to the extent that the receiving bank acts on the assumption that pending orders will indeed be executed (e.g. by paying out funds to customers), knowledge of queued messages can lead to interbank exposures analogous to those arising in discrete-time settlement systems.[54] Similarly, the ability to cancel messages can have potentially analogous

[52] If the settlement lag is defined as the lag between transmission and settlement of interbank payment orders, settlement risk is eliminated *by definition* in those gross systems where only payments orders with cover are transmitted and settled in real-time (no queuing exists). See Angelini and Giannini (1992) for a classification and analysis of gross systems based on this definition.

[53] For example, in TBF, the planned French system, an automatic centralised procedure (called "optimisation") would run three times a day so as to maximise the number of queued orders executed given the available cover.

[54] The provision that the initiating bank can cancel pending outgoing payments was introduced to discourage the practice of acting on the assumption that the orders would necessarily be executed. Banks can, of course, control such exposures by setting internal limits for each customer and sending bank.

consequences to revocability and conditionality provisions in those systems.[55]

In the initial period of its operations episodes of incipient gridlock in SIC were not infrequent (Vital and Mengle (1988) and BIS (1990a)). Participants, however, have adjusted to the system by spreading payment orders over the day and by splitting up large payments.[56] Nevertheless, queued payment orders are regularly deleted during processing at the end of the day, which may prevent the settlement of other participants' orders and result in corresponding interest claims for default.

None of the continuous settlement arrangements has liquidity-pooling and loss-sharing schemes to insulate the system as a whole from the settlement failure of individual participants. In principle, such schemes could be designed for the payment orders queued in the systems, where queuing facilities exist. They would not be feasible in their absence, since they would call for the sharing of the risks connected with the orders not entered in the system.[57] These orders would typically be unknown to other participants and failure to execute them would mainly affect the counterparties to the underlying transactions giving rise to the payments. The absence of mutualisation schemes in real-time gross settlement systems probably reflects the view that the traffic of orders handled, in conjunction with the other risk management features, does not warrant their introduction.[58]

The incentive for participants to manage risk depends in no small measure on the terms on which the intraday lending required for the running of the systems is granted. In virtually all cases, that lending is provided by the central bank, suggesting that its availability and relatively favourable conditions make interbank credit unnecessary, given also the

[55] In BOJ-NET orders can be entered for settlement at a designated time rather than on a real-time basis. Since at settlement incoming payments are regarded as cover, however, BOJ-NET is in effect a mixture of a gross and a net settlement system. According to survey evidence, almost 98% of all transfers are for settlement at a pre-specified time, of which about two-thirds at cheque-clearing time (1 p.m.) and the rest at the close of business (3 p.m.) (Kamata (1990a)). In the Netherlands part of the gross system's transfers are also revocable because of certain institutional peculiarities connected with the interaction between the coexisting net and gross systems (BIS (1990a)).

[56] In addition, since mid-1989 the three largest banks have relied on informal payment netting arrangement on a limited scale.

[57] Refraining from entering uncovered payment orders would be the only alternative available to the sending bank.

[58] Their implementation may also be more difficult in real-time gross settlement systems, which are generally open to a much larger number of participants.

existence of alternative settlement procedures, the demand for the system's usage and reserve requirement arrangements. An intraday interbank market has in fact developed only in Japan, where no central bank daylight standing credit facilities are available. Elsewhere, the facilities are limited by ceilings and/or by the eligible collateral posted by the institutions. The daylight credit is, however, effectively granted at a zero price, often because only the amount outstanding at the end of the day is turned into an overnight loan. Recognition of the importance of the terms on central bank lending has led to their tightening in some of the existing systems. In the United States, in particular, a risk reduction programme launched in 1986 has introduced self-imposed caps on the use of daylight credit from the Federal Reserve,[59] which is not collateralised, and envisages the pricing of overdrafts beginning in April 1994.

There is a growing consensus, particularly among central banks, on the benefits that continuous gross settlement systems can yield in terms of risk management. Provided that the terms on which central bank lending is granted are sufficiently prudent, the systems are seen as a way of making exposures both more transparent and controllable.[60] A continuous gross settlement system is due to start operations in France in 1993 (TBF) and its possible introduction is under study in the United Kingdom and Belgium. Moreover, continuous gross settlement systems have been endorsed in a recent report (1992) by the Ad hoc Working Group on EC Payment Systems to the Committee of EC central bank Governors,[61] which addresses the key issues raised by the completion of the Single Market and the implementation of Economic and Monetary Union in the field of payments. Besides recommending "co-operative oversight of payments systems in the EC countries", the report calls for "minimum common features" for all interbank large-value funds transfer systems, which "should include, whenever appropriate, use of gross settlement systems".[62]

[59] The cap system offers several options to participants. If a bank's daily use of intraday credit is below a certain level it is not required to file for a cap. If banks do file, compliance is generally voluntary, although repeated offenders and institutions of weak financial standing are placed on an electronic monitor, which prevents the caps from being infringed. In December 1989 the average daily value of daylight overdrafts extended by the Federal Reserve for funds transfer activity over Fedwire amounted to US$ 67 billion (total credit extension for funds and book-entry securities transfers amounted to US$ 125 billion; see below).

[60] See, for example, Angell (1992), Leigh Pemberton (1992), and Padoa Schioppa (1992a).

[61] See Committee of Governors of the Central Banks of the Member States of the European Community (1992b).

[62] The Report also recommends that "preparatory work on the large value interbank payment system required for a successful start of stage three of EMU needs to begin in the near future".

The settlement of selected financial transactions[63]

There are strong similarities in the analysis of the risks involved in the settlement of securities and foreign exchange transactions. In both cases the object of the analysis is the transaction itself (Diagram 3, page 25). Therefore, the main types of risk considered are the forward replacement cost and liquidity risks associated with the settlement lag and the principal and liquidity risks arising from the asynchronous completion of the two legs. In addition, because by far the most important risk incurred by the counterparties in both cases is the principal risk, DVP mechanisms play a prominent role, as these are designed to ensure that final delivery occurs if and only if final payment takes place.

The main differences in the two cases stem from the nature of the transactions. In particular, the two legs of a foreign exchange transaction are themselves payment legs, each denominated in a different unit of account. In the absence of special arrangements, two domestic payment systems are inevitably involved. This highlights issues relating to the coexistence of different legal and regulatory frameworks and the need for international cooperation.

The settlement of securities transactions

The adequacy of existing settlement arrangements for securities trades has received growing attention as a result of the surge in the value of securities transactions, both within and across national borders (Tables 7 and 8), and episodes of major price instability, such as the global stock market crash of October 1987.

A key objective of recent policy initiatives has been to eliminate the principal risk incurred by the counterparties to the transactions by introducing DVP mechanisms (Table 9).[64] The insulation of the counterparties generally shifts credit risk elsewhere: in order to facilitate settlement, for instance, some systems may incorporate cash and securities borrowing facilities (e.g. Euroclear and Cedel), or rely on central bank daylight credit

[63] This paper does not consider the risks involved in the settlement of derivatives such as futures and options. Risk management procedures in exchanges for derivatives are typically highly developed. For an interesting analysis, see Parkinson (1990).

[64] Note that even if a DVP mechanism is in place between direct participants in a securities settlement system, transfers between direct participants and third parties (their customers) may not receive such protection.

Table 7

Indicators of trends in turnover on securities markets

As a percentage of GNP

	United States	Japan	Germany	France	Italy	United Kingdom
Bonds						
1975	73.6	8.0	4.4	1.8	n.a.	35.5
1980	125.6	25.9	4.4	2.3	2.5	35.6
1985	427.6	316.9	13.9	15.7	3.2	39.7
1990	451.8	276.7	37.1	47.5	99.3	95.5
Equities						
1975	11.2	13.7	4.4	2.1	n.a.	8.1
1980	19.1	18.8	3.4	2.0	6.8	6.6
1985	34.1	32.2	19.5	3.3	13.5	15.0
1990	36.1	61.4	37.5	10.2	15.7	55.3
Total						
1975	84.8	21.7	8.8	4.0	n.a.	43.6
1980	144.7	44.7	7.7	4.3	9.3	42.2
1985	461.7	349.0	33.3	19.1	16.7	54.7
1990	487.9	338.2	74.6	57.7	115.0	150.8

Source: National data.

