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Financial Markets Department
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Interbank funds transfer systems: liquidity needs, counterparty risks and collateral

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Abstract

Over the next few years, we will see a pronounced increase in the speed at which payment transactions are executed and in the share of cross-border transactions, particularly in the euro area. Counterparty risks and liquidity needs connected with the transfer of funds continue to evolve and to provoke discussion. The fact that funds transfers occur and systems operate on a real-time and gross basis will significantly alter the operational character and technical solutions in this field. Systems following a daily timetable are being replaced by continuously operating systems, which will have a significant impact on banks' liquidity management. The trend toward immediate real-time payment transactions seems inevitable in the light of present trends.

It is generally presumed that RTGS systems operating on a gross basis require more liquidity than netting systems. Liquidity needs depend on payment system structures and payment flows. An even flow of payments requires less liquidity than an uneven flow. Liquidity needs can be significantly reduced by choosing an appropriate pa yment system structure, taking measures to even out payment flows and agreeing on market practices. The pricing, collateral and reserve requirement policies of the central bank affect also the efficiency of alternative payment systems. Thus the overall efficiency of a gross or net system depends on many factors. Factors arguing for a gross system are differences in counterparty risks, lack of reciprocity, steady interday payment flows and stable liquidity needs, both within and between days. Factors favouring net systems are the existence of small and varying counterparty risks and structurally unsteady payment flows that result in large interday variations in liquidity, even though overnight variations may be moderate.

Current, daily-oriented practices have focused on overnight liquidity needs. In a continuously operating environment, liquidity needs are continuously monitored across time-period borders. This means that banks' liquidity management will in the future operate under a new and broader time perspective.

Significant liquidity needs and large counterparty risks are inherent parts of Finland's present funds-transfer solutions. Liquidity can be freed for other uses and counterparty risks reduced by changing the structures. The necessary changes have been agreed and soon we will see fundamental changes in Finnish payment systems.

Key word: payment system settlement, gross settlement, RTGS, payment system counterparty risks, payment system liquidity needs

Tiivistelmä

Maksuliike on yleensä nopeutumassa ja kansainvälistymässä voimakkaasti lähivuosina erityisesti EMU-alueella ja suurten maksujen osalta. Maksuliikkeen katteensiirtoon liittyvät vastapuoliriskit ja likviditeettitarpeet ovat myös keskustelun ja muutoksien kohteena. Katteensiirtokäytännöissä ja järjestelmissä reaaliaikaisuus ja tapahtumakohtaisuus tulee merkittävästi muuttamaan toiminnan luonnetta ja teknisiä ratkaisuja. Päivärytmillä toimivista järjestelmistä ollaan siirtymässä jatkuvan toiminnan järjestelmiin erityisesti suurten maksujenkäsittelyssä. Tämä tulee vaikuttamaan huomattavasti pankkien likviditeetin hallintaperiaatteisiin. Muutoksen suunta kohti välitöntä reaaliaikaista maksuliikettä näyttää vääjäämättömältä nykykehityksen valossa.

Yleinen olettamus on, että bruttoperusteiset RTGS-järjestelmät vaativat enemmän likviditeettiä kuin nettopohjaiset järjestelmät. Likviditeetin tarve on riippuvainen maksujärjestelmien rakenteista ja käsiteltävistä maksuvirroista. Maksuvirtojen yleinen tasaisuus vähentää likviditeettitarvetta. Likviditeettitarvetta voidaan ratkaisevasti vähentää maksujärjestelmärakenteiden valinnoilla, maksuvirtoja tasaavilla toimenpiteillä ja sopimalla markkinakäytännöistä. Keskuspankin hinnoittelu-, vakuus- ja vähimmäisvarantokäytännöt vaikuttavat myös vaihtoehtoisten järjestelmien edullisuuteen. Brutto- ja nettojärjestelmän kokonaisedullisuus riippuu siten tapauskohtaisista tekijöistä. Bruttojärjestelmää suosivia tekijöitä ovat vastapuolien erilaiset riskitasot, vastavuoroisuuden puute maksuliikenneriskeissä, maksuvirtojen päivänsisäinen tasaisuus ja päivänsisäisen ja päivien välisen likviditeettivaihtelujen yhtenäinen taso. Nettojärjestelmiä suosivia tekijöitä ovat pienet ja samantasoiset vastapuoliriskit sekä rakenteellisesti epätasaiset maksuvirrat, jotka aiheuttavat suuria vaihteluita päivänsisäisessä likviditeettitarpeessa päivänvälisten vaihteluiden pysyessä kuitenkin kohtuullisina.

Nykyinen päivärytmiin kiinnitetty toimintatapa on myös keskittänyt huomion päivänkatkoon liittyvään likviditeettitarpeeseen. Jatkuvatoimisessa ympäristössä tarkastelu tapahtuu jatkumona yli aikarajojen. Pankkien likviditeetin hallinta operoi jatkossa tämän vuoksi laajemmalla ja uudella aikaperspektiivillä.

Suomalaisista nykyisistä katteensiirtoratkaisuista voidaan yleensä todeta, että tällä hetkellä ne kuluttavat huomattavia määriä likviditeettiä ja sisältävät laajojakin vastapuoliriskejä. Muuttamalla rakenteita voidaan tarvittaessa vapauttaa likviditeettiä ja vähentää vastapuoliriskejä. Tällaisista muutoksista on sovittu ja suomalaisten järjestelmien tilanne muuttuu oleellisesti lähiaikana.

Avainsanat: Maksujärjestelmien katteensiirto, bruttoselvitys, RTGS, maksujärjestelmien vastapuoliriskit, maksujärjestelmien likviditeettitarpeet

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1 Introduction

The aim of this study is to present a description of the processes and practices involved in the transfer of funds between banks within payment systems as well as the developmental needs and trends in those processes and practices. Payment systems are changing in fundamental ways due to the approaching launch of the euro and single monetary policy as well as the more general opening up of financial markets, technological advances and changes in the risks that are inherent in payment systems. As a result of these changes, it is inevitable that we will also see changes in the means by which interbank funds transfers are carried out. Counterparty risks, liquidity needs and the use of collateral in connection with interbank payments are currently under intensive discussion in the search for common principles to apply to interdependent payment systems[1], especially in the European context.

Section 2 deals with basic concepts concerning payment system-related counterparty risks and liquidity needs. Alternative settlement models - with and without counterparty risks - are defined and described in section 3. Liquidity needs and counterparty risks in connection with different models are analysed in sections 4 and 5.

Section 6 includes an examination of banks' counterparty risks and liquidity needs as well as a general comparison of cost-effectiveness within the different models.

Settlement systems are examined from the central bank viewpoint in section 7, with the emphasis on stability. An attempt is also made to describe some of the implications of different central bank policy options.

Finally, section 8 attempts to anticipate future developmental trends for payment systems.

The study includes, wherever appropriate, descriptions of structures and practices as well evaluations of developmental needs in the context of Finnish payment systems. Payment and settlement systems used by Finnish banks are described in appendix 1 according to the classification scheme applied in this paper.

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[1] See eg Angelini and Giannini (1993), Folkerts-Landau, Garber and Schoenmaker (1996), Folkerts-Landau (1997).

2 Basic concepts of payment systems

2.1 Settlement, liquidity needs and counterparty risk

Payment transactions can be divided into credit and debit transactions. This study deals only with credit transactions, ie with ordinary credit transfers. A debit (eg cheque) transaction can always be converted into a credit transaction by breaking it down into the debiting party's advising notification and the debtor party's credit transfer (ie payment). The Finnish direct debit system, for example, operates on this principle. Large-value payment systems are increasingly changing over to credit-transfer-based operations. In a debit-transfer-based system, the payer bank can run into difficulties concerning payment control and liquidity management if other banks can 'freely' debit its account.

Payment systems are closed systems in which customer- and bank-originated payments move between participating banks. A bank may participate in several different closed payment systems. Payment systems can be networked so that a bank participating in several networks is able to transfer transactions between them. Payment systems may also be hierarchical, in which case several networks are linked via a clearing centre/bank. The central financial institutions of the Finnish cooperative banks and savings banks are typical examples of hierarchical systems. The international network of correspondent banks typifies a networked operation.

In a normal payment transaction, a bank customer's debt obligation is transferred to another bank. In the closed network of a payment system, a customer's payment transaction results in changes in both banks' balance sheets of the same magnitude but opposite sign. The settlement connected with a payment transaction generates balancing entries on opposite sides of each bank's balance sheet.

From the payer bank's viewpoint, the necessary balance sheet change can be accomplished by

- transferring eligible assets (usually central bank money) to the receiving bank or
- incurring a liability position vs the receiving bank.

Payment systems may operate according to both of these principles, separately or simultaneously.

In a payment system operating on the debt principle, banks with payment surpluses must be willing to grant credit to deficit banks. This means that surplus banks take on counterparty risks vs deficit banks. Generally the debt principle is realized in a payment system only on an intraday basis, so that final settlement takes place at the end of the day, based on central bank money, ie via funds transfers between banks' central bank accounts. Thus counterparty risks arise in situations in which funds transfers are credited finally and irrevocably to customer accounts prior to interbank settlement and execution is not fully collateralized.

Risks between banks also depend on the legal framework of the payment system, eg concerning payment finality, parties' contractual responsibilities and validity of bilateral and multilateral netting[2].

Settlement models are categorized by payment system counterparty risk as those

- without counterparty risk and
- with counterparty risk.

Liquidity crises and systemic risk

A bank faces a liquidity crisis when it does not have sufficient liquidity for settlement and cannot obtain further financing from the markets. A liquidity crisis concerning one or more banks may expand into a systemic risk, which will to a large extent halt system operations if the liquidity remains in the hands of surplus banks that do not want to finance deficit banks. Thus in such cases liquidity crises and systemic crises are often caused by loss of confidence, which has caused customers to transfer their deposits elsewhere via payment transactions. A liquidity crisis may also arise for technical reasons, eg when one party's information system fails and the normal circulation of liquidity grinds to a halt. Payment systems liquidity crises and systemic crises are frequently studied by researchers and central banks[3].

2.2 Netting and time considerations

Settlement systems within payment systems are generally classified into gross and net systems. In a gross system, payments are settled on a transaction-by-transaction basis, without netting vs other banks. In a net system, each bank's incoming and outgoing payments during a specified time period are batched into a single incoming or outgoing settlement vs one or more banks. In multilateral netting, the number of settlement transactions is reduced to one per bank per time period. The reason for this type of batching is usually to reduce the costs of settling a large group of small-value payments.

Net settlement is always executed at designated times so as to include all the covering funds transfers originating in the period since the previous netting. This period has traditionally been one day, which has been the acceptable frequency for executing payments/funds transfers. Intraday interest has not traditionally been paid, as it has been considered sufficient that participants be paid or charged overnight interest on end-of-day positions. If settlement is deferred to the next day, a 'float' is created, which enables banks temporarily holding outgoing funds to earn overnight interest.