(e.g. Fedwire). However, as noted above, the shift from implicit to explicit lending should in principle allow for a better distribution and management of the risk.

DVP can be achieved by settling irrevocably and simultaneously both legs of the transactions on a gross basis. In this case settlement can take place either continuously during the day (e.g. Fedwire) or in batch mode at a particular time (e.g. Euroclear and Cedel). An alternative, and more common, procedure is to attempt to achieve DVP while still relying on netting arrangements so as to economise on liquid balances and/or securities inventories. In this case the value of all incoming and outgoing payments is offset for each participant, whereas his deliveries and receipts of securities may be netted per type of security (e.g. NBB Clearing) or all processed jointly in batch mode (e.g. Kassenverein, SEGA).[65] Final settlement of the two legs then takes place only once the system has verified

[65] A short time lag is typically provided for participants to put up the net funds due and for securities to be made available.

Table 8

Indicators of cross-border securities transactions[1]

As a percentage of GDP

	United States	Japan	Germany	France	Italy	United Kingdom[2]
Bonds						
1975	2.3	0.6	3.6	n.a.	n.a.	n.a.
1980	5.8	4.8	5.5	n.a.	n.a.	n.a.
1985	31.3	53.7	24.7	16.6	n.a.	352.3
1990	81.3	104.5	43.2	36.9	n.a.	614.3
Equities						
1975	1.8	0.9	1.6	n.a.	n.a.	n.a.
1980	3.4	2.2	2.0	n.a.	n.a.	n.a.
1985	5.1	6.7	9.2	4.8	n.a.	15.2
1990	11.2	14.1	14.3	16.3	n.a.	75.8
Total						
1975	4.2	1.5	5.1	n.a.	0.9	n.a.
1980	9.3	7.0	7.5	n.a.	1.1	n.a.
1985	36.4	60.5	33.9	21.4	4.0	367.5
1990	92.5	118.6	57.5	53.3	26.6	690.1

[1] Gross purchases and sales of securities between residents and non-residents. [2] The relatively large figures for the United Kingdom – also in comparison to turnover on domestic securities markets in Table 7 – reflect active trading by UK residents in foreign securities.

Source: National data.

that all net debit positions for the securities and funds have been covered. With the exception of Euroclear and Cedel, the payment leg is settled through a large-value funds transfer system which also handles other transfers.

An intermediate mechanism similar to DVP is the so-called assured payment (e.g. CGO). In this case the delivery of securities automatically generates an irrevocable commitment from the buyer's bank to make payment to the seller's bank at the end of the settlement cycle of the funds transfers. This procedure can be employed when the securities transfers are executed on a continuous gross basis while the funds transfers are completed at the end of the day on a net basis through a large-value system. The buyer's bank, which assumes the principal risk, can normally manage it by taking a lien on the underlying securities.

Even if the final settlement of the two legs of a trade takes place simultaneously, the settlement lag exposes counterparties to forward

replacement cost and liquidity risks. Forward replacement cost risk can be particularly important when prices exhibit high volatility, such as during episodes of market stress. During the stock market crash of 1987, for instance, price declines of the order of 25–35% between trade and settlement date were not uncommon.

Settlement lags have traditionally been rather long in securities markets, reflecting the need for trades to be matched and confirmed, for paper certificates to be exchanged and for payments to be collected. When settlement takes place at fixed dates only once a month ("account settlement procedures", e.g. Italy) settlement lags are dependent on the date on which the trades are struck. The practice of settling on a rolling cycle generally reduces the average settlement lag, although the standard lags remain considerable in many cases (Table 9). The speeding-up of the delivery leg, notably through the setting-up of central securities depositories and book-entry systems, together with improved technology for trade matching and confirmation, are the main ways of shortening the settlement cycle.

The settlement lag gives rise to the risk of a settlement failure. In systems that settle trades on a gross basis the rejection rate of uncovered trades may be significant given the pressures on the liquidity and inventory positions of participants unless sufficient credit is available (e.g. Fedwire).[66] In extreme cases gridlocks could occur. In systems relying on the netting of funds and/or securities a settlement failure typically results in the unwinding of some or all of the transfers of the defaulting participants and, possibly, in the postponement of the whole settlement until the following day (Table 9). As in large-value funds transfer systems, the application of unwind clauses generates uncertainty and can lead to considerable disruption.

The origin of the failure can lie within the system for the settlement of securities, as when a participant is unable to honour his commitments. It may, however, also lie outside, in a failure to settle other transactions in a large-value system through which the funds transfers are executed. For example, an unwinding in a large-value system can be the shock which leads to the unwinding of the securities trades. Insulation from such external shocks can be secured through intraday finality of the payment leg of the

[66] In December 1989 the average daily value of daylight overdrafts for book-entry securities transfers amounted to about US$ 60 billion.

Table 9

Selected features of securities settlement systems

	Belgium	Canada	France		Germany	Italy	Japan
	NBB Clearing	CDS	Saturne	RELIT	DKV	Liquidazione dei Titoli	BOJ-NET
Type of securities							
debt instruments	*	*	*	*	*	*	*
equities		*		*	*	*	
Participants							
banks	*	*	*	*	*	*	*
other financial institutions	*	*	*	*		*	*
Standard settlement lag (days)	3	5	1[1]	5	2	2/3/15–45[2]	5–10
Settlement of the payment leg							
default-free medium	*	*	*	*	*	*	*
specific to the system							
via LVFTS	*	*	*	*	*	*	*
finality[3] (intraday I/end of day E)	E	E	E	I[P]	I	I	I
on a net (N)/gross (G) basis	N	N	G	N	N	N	[4]
Settlement of the delivery leg							
default-free depository	*		*			*	*
book entry	*	*	*	*	*	*	*
on a net (N)/gross (G) basis	N	G	G	[5]	[6]	N	[4]
Linkage of the two legs							
synchronous settlement (DVP)	*		*	*	*	*	p
securities borrowing facility	*		[7]	[5]	*		
cash credit facility	[8]	[8]	[8]	[8]	[8]	[8]	[8]
ceilings/collateral							
asynchronous settlement		*					
securities first		*					
third-party cash guarantee (AP)		*					
Resolution of settlement failure							
rejection/queuing of orders		*					*[9]
partial unwind of deliveries	*		*	*	*		*[10]
system guarantees						*	
loss-sharing		*				*	
collateral/guarantee fund		*					

Table 9 (continued)

Selected features of securities settlement systems

	Netherlands	Sweden	Switzerland	United Kingdom		United States		International
	Effecten-Clearing	VPC	SEGA	CGO	TAURUS[p]	Fedwire	DTC	Cedel/Euroclear
Type of securities								
debt instruments	*	*	*	*	*	*	*	*
equities	*	*	*				*	*
Participants								
banks	*	*	*	*	*	*	*	*
other financial institutions	*	*		*	*		*	*
Standard settlement lag (days)	7	3	3	1	3/10[11]	0	4/5	0–5
Settlement of the payment leg								
default-free medium		*	*	[10]	[10]	*		
specific to the system	*			*				*
via LVFTS		*	*		*	*	*	
finality[3] *(intraday I/end of day E)*		I	I	E	E	I	E	
on a net (N)/gross (G) basis	N	N	N	N	N	G	N	G
Settlement of the delivery leg								
default-free depository				*		*		
book entry	*	*	*	*	*	*	*	*
on a net (N)/gross (G) basis	N	G	G	G	G	G	G	G
Linkage of the two legs								
synchronous settlement (DVP)	*	*	*			*	*	*
securities borrowing facility								*
cash credit facility	*	[8]	[8]			*[8]	[8]	*
ceilings/collateral	*							*
asynchronous settlement				*	*			
securities first				*	*			
third-party cash guarantee (AP)				*[12]	*[12]			
Resolution of settlement failure								
rejection/queuing of orders								*
partial unwind of deliveries		*	*				*	
system guarantees	*							
loss-sharing								
collateral/guarantee fund	*				*			

* = yes; p = planned; blank = no.