In a netting system the participating banks decide on intraday practices. A bank may choose the counterparty-risk-free practice of deferring credit entries to customer accounts until the end-of-day settlement or take on counterparty risk by

[2] Banks may make payments on a net basis, in which case only net amounts (ie differences between outgoing and incoming payments) are transferred between banks. The netting can be done on a bilateral or multilateral basis. In certain countries, a bankruptcy estate can demand the unwinding of a netting, in which case the validity of netting is not completely certain.

[3] See eg BIS(1997), Freixas and Parigi (1997), Rochet and Tirole (1996), Leinonen and Saarinen (1998).

crediting these accounts earlier in the day. These choices depend on interbank and customer agreements on payments and timetables.

Netting intervals are becoming shorter. Customers want faster crediting of their accounts, and this requires more frequent interbank settlements for the risk-free case. With frequent batching, the operations are becoming more like real-time operations. Until now, the shortest period for paying interest has generally been one day. The charging of interest for a shorter period, eg an hour, will require that debt positions be cleared several times a day.

Settlement and netting intervals have previously been much longer – several days or weeks. Because technological development has enabled faster and more efficient payment practices, settlement intervals have been shortened. However, in cross-border payments, execution can still take a fairly long time - typically two days.

2.3 Liquidity sources and costs

Banks have various sources of liquidity. The central bank typically plays a key role in the provision and pricing of liquidity. Liquidity costs are bank- and situation-specific.

Minimum reserves required by the central bank are a liquidity source with zero opportunity cost to banks if they can be used as intraday liquidity.

A priced uncollateralized intraday overdraft facility associated with an account at the central bank carries an explicit price, which the bank can apply in calculating the profitability of the liquidity source on a case-by-case basis, eg using the Federal Reserve model (no longer possible in Finland).

An unpriced collateralized intraday overdraft facility tied to central bank accounts carries no explicit price or interest (ECB model).

The opportunity costs of collateral depend on the bank and the specific circumstances as well as on the rules of the game as set by the central bank; these cover the following:

- the range of eligible collateral and the applied haircut
- the degree of flexibility in the use of collateral (in an extremely flexible case, a bank could post its trading portfolio as a collateral pool, eg the automated collateral pool of the Finnish Central Securities Depository[4]),
- the size of the untraded part of the bank's eligible portfolio and
- level of return on collateral-eligible securities.

Intraday repo credits are an alternative means by which a central bank can ensure that a payment system has sufficient liquidity. In principle, the same factors effect the cost of repo credits as the cost of collateral use.

Longer term funds can be obtained from money markets or the central bank when a bank notices that it will have a negative balance at the end of a business day. Obtaining such liquidity earlier in the day will mean a better end-of-day position. Forecasting the position requires that the bank have an effective liquidity

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[4] In May 1998 the Bank of Finland adopted an automated collateral pool set up by the Finnish Central Securities Depository, in which banks can trade their collateral assets, provided the value of a pledged portfolio always exceeds the minimum value, which is automatically controlled by the FCSD system.

monitoring system. Overnight funds need to be obtained, especially at the end of the day, to execute queued transactions and the day's net settlements.

Intraday funds obtained from money markets. Banks may also introduce intraday (eg hourly) markets in which they lend each other funds for covering temporary liquidity needs. Hourly credit involves no risk provided it is repo-based. If the credits are not collateralized, they increase banks' counterparty risks. Covering such risk requires risk-based pricing. There will not be any great need for an intraday interbank market if the central bank has a comparable inexpensive lending facility. As the speed of funds transfers and banking activities in general increases, so too do the need for and interest in having intraday interest-based markets.

2.4 Costs of delay

If payment execution is delayed, the bank causing the delay may become liable for compensation. The costs of delay are usually determined on the basis of interbank and customer agreements, usually in the form of a penalty for delay. The penalty is applied after the passing of a critical time limit. Banks usually have greater 'time buffers' for meeting deadlines in respect to customer as compared to interbank agreements. Large-value payments, eg those connected with securities transactions, usually have stricter terms of execution than retail payments. Interbank settlement agreements often include penalties for faulty or delayed payments.

A clear and sufficiently heavy penalty for a payment delay enhances payment discipline and encourages observance of agreed timetables.

In Finland banks make every effort to meet agreed timetables in their daily payment transfers. Delays are usually due to technical or other exceptional problems. In connection with their customer payments, the banks take advantage of float opportunities that arise within the agreed timetables. Costs of delay are so high in Finland that the banks try to avoid delays that trigger penalties by obtaining sufficient liquidity in advance.

2.5 Liquidity needs

Banks' liquidity needs depend on the volatility of their payment surpluses and deficits. If the volume of payments is evenly distributed and banks' balances are subject to proportionate expansions and contractions in response to external factors, liquidity needs can be fairly small relative to payment volumes. If payment volumes fluctuate widely, more liquidity will be needed. Payment flows depend on payment decisions of individual customers and hence are difficult to predict in advance. In order to be able to fulfil its payment obligations, a bank must anticipate its coming liquidity needs over different time horizons (day, week, month etc) and also be prepared for unexpected needs. If the costs associated with a liquidity shortfall are high, banks will find it propitious to keep abundant supplies of liquidity on hand.

Figure 1. **Fluctuations in liquidity and counterparty risk**

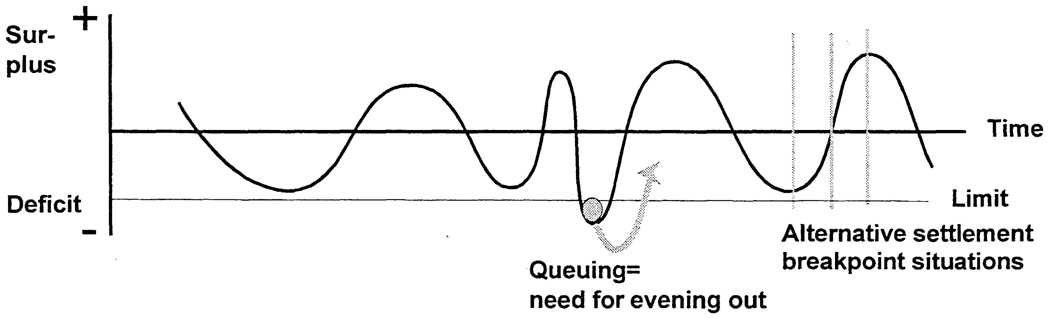


Figure 1 depicts in a general way and from a bank's perspective some basic ideas concerning payment flows. If a bank's balance is in deficit, it must obtain liquidity or funds transfer credit from other participants. A surplus bank will need to grant credit to other participants if the system is based on funds transfer credit. Peaks that exceed absolute limits must always be evened out by deferring payment or obtaining liquidity.

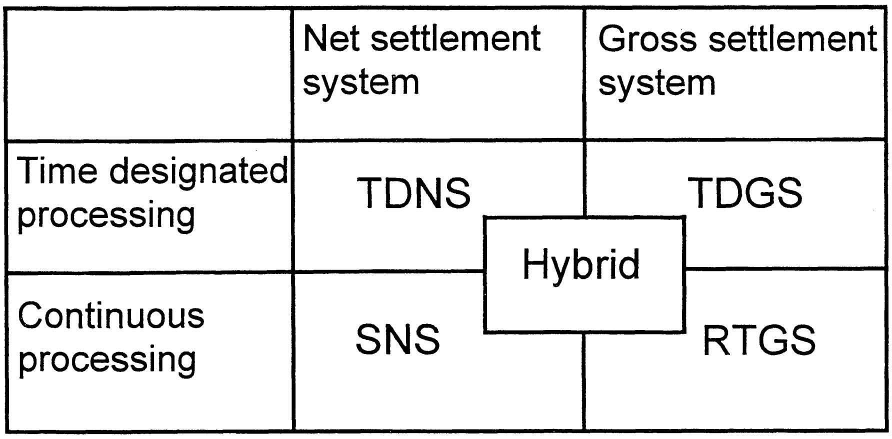
In a continuously operating system, a bank will need to continually monitor its liquidity position. In a system on a daily timetable, the end-of-day position is critical. End situations are characterized by fluctuations in liquidity needs similar to those that occur during the day, and banks must ensure that they have adequate liquidity on hand. Liquidity is usually obtained from or invested in overnight or longer-maturity markets as necessary. Effective liquidity management requires anticipation of coming needs. Intraday and overnight liquidity needs are determined by system structural factors and fluctuations in customers' payment flows.

Differences between the liquidity needs of gross and net systems depend on fluctuations in payment flows. It is generally assumed that net systems require less liquidity than gross systems because the intraday peaks are evened out. However, a kind of continuous netting also occurs in a centralized gross system in that liquidity circulates among the banks in step with the transactions. Various practices for evening out liquidity needs during the day have been created for gross systems (see section 3.3 for more detail). Various system structural factors also affect payment flows (see section 3.4 for detail). Liquidity needs vary across different payment system environments depending on observed practices and payment flows. Different types of settlement models and related liquidity and counterparty risk aspects are examined in the following.

3 Settlement models

3.1 Settlement systems without counterparty risk

Payment systems without counterparty risk can be classified into the following groups[5] according to their operational methods.



In a netting system, interbank payments are netted whereas in a gross system, settlements are executed individually or in batches without netting. In a time designated system, payment transactions and covering funds are collected and settled collectively. In a continuous processing system, payment transactions are executed individually on a continuous basis and usually in real time.

In a time designated net settlement (TDNS) system, payments are collected in batches for netting. A bank will then transfer funds to cover each of its bilateral or multilateral net positions. Execution timetables for payments and settlements are usually synchronized so that, after a payment deadline, settlement is executed at the end of the day or on the following day. Counterparty risk does not arise if payments are credited to customer accounts only after receipt of covering funds from the payer bank. The Finnish interbank payment system (PMJ) will operate according this principle after counterparty risks are eliminated (presumably in 1999).

In a time designated gross settlement (TDGS) system, payments are batched but not netted. A bank will send funds to another bank sufficient to cover all its payments (ie the gross payment) to that bank. Each bank may operate according to

[5] See also BIS (1997), p. 5 and Angelini – Giannini (1993), p. 31.

its own timetable. This is common settlement practice in international payments when a correspondence network is used.

In a secured net settlement (SNS) system, payments are credited individually and immediately but final settlement occurs at designated intervals (usually at the end of the day). Intraday risks are eliminated by collateral arrangements. Each participant has a fully collateralized debt limit. Transactions exceeding the limit are not executed but instead are queued to await freeing or raising of the limit. Transactions are processed continuously throughout the day.

In a real time gross settlement (RTGS) system, payments and settlements are executed continuously during operating hours on a transaction-by-transaction basis and in (or almost in) real time. EU central banks will offer RTGS services after the introduction of the TARGET system[6]. The Bank of Finland's current account facility (BoF-RTGS system) includes RTGS services. Finnish banks use the RTGS system for their large-value payments exceeding the gross transfer limits set bilaterally by the banks.