[1] Standard practice for Treasury bills traded on secondary market; longer lags for grey market trades. [2] 2 days for Treasury bills, 3 days for bonds, monthly settlement on specific days (lag between 15 and 45 days) for equities. [3] I = intraday; E = end-of-day. [4] System allows for gross continuous (securities and cash) and net settlement of trades. [5] Only for sub-system handling broker-to-broker trades. [6] No formal netting, but all trades are settled jointly during batch program. [7] Not through the system; sellers of securities can borrow over the counter. [8] There are no specific facilities but participating banks can draw on standard (standing) credit facilities at the central bank. [9] For real-time transfers. [10] For batch/net transfers. [11] Initially ten days, then three. [12] Intraday claims on guarantor banks which settle at the end of the day on accounts at the Bank of England.

trades. Sequential settlement on a continuous basis is the simplest way of achieving this (e.g. Fedwire). When the funds transfers are completed through an open-ended discrete-time net settlement system, it may be more difficult to do so.[67]

More generally, the procedures for preventing and managing a settlement failure are similar to those already discussed in relation to large-value funds transfer systems. They range from membership standards for direct participants to resource-pooling mechanisms designed to ensure the completion of all the trades scheduled for a particular day.[68] The completion may, for instance, be guaranteed by the system operator or by the clearing corporation acting as central counterparty in all trades through legally binding multilateral netting. As long as one leg of the transaction is settled, the clearing house can always buy or sell the required securities in the market to complete the transaction. Loss-sharing rules and collateral requirements are needed to cover the potential losses. Very few systems have such inbuilt arrangements (e.g. SCC in the Netherlands and Liquidazione dei Titoli in Italy) (Table 9).

In the wake of the global stock market crash, policy initiatives have multiplied with a view to ensuring that transactions in securities markets can be completed without disruption even under extreme circumstances. Various international bodies have issued recommendations to improve settlement procedures, including the Group of Thirty (1989 and 1991), the Fédération Internationale des Bourses de Valeurs (1989), the EC Commission (1988), the International Organisation of Securities Commissions and the International Society of Securities Administrators. More recently, the Committee on Payment and Settlement Systems of the central banks of the G-10 countries has published a report on delivery against payment, providing an in-depth analysis and evaluation of the risks and risk control procedures in securities settlement systems (BIS (1992b)). As might be expected on the basis of the above discussion, the primary objective of the recommendations is to promote the shortening of settlement lags and the introduction of DVP mechanisms.[69] In many countries

[67] There is, of course, less need to insulate settlement to the extent that the large-value system has liquidity-pooling and loss-sharing arrangements aimed at ensuring settlement.

[68] One potential source of settlement risk is the failure of the intermediary issuing the settlement medium or holding the securities. With the exception of Cedel and Euroclear, all securities systems settle on the books of the central bank, which also acts as central depository in a few cases, mostly for government securities (Table 9).

steps have already been taken, and more are planned, to implement the necessary improvements in risk management.

The settlement of foreign exchange transactions

Most foreign exchange transactions settle two business days after the trade date (T + 2). This settlement lag may expose the counterparties to considerable forward replacement cost risk because of the potential volatility of exchange rates. It is not unusual, for instance, for the exchange rates of the major floating currencies to move by a few percentage points in the course of one or two days.

The main concern, however, relates to the principal and liquidity risks incurred by the counterparties when they do not receive final funds denominated in the respective currencies contemporaneously ("cross-currency settlement risk" or "Herstatt risk").[70] Herstatt risk can have serious systemic implications because foreign exchange transactions account for a large share of all payments in the major financial centres and because most of them are entered into between banks. According to a BIS survey (BIS (1990c)), by 1989 the average daily turnover in foreign exchange markets amounted to some $640 billion. Interbank trading was estimated to constitute about 85% of net market turnover.

The key constraint giving rise to Herstatt risk is the difference in time zones and working hours of banking systems across countries (Diagram 5). There is, for instance, no overlap at all between the operating hours of the large-value interbank funds transfer systems of the countries of the three most actively traded currencies, viz. the United States, Japan and Germany. As settlement typically takes place in the country of issue of the respective currency, the counterparties to a transaction would be exposed to Herstatt risk. The lag can be particularly long in a yen/dollar transaction. Assuming that the counterparties obtain unconditional funds availability only at the time of settlement in the interbank systems handling most

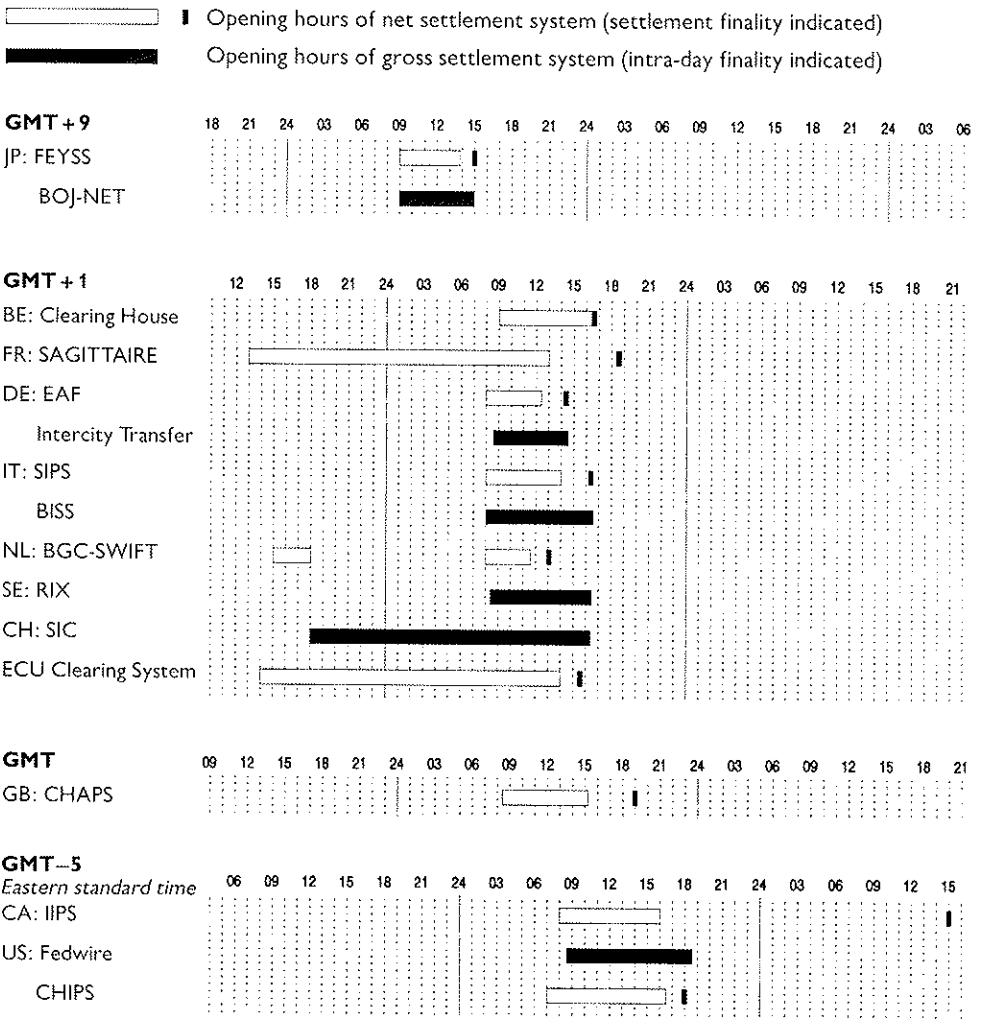
[69] The specific recommendations of the G-30 report, which have essentially been confirmed by the other international bodies, include: improved trade comparison and confirmation systems, the creation of central securities depositories, the introduction of trade netting systems, reliance on DVP mechanisms, the use of rolling settlement together with a limit on settlement lags to three business days, and the adoption of common message standards.

[70] Angelini and Giannini (1992) note that the problems associated with cross-currency settlement were already well appreciated during the Renaissance in Europe, where they had led to the creation of centralised clearing and settlement procedures in "exchange fairs". See also Boyer-Xambeau et al. (1987).

Diagram 5

Global time zone relationships: Opening hours of selected large-value interbank transfer systems

For same value day *



* The diagram shows the opening hours, as of October 1992, of selected interbank funds transfer systems as they relate to the same value day; some systems, including SAGITTAIRE and the ECU Clearing System, may accept payment orders for a number of value days. As indicated, some systems open on the day before the value day. For Canada, settlement finality for IIPS occurs on the next business day, with retroactive value dating.

foreign exchange transactions (FEYSS and CHIPS), the party delivering the yen pays out the funds at least 17 hours before receiving the dollars.[71] If the parties received final funds on the basis of the opening hours of BOJ-NET and Fedwire, then the shortest lag would be 7 1/2 hours.

The risks arising from the asynchronous settlement of foreign exchange transactions were highlighted in July 1974, when Bankhaus Herstatt, a relatively small German bank very active in foreign exchange dealings, was ordered into liquidation by the German banking supervisory authorities. As the closure was announced after the settlement of same-day interbank systems in Germany, several of Herstatt's counterparties in the foreign exchange market had irrevocably paid out Deutsche Mark to Herstatt on that day. Although Herstatt's correspondent bank in New York had already input the payment orders for the settlement of the dollar leg of the transactions through CHIPS – at the time still operating in next-day settlement mode – the failure of the bank prevented their completion. Herstatt's counterparties, therefore, faced the prospect of losses as a result of the asynchronous settlement of funds. Despite the fact that typical exposures were much smaller than they are today, the episode caused great disruption to CHIPS, not least because the general confidence of counterparties was shaken. The difficult re-establishment of orderly conditions called, inter alia, for the introduction of a temporary rule allowing payment orders through CHIPS to be revoked the morning after they had been sent.[72] Creditors did in the end receive partial compensation for the losses suffered, but the episode illustrated how uncertainty regarding the size, distribution and resolution of exposures might lead to a broader financial disruption.

There are a number of ways in which the risks connected with settlement of foreign exchange transactions can be reduced. Firstly, the safety of each of the payment legs can be improved. Secondly, the size of the settlement flows across currencies can be reduced through netting schemes applying to the underlying contracts and to the payment flows across contracts and counterparties. Thirdly, the size of settlement flows *across borders* can be limited through the development of payment arrangements outside the country of issue of a currency ("off-shore").

[71] The lag could be longer if the funds are paid out before final settlement in FEYSS. For an attempt to measure Herstatt risk, see Kamata (1990b).

[72] There was uncertainty at the time as to whether payment orders were revocable.

Finally, DVP mechanisms may be introduced, which would generally call for an upgrading of central bank services partly as a way of encouraging and facilitating private sector initiatives. As with the settlement of securities, ensuring DVP generally shifts credit risk among participants, in this case typically from the counterparties in the transaction to the banks with which correspondent balances are held. Since the choice of correspondents is more controllable and based on better information than the choice of counterparties in a market trade, the possibility of settling simultaneously should in principle result in a better distribution of risks.

The possible steps to improve the safety of each of the payment legs have already been discussed in the context of risk management in domestic large-value funds transfer systems, through which foreign exchange transactions are ultimately settled. Particularly relevant are mechanisms aimed at achieving intraday finality, notably the introduction of continuous settlement arrangements.

The netting of the foreign exchange contracts can greatly reduce Herstatt risk by operating at the source of the funds transfers. Contract netting offsets the current value of credit exposures between parties and, by the same token, reduces the settlement payments due at each point in time to a net amount.

The main scheme of this kind already in operation is FXNET,[73] a system run by several large banks for the bilateral netting by novation of spot and forward foreign exchange contracts (Table 10). The system started in London, was then extended to banks operating in the United States, now also covers institutions in the main East Asian financial centres and may in the future also be established in Paris and Zurich. The service allows netting both within and between centres. Another bilateral netting scheme was launched in July 1992 by International Clearing Systems Inc. (ICSI), covering initially eight Canadian and US banks. There are plans to upgrade the service to multilateral netting. Similarly, a multilateral system set up by European banks to be domiciled in London and known as the European Clearing House Organisation (ECHO) is due to open in 1994. The system is expected to include some fifty OECD banks and possibly as many as twenty-four currencies. Finally, although its main goal is to reduce credit risks on outstanding obligations, a bilateral netting scheme for swaps based on a standard master agreement drawn up by the International Swap

[73] For details of the various schemes, see Hartmann (1991) and Allsopp (1991).

Dealers Association (ISDA) also provides for the netting of settlement flows connected with the contracts.

Multilateral payment schemes outside the country of issue of a currency can lead to a further major reduction in cross-border interbank funds transfers, even though such schemes partly rely on traditional correspondent banking relationships. The most important example is Chase Manhattan's Tokyo Dollar Clearing (Table 10),[74] which is thought to handle more than 90% of the dollar-denominated foreign exchange trades originated in Japan. The scheme, which was originally designed as a payment netting arrangement, has been revised in recent years but still contains a number of typical features of netting systems. During the Tokyo business day correspondent customers of Chase send and receive dollar payment orders which result in credits and debits to their account at Chase's Tokyo branch throughout the day. Some customers are allowed to overdraw their account within specified limits. At the end of the Tokyo day customers are notified of their respective account positions. Overdrafts have to be covered in New York during the US business day. Credit balances may be withdrawn by advising Chase-Tokyo to transfer part or all of the balance in New York during the US business day. In a loss-sharing scheme similar to those found in net settlement systems, participants undertake to reimburse Chase if one of them defaults. Chase is developing analogous off-shore interbank funds transfer arrangements for other currencies and in other centres.

Although any contract or payment netting scheme can in principle reduce the credit and liquidity risks faced by participants, the full potential benefits may not be realised if the systems are poorly designed. The international dimension of the arrangements also raises questions regarding the allocation of supervisory responsibilities. The recent report on interbank netting schemes of the G-10 countries (the Lamfalussy Report) considers these issues in detail and recommends a set of minimum standards for the operation of cross-border multi-currency netting schemes (BIS (1990b))[75] – standards which, to be sure, could in principle equally apply to single-currency domestic schemes (Van den Bergh (1992)). The Report stresses the importance of a well-founded legal basis for the arrangements and of clearly defined, well-structured procedures for the

[74] In a class of its own is the ECU clearing system, which is described in Appendix IV.
[75] The Report follows upon an earlier preliminary study (BIS (1989b)).

Table 10

Selected features of cross-border interbank netting shemes

	FXNET	ISDA master agreement	ICSI	ECHO (planned)	Chase Tokyo
Type of netting					
bilateral	*	*	*		
multilateral			planned[1]	*	[2]
Type of contract					
spot and forward forex	*		*	*	
swaps		*[3]			
payments					*
Currencies					
single currency					*(US$)
multi-currency	*	*	*	*	
Legal characteristics					
advisory netting[4]					[2]
netting by novation[5]	*		*		
substitution[6]					[2]
open offer				*[7]	[2]
master agreement[8]	*	*	*	*	*
close-out clause[9]	*	*	*	*[10]	
Participants					
type	banks	all market participants	all market participants	banks	banks
number	± 40[11]	± 200	9	14[12]	± 200

Table 10 (continued)

Selected features of cross-border interbank netting shemes

	FXNET	ISDA master agreement	ICSI	ECHO (planned)	Chase Tokyo
Location/area of operation . . .	London/ Hong Kong/ Los Angeles/ New York/ Singapore/ Tokyo	global	North America	London/ OECD countries	Tokyo/ New York
Year of introduction	1987	1987	1992	1994	around 1950