In hybrid systems, the different features of conventional settlement systems can be applied case by case. The principles of gross and net settlement can be combined by eg operating mainly on a gross basis but netting queued transactions so as to save on limits or real-time covering funds. Continuous real-time processing is interrupted and transactions queued whenever covering funds or limits are insufficient. Plans call for the introduction of a system for queuing and netting queued transactions within the BoF-RTGS system, which will give the system some hybrid features.

3.2 Settlement systems with counterparty risk

Settlement systems with counterparty risk operate in two phases. In the first phase, payment transactions are processed and customer accounts credited, which creates a debt position and counterparty risk between a sending bank and a receiving bank. In the second phase, this debt position is settled with central bank money or other acceptable liquid assets. Settlement can be executed either on a net or gross basis and is usually done at designated times. In other words, in a settlement system with counterparty risk, final settlement is effected on a TDNS or TDGS basis. Of these, the TDNS system is the more commonly used, due to the significantly smaller liquidity needs.

[6] TARGET is a payment network formed by the EU central banks. It will be introduced at the start of 1999, after which participants in national RTGS systems (mostly credit institutions) will be able to make cross-border payments to each other almost in real time.

Payment systems with counterparty risk can be classified into following groups [7]

	Credit-based system without limits	Credit limit based system with risk limits	Limits + loss sharing rules
Decentralized counterparties	DCS	DCLS	DCLS+LSR
Centralized counterparty	CBCS	CBLS	CCLS+LSR

In almost all payment systems with counterparty risk, limits are being introduced to contain maximum risks. If no ceiling is set for counterparty risks, this means that in a bank-specific crisis counterparty risks are realized at full value to the other banks and that risks can accumulate as long as the problem bank continues to participate in the system.

Banks may agree on loss sharing rules (LSR) in order to even out their losses. To reduce potential losses, banks may also agree on partial collateralization of limits or participants' advance contributions to a loss sharing fund. A loss sharing system is often based on the amount of the limit.

A system may be decentralized, in which case the banks transfer payments directly to each other and maintain bilateral limits. In a centralized system, one participant acts as a counterparty to all the banks, each of which has only one account - held with the central participant.

A decentralized credit-based system without limits (DCS) does not impose limits on funds transfer credits. The present settlement practice of the Finnish interbank payment system (basic funds transfers including credit transfers, card payments and direct debits) corresponds closely to the DCS model, without restrictive credit limits. The banks have no limits on intraday interbank debt. As mentioned above, cover is transferred at the end of the day in the BoF-RTGS system, after multilateral netting.

A central bank credit-based system without limits (CBCS) has no limits that restrict funds transfer credit. Central banks usually have limits and collateral requirements that do restrict credit granting. In Finland the central financial institutions of the cooperative banks and savings banks are committed to fully guaranteeing their member banks' funds transfer credits. Presently, due to technical capacity limitations, they are able to monitor credit positions only ex post.

[7] See also BIS (1997, p 5) and Angelini – Giannini (1993, p 31).

In a decentralized credit limit-based system (DCLS), banks set bilateral credit limits for intraday funds transfer credit. Bilateral payment flows may be netted. A bank's overall risk position in the payment system consists of the aggregate debt position of its counterparty banks.

According to plans, the Finnish POPS system for express transfers and large cheques will commence operations - based on this principle - in spring 1998. The settlement practice of the Finnish interbank payment systems PMJ will be changed so that in the first phase, starting at end-1998, limits will be set on counterparty risks, ie the system will become a DCLS. Then in 1999 counterparty risks will be eliminated by crediting customer accounts only after cover has been transferred, ie the system will become a TDNS.

A decentralized credit limit-based system with loss sharing rules is referred to as a DCLS+LSR.

EBA's ECU clearing system[8] is for the most part a DCLS+LSR, even though netting of payment claims (SOS arrangement[9]) introduces some elements of a centralized system. Presently, no Finnish banks are participating in ECU clearing, even though one Finnish bank is a member of the EBA. Two Finnish banks have applied for clearing rights.

In a central bank credit limit-based system (CBLS), banks have access to intraday credit from the central unit, subject to prescribed limits. Since the system has no loss sharing facility, the central unit must be a national central bank or a special private central financial institution with an very strong capital base or other means of ensuring its loss-bearing capacity. Consolidation of cooperative and savings banks has changed the roles of the Finnish central financial institutions, but they still operate as clearinghouses for their member banks.

In a centralized credit limit-based system with loss sharing rules (CCLS+LSR), the central unit can be a clearinghouse with little equity capital, since any credit losses are shared by the participating banks.

Both systems with and without counterparty risks have their counterparts. If in a CCLS+LSR a sufficiently large loss sharing fund is collected in advance, the system becomes an SNS system without risk. If a central bank is the central unit in a CBLS, the system, from the banks' viewpoint, is an RTGS system without risk. Final settlement is executed with central bank money, but here the central bank assumes credit risk by granting uncollateralized intraday credit. Aspects of central bank credit policy are examined in more detail in section 7.

In a system with counterparty risks, transactions can be processed continuously or in batches, in the same way as in counterparty-risk-free systems. Counterparty limits must be imposed in connection with processing. If limits are reached, payments are queued, as is the case in a risk-free system, whenever cover or limits are insufficient. The information technology requirements are much the same as regards liquidity transfers and monitoring of counterparty risks.

Central banks have been concerned with the magnitude of risk in netting systems with counterparty risks and have prepared minimum standards for limiting these risks to a reasonable level (Lamfalussy report[10]). The key

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[8] The EBA (ECU Banking Association) is an interbank organization for clearing large-value ECU payments. The importance of EBA's clearing system will increase when it begins to clear euro payments.

[9] The SOS (single-obligation-structure) combines all of an individual bank's payment claims into a single system obligation.

[10] BIS (1990).

requirement is that a payment system must be able to survive a situation where the participant with the largest debt position becomes insolvent.

Since the report was published, netting systems have been improved, especially in the EU, so as to meet the Lamfalussy standards as part of the minimum common standards for EU payment systems[11].

3.3 Settlement optimization

Liquid assets and limits are always in limited supply. Since they entail costs, it is worthwhile to minimize the need for them. In general, the more even the two-way payment flows, the narrower the fluctuations in the needs for liquidity and limits.

The following practices may be used to even out payment flows and settlements:

- queuing, prioritizing and reordering transactions
- timing rules and rules of the game for evening out payment flows
- netting of transactions and
- breaking down of oversize transactions.

Queuing may be decentralized, ie handled in participants' systems, or centralized in a common, continuously processing system. Transactions being processed are queued when the sending bank has insufficient cover or limit. Queues usually operate on the first-in-first-out (FIFO) principle. In some systems, transactions are separated by priority into different queues and executed FIFO within their respective queues. A system may also include time limits for processing, as a means of ensuring timely execution of time-critical transactions. Participants may also have the possibility of rearranging queues. The objective of a queuing facility is to optimize queues according to how time-critical the payments are and to evening out payment flows over time.

All of the above queuing features will become available to BoF-RTGS system participants in early autumn 1998.

Timing rules and rules of the game for evening out payment flows enable participants to reduce their liquidity needs. The objective of the rules of the game is to have liquidity circulating continuously and evenly. If all banks operate according to a similar payment schedule, liquidity circulates effectively. Should any participating bank operate on a slower schedule or defer payments, liquidity will get stuck somewhere instead of circulating effectively.

Queue netting is possible in centralized systems. The objective of a netting queue is to enable unwinding of gridlock[12] situations without resorting to additional liquidity or limits. In this case the settlement system checks transactions in bank-specific queues in order to form groups of transactions that can be settled by netting with the available liquidity. However, this procedure involves a difficult choice whenever it is possible to unwind either subgroup A or subgroup B but not both. Thus the participants must agree on legally valid criteria for making such choices.

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[11] EMI (1993).

[12] Gridlock occurs when banks await payment/cover from each other in a circular fashion (eg C owes A, which owes B, which owes C) but none have sufficient liquidity to unwind the situation.

In early autumn 1998 the BoF-RTGS system will operate with aggregate netting of queues, ie netting takes place only if all queued transactions can be settled at the same time. This practice avoids the choice problem.

Breaking down of oversize transactions. In a continuous processing settlement system, the huge transactions cause the greatest liquidity needs. The breaking down of transactions can be done either centrally or within decentralized systems. If done centrally, the procedure can be carried out so as to be transparent to the participants. Technically, the breaking down can also be done by adopting a maximum transaction size for processing. Larger transactions are broken down by the participants into two or more 'technical subtransactions'. Breaking down transactions enables nearly full usage of system liquidity for settlement purposes at all times. This means that liquidity is circulating rapidly from bank to bank and that the system is economizing on its liquidity. Technically, this increases the number of transactions processed in the system. It may also aid in unwinding a gridlock if there is some unused liquidity in the system.

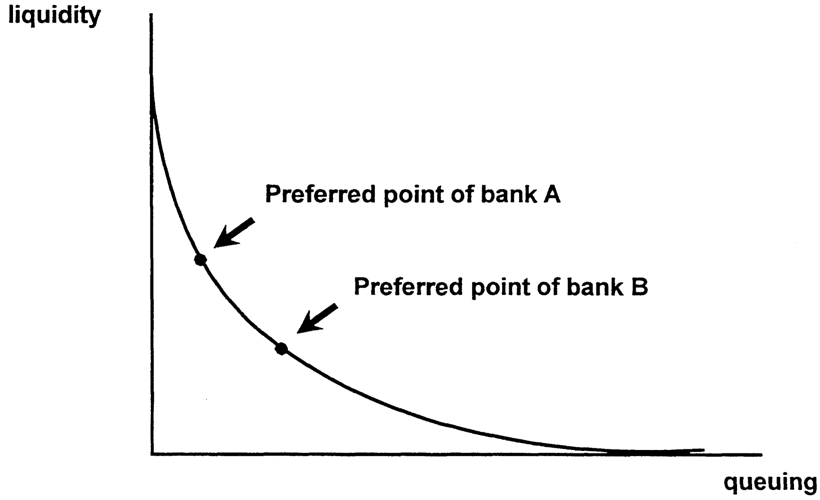
Breaking down settlement transactions may in some cases create new situations requiring operative and legal solutions, eg when some subtransactions are still in progress at closing time and a participant has been declared insolvent. Breaking down transactions is technically and legally challenging.

There are no current plans to introduce this feature in the BoF-RTGS system.

The end results of queue netting and breaking down transactions are very similar. Once these options have been exhausted, deficit banks can only queue their transactions, ie obtain further liquidity or wait for incoming payments.

The relationship between liquidity and queuing is presented in figure 2.