[1] Information in this column relates to bilateral netting only. [2] Correspondent customers of Chase send and receive payment orders throughout the Tokyo day that result in final credits and debits to their accounts at Chase's Tokyo branch. At the end of the Tokyo day customers are notified of their respective account positions. Credit balances may be withdrawn at the beginning of the same calendar day in New York; overdrafts have to be covered by the end of the New York day. Chase's customers contract to participate in a loss-sharing arrangement to reimburse Chase if a participant defaults. [3] The 1992 master agreement aims to incorporate more derivative transactions, in addition to interest rate derivatives and currency swaps, including cash-settled commodities swaps and options, foreign exchange transactions and currency options, and cash-settled equity index options. [4] Also known as position netting. It is not legally binding as there is no change in the counterparties' contractual obligations. [5] Provides for the discharge of individual contractual commitments at the time of confirmation and their replacement with new obligations. [6] Amendment of a contract between two parties, so that a third party is interposed as an intermediary creditor/debtor between the two parties. [7] The technique proposed by ECHO is that it would immediately become a party to foreign exchange deals, by the contractual procedure of "open offer", as soon as they are agreed by users. [8] A document written in such a fashion that its terms govern specific activities between the counterparties. Each new transaction is viewed as a supplement to this agreement. When such an agreement provides for a netting of exposures and to the extent that it can be upheld in the courts, it can prevent any receiver or liquidator of a defaulting party to be selective in terms of the currencies or the payments to be received or made on various forward dates. In contrast to novation it is possible for the individual transactions to retain their specific terms, so that they can be individually assigned or terminated. [9] In the event of default, the clause permits the early termination of the contracts covered and the replacement of all the forward value contract commitments by a single net present value amount. [10] Arrangements for an event of default are similar in effect to a close-out clause but take the form of a series of supplementary foreign exchange and money market contracts between the defaulter's trading counterparties and ECHO. [11] Bank branches participating since February 1992. [12] As of September 1992.

Minimum standards for the design and operation of cross-border and multi-currency netting and settlement schemes

I Netting schemes should have a well-founded legal basis under all relevant jurisdictions.

II Netting scheme participants should have a clear understanding of the impact of the particular scheme on each of the financial risks affected by the netting process.

III Multilateral netting schemes should have clearly defined procedures for the management of credit risks and liquidity risks which specify the respective responsibilities of the netting provider and the participants. These procedures should also ensure that all parties have both the incentives and the capabilities to manage and contain each of the risks they bear and that limits are placed on the maximum level of credit exposure that can be produced by each participant.

IV Multilateral netting systems should, at a minimum, be capable of ensuring the timely completion of daily settlements in the event of an inability to settle by the participant with the largest single net debit position.

V Multilateral netting systems should have objective and publicly disclosed criteria for admission which permit fair and open access.

VI All netting schemes should ensure the operational reliability of technical systems and the availability of backup facilities capable of completing daily processing requirements.

management of credit and liquidity risk (see Box). These should include, at a minimum, the capability of ensuring the timely completion of daily settlements in the event of failure to settle by the participant with the largest net position.

The central banks of the G-10 countries are actively studying possible ways to help reduce the risks involved in cross-currency transactions, particularly with a view to facilitating the introduction of DVP mechanisms. As the ultimate settlement agents in individual currencies and issuers of default-free settlement media, they are clearly in a good position to do so.[76] The possible steps may be as limited as extending the opening hours of the respective payment systems so as to reduce or eliminate time zone gaps. At the other extreme, they could take the form of joint provision of

[76] For example, unless ultimate counterparties settle in a risk-free medium (central bank balances), they are still exposed to the default of the issuer.

multi-currency final settlement services, either by individual central banks or, conceivably, through an international institution (Padoa-Schioppa (1990)).

Conclusion

The last two decades have been a period of momentous change for the financial services industry worldwide. As an integral component of that industry, payment services could not have been left unaffected. In the wake of rapid technological innovation, deregulation and a tendency for asset prices to display greater volatility, a remarkable expansion in financial activity has gone hand in hand with a surge in the volume and value of payments, both within and, above all, across national borders, and profound changes in payment arrangements. These developments have had major implications for the nature and significance of payment system risks.

Safeguarding the integrity of the payment system is a fundamental policy objective. Payment arrangements represent the connective tissue of all economic activity, as it is the ability to settle transactions, and confidence in the counterparties to do likewise, that underpins it. By the same token, they are also a key channel for the propagation of systemic crises, typically triggered and spread by a failure to settle obligations. The fundamental question, therefore, is how to adapt risk management procedures to the new environment, where the spectacular increase in the value of trading and payments has resulted in unprecedented liquidity and credit exposures for participants, especially for the providers of the payment service, and where the growing importance of cross-border exposures exacerbates the problems deriving from differing operating, regulatory and legal arrangements in the domestic jurisdictions.

Ensuring the safety and soundness of the payment system largely means seeing that safeguards are put in place to limit the likelihood and repercussions of a failure to settle obligations – the typical trigger and propagating channel of a financial crisis – through a better distribution and control of participants' liquidity and credit exposures. This paper has examined these issues in some detail from a broad perspective and also with particular reference to three areas of special importance: large-value interbank funds transfer systems, which lie at the core of payment arrangements,

and the settlement of securities and foreign exchange transactions, which together account for a large share of all financial transactions.

What emerges from the analysis is that significant steps have been taken with a view to improving risk management in a number of respects. One is better identification and transparency of credit and liquidity exposures, notably through real-time monitoring of the positions of participants in certain systems. A second is a better distribution of those exposures, for example through delivery-against-payment mechanisms in securities markets, which achieve the simultaneous settlement of the two legs of the trades. A third is better control, for example through wider use of bilateral and multilateral limits on participants' positions and of collateral requirements. A fourth is greater certainty of settlement for sub-sets of transactions, as can be gained through a shortening of settlement lags, notably through the introduction of real-time gross settlement systems.

Nevertheless, progress has been uneven and much still needs to be done in all the areas just mentioned. For example, it is still not possible to secure delivery against payment for foreign exchange contracts denominated in the major international currencies. Similarly, several large-value funds transfer systems lack real-time monitoring facilities, while bilateral and multilateral position caps are still rare.

But the most important challenge is introducing appropriate liquidity-pooling and loss-sharing mechanisms to ensure settlement in specific systems in the event of a failure to settle on the part of individual participants. At present very few systems contain this safeguard. In its absence, a settlement failure could have unpredictable and disruptive knock-on effects, possibly triggering a systemic crisis: uncertainty about the size and distribution of underlying exposures and about the extent to which the settlement failure reflects cash-flow or solvency problems can exacerbate the shortage of liquidity by encouraging a rationing of funds and the withdrawal from transactions. Under these conditions, the resolution of a settlement failure relies excessively on the ability of the central bank to provide emergency liquidity assistance, to the detriment of transparency and incentives for prudent behaviour.

The years ahead should see the further implementation of risk reduction policies in payment systems along the lines described. As guarantors of the integrity of the financial system, and ultimate creators of liquidity, central banks will continue to play a key role, helping to identify potential areas of risk and appropriate risk management mechanisms. In the process,

difficult questions will need to be asked, ranging from the precise nature and distribution of the risks in payment arrangements to the appropriate degree of involvement of central banks. Whatever the answers may be, however, there is little doubt that ensuring the safety and soundness of the payment system is a goal that will command increasing attention. As the internationalisation of markets proceeds, it is also one that it will not be possible to pursue exclusively within the narrow confines of national borders and without strengthening international cooperation.

Appendix I
An illustration of net and gross settlement systems

Diagram A1 illustrates the difference between gross and variants of net settlement systems. The example is a stylised one but the order of magnitude of the reduction in interbank transfer flows is reasonable.

The following notation will be used:
minus (−)/plus (+) = transfer made/received
superscript = bank to/from which funds are sent/received
subscript = settlement agent to/from which funds are sent/received
first and second columns for each bank = gross funds transfers
third column = net funds transfers

In the example considered, banks 1 to 6 are the institutions engaged in "primary" funds transfers to each other, i.e. the funds transfers determined outside the settlement system. In certain arrangements, banks A to C also become relevant. Banks A to C are assumed, for simplicity, to be "pure" settlement participants, i.e. banks which act as intermediaries in the settlement of other banks' transfers but which do not send (receive) own transfers to (from) the other participants.[77]

Single-tiered gross system

In a single-tiered gross system all banks are on an equal footing and settle the transfers received separately from those paid out. In the diagram, therefore, only banks 1 to 6 are relevant. Bank 1, for instance, settles independently the 32 units of account paid out and 21 units received. The total value of the transfers to be settled can be obtained by adding the orders received/sent by each bank (i.e. 222 units). Fedwire in the United States is a typical example of such a system.