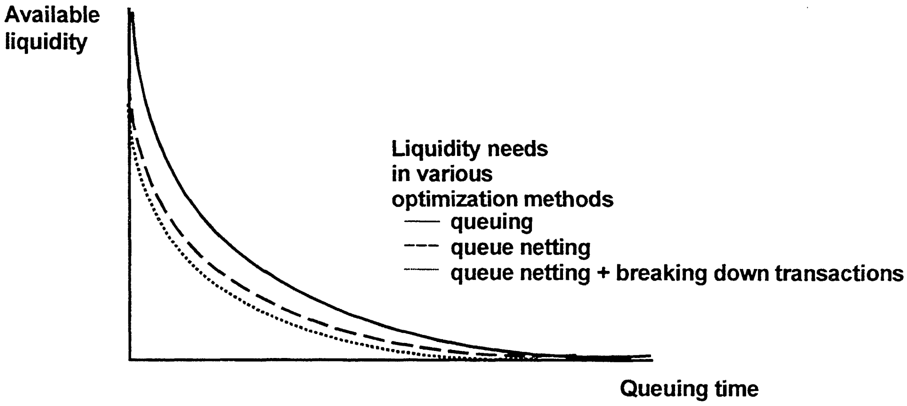
Figure 2. **The interdependence of liquidity and queuing**



If there is sufficient liquidity to cover peak needs, all transactions can be processed immediately without queuing. If the liquidity in a pure RTGS system is less than this, queues can arise. In the extreme case of a system with no liquidity, queues are extremely long and payments are not timely processed. A participant can usually choose its preferred point on the curve in figure 2. If the costs of settlement lags are small compared to costs of obtaining liquidity, it is more advantageous for a bank to operate on the right side of the curve, ie to queue transactions. In contrast, if the costs of settlement lags are high compared to liquidity costs, it is more profitable for a participant to operate on the left side of the curve and avoid queuing. Liquidity costs and settlement delay costs vary according to system and transaction (see section 2 for more detail).

This curve can be shifted leftward, ie liquidity and queuing needs can be reduced, via queue netting and breaking down of transactions (figure 3).

Figure 3. **Liquidity optimization**



The advantages of optimization features vary according to the system, depending eg on structural and cost factors. Figure 3 presents only the baseline theoretical situation. The significance of optimization practices increases as costs increase. It is worthwhile to invest in optimization features if the advantages gained in terms of lower settlement delay costs outweigh the costs of installing the features and the risks remain unchanged.

3.4 The effects of payment system structures on liquidity needs

The structures of banking and payment systems[13] have a significant impact on liquidity needs.

<u>A banking system's liquidity needs are increased by</u>

- having more banks, since liquidity is then spread among more participants, in which case more liquidity is held for precautionary purposes and more is tied up in waiting. (In a large bank internal transactions are executed internally in real time, without external liquidity. There is less interbank transferring of funds in a system consisting solely of a few large banks.)
- significant differences in the sizes of banks and hence in transaction sizes
- different degrees of specialization, which means that the size of funds transfers will not be proportionate to bank size

[13] See also BIS (1997, p 20).

A payment system's liquidity needs are increased by

- the settlement model and optimization methods applied
- distribution of payments into various payment systems (multiple parallel RTGS and/or DNS systems)
- number of time-critical net settlements
- number and time-criticalness of the interfaces for foreign payment systems
- the interdependence of different payment flows.

Liquidity needs of securities markets and securities settlement systems are increased by

- settlement practices
- number of markets and securities settlement systems
- concentration of markets and payment flows within certain short periods
- concentration of exceptional payment flows within certain periods
- frequency of oversize payments.

The effects of these factors are not completely unambiguous but depend in part on circumstances and examination viewpoint. A given situation may increase liquidity needs in a certain bank while reducing them in another. The situation can vary considerably according to the nature of the banks' queued transactions and the agreed market practices. Generally, liquidity needs can be reduced by evening out liquidity peaks, eg by batching settlements in subsystems and using the settlement optimization practices presented in section 3.3.

From a liquidity standpoint, present settlement practices of banks operating in Finland can be characterized as follows:

- the separate time-critical clearing of loro transfers[14] increases liquidity needs
- the time-critical settlements of the guaranteed net clearing of the Helsinki Securities and Derivatives Exchange (HEX) and the Finnish Central Securities Depository (FCSD) skew the payment flows in that these institutions absorb liquidity and return it to receiving parties only after several hours
- banks vary considerably in size and specialization is increasing
- certain participants process oversize (relative to their own size) transactions and
- the guaranteed net clearing of the FCSD requires considerable collateral.

Liquidity needs can be reduced significantly in Finland by concentrating transactions within a single system or at least a smaller group of systems and by introducing liquidity optimization methods in the RTGS system. The simulation model for payment system liquidity needs (developed at the Bank of Finland) is uncovering possibilities for reducing liquidity needs and helping to clarify liquidity dependencies in Finnish payment systems.

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[14] Credit transfers of foreign banks and other customers to and from Finnish banks. Merita Bank Ltd calculates total net positions for each bank and transfers payment orders to the Bank of Finland for so-called loro clearing. In 1998 RTGS transfers will be introduced for large-value loro payments (exceeding FIM 50 000).

4 Liquidity needs in different models

Liquidity needs vary according to the settlement model employed and can be influenced by changes in structures and practices.

Time designated processing: Time designated net settlement (TDNS) requires less liquidity than time designated gross settlement (TDGS), since liquidity needs can be netted.

Continuous processing: RTGS systems use less liquidity resources (central bank money and eligible collateral) than SNS systems, in which collateral is posted for intraday credit limits on funds transfers. In an RTGS system a participant uses the balance on its central bank account or obtains an intraday limit from the central bank by posting collateral. Limit needs are the same in the two processing models. However, the final settlement of an SNS system requires additional liquidity to cover the total net position. If collateral can be used for the final settlement in an SNS system, the liquidity needs will be the same as in an RTGS system.