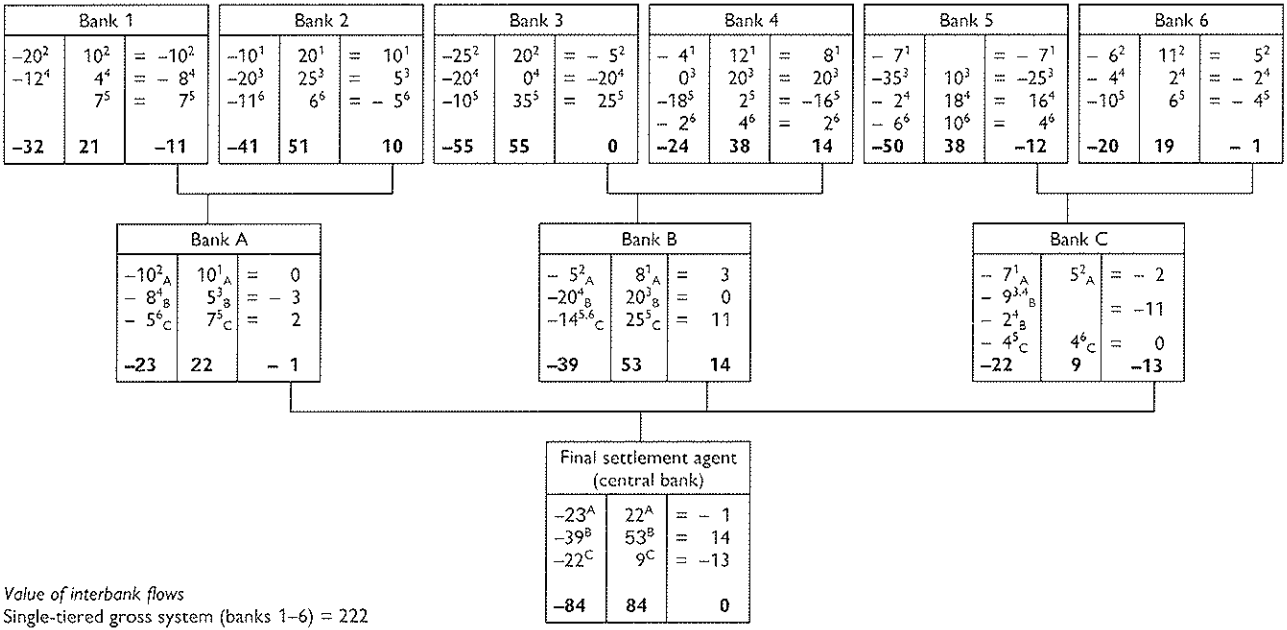
Single-tiered bilateral netting

In a single-tiered bilateral netting system banks are on an equal footing and settle bilaterally only the net balances due to/receivable from other participants. In this case, for instance, bank 1 pays 10 and 8 units to banks 2 and 4 respectively and receives 7 units from bank 5 for total individual transfers of 25 units. In a gross system, this bank would have paid out 32 units *and*

[77] In practice, settlement participants also send own messages through the systems.

Diagram A1

Interbank funds transfer flows under alternative arrangements



Value of interbank flows

Single-tiered gross system (banks 1–6) = 222

Single-tiered bilateral netting (banks 1–6) = 102

Single-tiered multilateral netting (banks 1–6) = 24

Two-tiered: multilateral netting (banks 1, 2; 3, 4; 5, 6) plus multilateral netting (banks A–C) = 38 = 24 (non-settlement participants, 1–6)
= 14 (settlement participants, A–C)

Two-tiered: multilateral netting (banks 1, 2; 3, 4; 5, 6) plus gross (banks A–C) = 78 = 24 (non-settlement participants, 1–6)
= 84 (settlement participants, A–C)

received 21. The aggregate value of the transfers settled in the system is 102 units, which is equal to the sum of each bank's *net* payments/receipts. The saving with respect to the gross system is around 50%. Settlement at discrete-time intervals through net adjustments to mutual correspondent balances is in effect a form of bilateral netting.

Single-tiered multilateral netting

The single-tiered multilateral netting system is similar to the bilateral netting system except that each bank now settles only its net balance vis-à-vis *all* other participants, thereby being able to offset net payments to one participant with net receipts from another. Bank 1, for example, only pays 11 units. Settlement is carried out on the books of a settlement agent, normally the central bank. In the example, the aggregate value of the transfers to be settled is 24 units, with savings of the order of 90% and 75% relative to the gross and bilateral netting systems respectively. At least for a sub-set of all transactions between institutions, many real life arrangements correspond to this model, including the majority of large-value interbank funds transfer clearing systems discussed in the text.

Two-tiered systems

In two-tiered systems there is a distinction between settlement and non-settlement participants. Non-settlement participants settle their positions on the books of settlement participants, which in effect act as their correspondents and settlement agents. Settlement participants, by contrast, typically settle on the books of the final settlement agent, generally the central bank.

In Diagram A1, banks A, B and C act as settlement agents for the pairs of banks (1, 2), (3, 4) and (5, 6) respectively. Bank A, for example, channels all the orders of banks 1 and 2. It can therefore offset the net bilateral balances between the two (10 units), but must pay out/receive balances vis-à-vis the other banks (3 to 6) that rely on different settlement agents (B and C).

In the most common system, both settlement and non-settlement participants settle on a multilateral net basis. In the illustration considered, banks A and C pay the final settlement agent 1 and 13 units respectively, while bank B receives 14 units. The aggregate value of transfers to be settled is 38 units, i.e. 14 units between settlement participants and 24

units between them and the first-tier banks. Although the *overall* value of interbank settlements is higher than in a single-tiered system, there is a saving in transfers of central bank balances (14 rather than 24 units) because some of the transfers occur only in the books of the settlement participants. CHAPS in the United Kingdom is one example of such systems.

It is in principle possible that the procedure for calculating settlement balances will differ between the first-tier banks and their settlement agents. In practice, no such *system* exists although different types of arrangements connecting banks could lead to similar results. For example, banks 1 to 6 could use banks A and C as correspondents, with banks A and C settling their interbank funds transfers via a gross settlement system. One such variant is considered in the diagram.

Appendix II
Credit risk, aggregate risk and payment arrangements

This appendix illustrates the relationship between the credit risks connected with asynchronous exchanges, loans to execute synchronous exchanges and the default risk on the settlement medium. It considers in what sense risks of losses are redistributed among agents and under what conditions overall losses may be dependent on payment arrangements. The illustration is based simply on the portfolio shifts which take place in each case between participants in a transaction (Diagram A2).[78]

The following notation will be used:

E = asset unrelated to payment arrangements

L = loan

D = settlement balances

Superscripts: agent for which the financial instrument is an asset

Subscripts: agent for which the financial instrument is a liability

The diagram illustrates the situation of payment participants under the various types of payment arrangements. There are three payment participants (A, B, C). They hold claims unrelated to payment arrangements (E) and on each other (D, L). The Es can be thought of as claims on real

[78] The analysis, therefore, is not based on a fully-fledged model of valuation and exchange. Nevertheless, it seems appropriate to illustrate the gist of the argument.

Diagram A2

Portfolio configurations under different payment arrangements

Row 1: Initial conditions

A			
E^A	40	L^C_A	20
E^A	10		

B			
E^B	20	L^C_B	20
D^B_C	10		

C			
E^C	10	D^B_C	10
L^C_B	20		
L^C_A	20		

Row 2: Sale with immediate settlement (E^A for D, value = 10)

A			
E^A	40	L^C_A	20
D^A_C	10		

B			
E^B	20	L^C_B	20
E^B	10		

C			
E^C	10	D^A_C	10
L^C_B	20		
L^C_A	20		

Row 3: Sale with delayed settlement

A			
E^A	40	L^C_A	20
L^A_B	10		

B			
E^B	20	L^C_B	20
E^B	10	L^A_B	10
D^B_C	10		

C			
E^C	10	D^B_C	10
L^C_B	20		
L^C_A	20		

Row 4: Sale with immediate settlement, B borrows funds from C

A			
E^A	40	L^C_A	20
D^A_C	10		

B			
E^B	20	L^C_B	20
E^B	10	L^C_B	10
D^B_C	10		

C			
E^C	10	D^A_C	10
L^C_B	20	D^B_C	10
L^C_A	20		
L^C_B	10		

resources which therefore represent the "net wealth" of this stylised economy. They are the ultimate source of losses (gains) to be distributed among the agents. The change in the valuation of the intra-sectoral claims (D, L) is therefore *induced* by changes in the value of the Es. This is the fundamental reason why, for *given* Es, credit primarily redistributes risk among participants.

Row 1 indicates the initial conditions. Row 2 illustrates the benchmark transaction, viz. a sale by A (payee) to B (payer) of a sub-set of claims on real resources in exchange for an equivalent amount of settlement balances (D). These in turn represent a claim on C (payment intermediary). C may, but need not, be regarded as the central bank.

Row 3 considers the case in which the transaction is asynchronous. Specifically, B receives the claim E before transferring the settlement balances. The question is what distinguishes the asynchronous from the synchronous exchange in terms of the distribution of risk of losses. By construction, all other things are kept equal.

In terms of portfolio changes, the key differences are that A (the seller and payee) has a claim on B rather than on C, while B retains the settlement balances (claim on C) against which it has an obligation ("loan") vis-à-vis A. This indicates a redistribution of the potential losses associated with the Es.[79] It may also affect the probability of insolvency of the participants, defined as the probability that the valuation of the assets will fall short of commitments whose values are contractually fixed. In addition, it may affect the distribution of losses incurred by agents qua "creditors" and "shareholders". However, the changes cannot be determined without knowledge of the probability distribution of returns on the Es.

One interesting restriction is the case in which the settlement balances are risk-free, i.e. when the probability of bankruptcy of C is zero. Under these conditions B's probability of bankruptcy remains unchanged: it holds a risk-free asset matched by an equivalent fixed-value obligation. By contrast, the probability of bankruptcy of A has increased as it has given up a risk-free asset in exchange for a risky claim on B. In other words, A is now exposed to some of the losses which would otherwise have been absorbed by C in the event of B's bankruptcy.[80] In this case one may wish to say that the transaction *concentrates* credit risk on A.

Row 4 illustrates the case in which B borrows from C in order to complete a synchronous transaction. In this specific example the situation is entirely analogous to the synchronous transaction without borrowing, i.e. to immediate settlement.[81] The reason is that B's probability of default

[79] If B defaults with $E^B = 0$ the losses are as follows in the two situations: synchronous exchange (A = 0, B = 10, C = 20); asynchronous exchange (B = 10, A and C share 20 according to some rule).

[80] It seems misleading, therefore, to argue that lending by A to B imposes a negative externality on B's outstanding creditors by *raising* the credit risk which they face (Board of Governors of the Federal Reserve System (1988) and Gelfald and Lindsey (1989)). The result depends crucially on the benchmark of the comparison. Those who argue that the risk of losses for B's creditors rises presumably assume that as a result of the loan the riskiness of B's assets rises or that the loan replaces B's equity.

[81] Of course, if B borrowed explicitly from A, then the transaction would be equivalent to an asynchronous exchange between A and B (Row 3).

remains unchanged and the same holds for A because C is the only claimant on B. The equivalence between the two situations holds *regardless of whether C's balances are risky or risk-free.*

The analysis confirms that for any given Es the aggregate loss does not depend on whether a synchronous transaction is settled with a risky or a riskless settlement medium. The reason is that in both cases the settlement medium represents a claim between agents. Whether the claim is considered a settlement medium or not depends on conventions and on the specific terms of the contract. That of course may affect the degree of "liquidity" in the system but not *directly* the losses which agents would be incurring.

More specifically, for given Es increasing the supply of the riskless settlement medium would normally tend to shift the risk of losses to the issuer. This would occur whenever the issuer raised the supply through lending or through the acquisition of risky securities from other agents (e.g. loans). Alternatively, if the claims acquired were riskless (e.g. a fully and safely collateralised loan), the risk of loss would simply be redistributed among the non-issuers.

For the aggregate losses to be affected by payment arrangements the risk properties and valuation of the Es must somehow be a function of the type and distribution of claims among agents. This can occur for a number of reasons which ultimately rely on asymmetric information between economic agents about their actions ("moral hazard") and about the quality of assets ("adverse selection"). There is extensive literature on the subject.[82] The impact on asset values of bankruptcy and liquidity crises discussed in the text are two possibilities. The deleterious effects of a crisis on the willingness to enter future contractual relationships can similarly have long-lasting consequences. Another mechanism could be differential monitoring capabilities on the part of agents. For example, if a large fraction of all payment loans is granted by an institution at a price which does not reflect the underlying risks and without due monitoring, then borrowers have a greater incentive to undertake risky activities. The risk reduction policies adopted in recent years in the United States, for instance, largely reflect concerns about the size of, and terms on, the intraday loans granted by the Federal Reserve to banks in order to facilitate payments. Similarly, as discussed in the text, the risks connected with

[82] For general reviews see, for example, Gertler (1988).

asynchronous settlement may generally be associated with a distribution of risk that does not fully exploit comparative advantages in information.

Appendix III
Funds transfers: liquidity and credit risk[83]

Funds transfer orders per se contain only information about the *liquidity* risk incurred by the two parties concerned but say nothing about the *credit* (principal)[84] risk involved. A transfer order from bank A to bank B necessarily implies that bank B is exposed to liquidity risk for the amount of the transfer. The same transfer may imply no credit risk for either A or B, or may imply credit risk for one or both of the two banks.

Neither bank would face credit risk if (a) the transfer was a third-party transfer and neither bank extended any credit to its customer in the process or (b) the transfer was one leg of a synchronous (delivery-against-payment) exchange between the two banks or one of the banks and a third party (i.e. the delivery taking place only when the funds transfer was final).

The transfer order would imply credit risk for the *sending* bank A if (a) bank A granted credit to its customer in a third-party transfer or (b) the transfer was related to an asynchronous exchange contract between A and B or a third party in which A performed first, e.g. an explicit *loan* extended by A or a foreign exchange transaction.

The transfer order would give rise to credit risk for the *receiving* bank B if (a) B extended credit in a third-party transfer or (b) the transfer was part of an asynchronous exchange contract between B and A or another party and B had already performed (e.g. a loan reimbursement) or (c) the transfer represented a loan from A to B in which the mere sending of an irrevocable payment order by A triggered B's obligation to perform, i.e. to subsequently repay the loan.

What is true of individual transfer orders is also true of netted transfers, as these will be connected with a variety of transactions. Furthermore, netting raises the further question of the legal treatment of the relationship between the net amounts due and the underlying gross exposures involved in the individual transactions.

[83] Based closely on Borio et al. (1991).
[84] Only principal risk is considered in this appendix.

It is therefore somewhat confusing to call net positions "daylight credit" to the extent that the term implies that the position is a measure of credit risk.[85] The relationship, however, may be quite close in certain systems, e.g. where the interbank transfers are connected with customers' transfers and funds are automatically credited to the customers' accounts before settlement.

Appendix IV
The private ECU clearing and settlement system[86]

The private ECU clearing system is a set of arrangements for the multilateral netting and settlement of ECU payments between banks. The system was set up in 1985 after consultations with the Committee of Governors of the EC central banks and the BIS. It is run by the ECU Banking Association (EBA), a body formed under French law whose membership is open to banks established in EC countries. The BIS acts as settlement agent, while S.W.I.F.T. Service Partners, a S.W.I.F.T. subsidiary, provides data support for the netting phase. Over forty banks participate directly in the system, with others gaining access through correspondent relationships (Diagram A3).

In 1990, the year for which the latest comparative data are available, the daily average value of transactions was slightly over ECU 25 billion (US$ 27 billion). That was similar to the value of payments through many domestic large-value systems, including both SAGITTAIRE in France and RIX in Sweden (Table 2 in the main text). Since then traffic has increased very rapidly, in line with the development of the private ECU markets. By the end of 1991 it had about doubled.

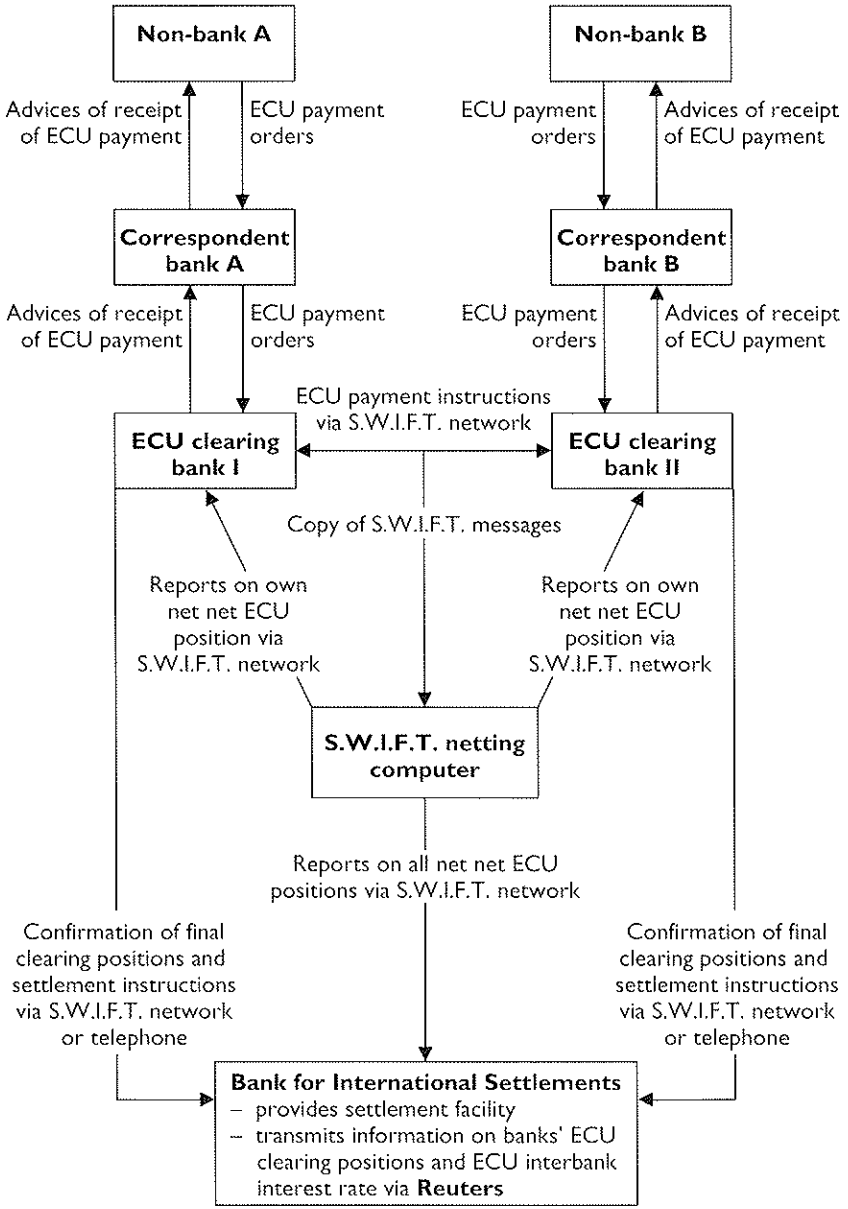
The key characteristic of the system is that, in contrast to domestic interbank arrangements, it does not rely on outside credit facilities. The (non-interest-bearing) accounts held at the BIS cannot be overdrawn and no central bank provides lending support. As a result, the settlement of the final multilateral positions at the end of the day can only be ensured through borrowing and lending in ECUs between participants. These loans

[85] This term is commonly used in the context of CHIPS, for example.

[86] For more details, see the Committee of Governors of the Central Banks of the Member States of the EEC (1992a).

Diagram A3

The ECU clearing and settlement system



are extended overnight and bear an interest rate which is calculated by the BIS on the basis of the "tomorrow/next" ECU rate reported by banks on the previous day. If one or more of the banks in a net debtor position were unable to obtain the necessary loans from those in a net creditor position, settlement would fail, triggering an unwinding procedure. All the payments involving the banks with insufficient cover would be withdrawn from the day's clearing and new balances calculated and added to the clearing for the following settlement day.[87]

Since 1990, as a result of close cooperation between the EBA, the BIS and central banks, a number of steps have been taken with a view to reducing the settlement risks in the system. The guidelines laid down in the Lamfalussy Report have served as the basic framework for these policy initiatives.

In August 1991 an "intermediation facility" was introduced. When a creditor bank refuses to lend to a specific participant, its surplus is automatically channelled through the other participants which in turn onlend the amount to the original counterparty. For that purpose, each bank pre-commits itself to lend up to a maximum of ECU 5 billion through the scheme. In order to smooth the end-of-day lending process, some central banks have also been developing collateralised liquidity facilities. These are designed to help net debtor banks to mobilise the necessary collateral to secure loans from net creditor banks. The Bank of England and the Banque de France were the first to announce such facilities in September 1991.

In the same month, after a review of the system, the Committee of Governors of the EC central banks recommended a number of changes to the arrangements in the light of the Lamfalussy Report guidelines. These included the performance of legal and technical audits, the introduction of bilateral and multilateral position limits and the setting-up of a loss-sharing agreement. In response, in March 1992 the EBA agreed to implement bilateral position limits and a loss-sharing scheme. The Association has also decided to explore the possibility of moving to a gross settlement system.

[87] Preliminary bilateral and multilateral balances are calculated at 2 p.m. (Brussels time). Banks then have until 3.15 p.m., exceptionally until 3.45 p.m., to reduce their multilateral positions below ECU 1 billion. The BIS, as agent, has the discretion to arrange the necessary funds transfers to complete settlement provided they do not exceed that amount. These transfers take place via special non-interest-bearing sight accounts which participant banks hold with the BIS.

Appendix V
List of abbreviations of large-value interbank funds transfer systems

Belgium

C.E.C.: the Centre for the Exchange of operations to be Cleared

Canada

IIPS: the Interbank International Payment System

ACSS: the Automated Clearing and Settlement System (run by the Canadian Payments Association)

France

SAGITTAIRE: the Automated System for the Integral Handling of Transactions by Telecommunication Means and the Settlement of Foreign Transactions

Germany

Daily Clearing: the daily clearing house procedure (for credit transfers) of the clearing offices of the central bank

CB Express System: the express intercity and the local transfer system of the central bank

Italy

BISS: Banca d'Italia continuous settlement system

ME: "Memorandum Elettronico" system

SIPS: the Interbank Payment System (operated by the Interbank Society for Automation)

Japan

BOJ-NET: The Bank of Japan Financial Network System

FEYSS: the Foreign Exchange Yen Settlement System

Zengin System: the Zengin Data Telecommunication System

CB Cheque System: the Bank of Japan Cheque System

Netherlands

CB Current Account: the Netherlands Bank's current account system

BCH-S.W.I.F.T.: the Banks' Clearing House-S.W.I.F.T. system

Sweden

RIX: the Riksbank clearing and interbank system

Switzerland

SIC: the Swiss Interbank Clearing

United Kingdom

CHAPS: the Clearing House Automated Payment System

Town Clearing: clearing and settlement system for high-value paper debit instruments in the City of London

United States

Fedwire: the Federal Reserve funds (and book-entry securities) transfer network

CHIPS: the Clearing House Interbank Payments System

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