The guaranteed net clearing of the FCSD is a typical SNS system requiring considerable liquidity resources compared to transaction-specific RTGS clearing.

Comparing the liquidity needs of the most efficient time designated (TDNS) and continuous processing (RTGS) payment processing models is best done by assuming the same delivery time requirements for transactions, which results in equal liquidity needs. In practice this means that if payment processing is to be accelerated in time designated systems, additional settlements must be effected during the day. If the speed of a time designated system is sufficient, transactions can be queued in an RTGS system until processing time in the time designated system. Thus the liquidity needs in RTGS and TDNS systems are the same if delivery time requirements are the same. In an RTGS system the clearing account is netted continuously during processing. However, there is a danger of gridlock in a pure RTGS system, which may be caused by skewed payment flows or oversize transactions. The RTGS model can be enhanced via the optimization methods of hybrid systems, thereby avoiding gridlock. One reason for developing RTGS systems was to enable faster payment transfers than in TDNS systems.

Hybrid systems aim at utilizing the features of different models according to transaction-specific needs. In a versatile hybrid system, transactions can be processed at designated times, queues can be netted, urgent transactions can be prioritized for immediate processing, etc. Hybrid systems are designed to optimize delivery times and liquidity needs on the basis of given limitations and costs. Hence hybrid systems are generally the most efficient systems, since they offer the widest possibilities for taking various delivery time requirements into account. The present, pure systems will probably gradually evolve in time into hybrid systems in which delivery time requirements are taken into account.

5 Counterparty risks in different models

The extent of counterparty risk in different systems depends on the volume and composition transactions processed. A bank can control its counterparty risks by setting bank-specific counterparty risk limits for intraday funds transfer credit. When counterparty limits are reached, transactions are queued to await the freeing up of liquidity. A limit can be freed eg by countertransactions or cover transfers. Counterparty risks can be reduced by collateral requirements, and realized risks can be evened out via loss sharing arrangements.

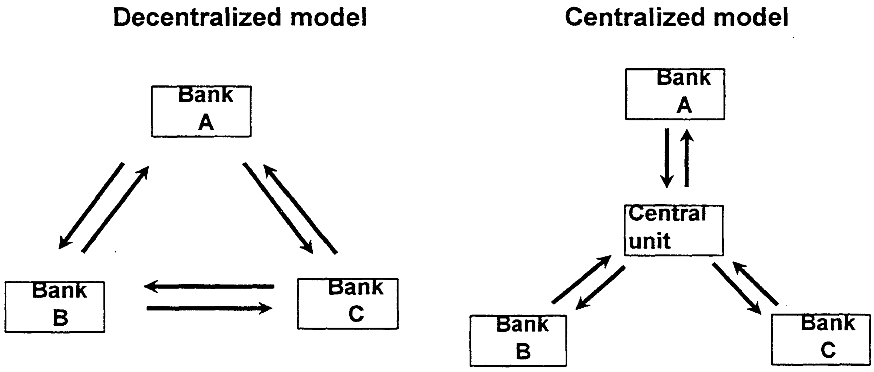
In a decentralized system counterparty risks stem from bilateral net positions at a specific time during the day. Positions are usually settled at the end of the day. Counterparty risks can be large in systems with only some bilateral transfers and/or if transfers are unevenly distributed. Specialization among banks is leading to a situation where interbank funds transfers are often not in balance. In a nonbalanced decentralized system, a lengthy processing cycle prior to final settlement will also mean large counterparty risks. In decentralized systems transfers must be settled several times during the day in order to free up limits and process queued transfers.

The Finnish banks' POPS system is a typical system based on decentralized credit limits. Cover transfers are executed on an RTGS basis when limits are reached, in order to prevent processing stoppages during the day. EBA's international ECU Clearing system is another example of a payment system with counterparty risks.

The key difference between a decentralized system based on counterparty risks and a continuous system based on cover transfers stems from the fact that counterparty risks cannot be transferred. Liquid funds can be reused and transferred during the day. Counterparty risks will only accumulate during the day, since only bilateral payments can be netted in a decentralized system. In the example shown in figure 4, surplus funds flow in a circle from A to B and from B via C back to A. In this case, counterparty risks cannot be totally netted out.

An exception to this is the single obligation structure (SOS) of the EBA Clearing system, where a multilateral agreement is used to guarantee a legally valid aggregate obligation to all participants, which no single creditor can contest. The validity of this structure in all situations is under examination.

Figure 4. **Basic features of decentralized and centralized models**



In a centralized system counterparty risks are netted multilaterally. Throughout the day, the central unit has a net position vs each participant. Because of the credit positions, the central unit carries counterparty risk. It can set counterparty-specific limits and a limit for aggregate debt positions. Exceeding a limit triggers a processing stoppage and a queuing of transactions. In liquidity transfers executed according to the centralized model, eg including the central bank, liquidity needs are evened out multilaterally.

A centralized credit limit-based system uses IT solutions similar to those of counterparty-risk-free SNS and RTGS systems. The credit positions in CBLS and CCLS+LSR systems, the guaranteed credit position in an SNS system and the liquidity needs of an RTGS system are all the same size for the processing of identical transactions under the same timetable and same restrictions (credit limit and amounts of collateral and liquidity).

Compared to a decentralized system, the counterparty risks in a centralized system are, in principle, always smaller (or in exceptional situations of equal size). The difference depends on the netting level of the decentralized system.

In a system based only on limits, a bank's risk of loss equals its current position vs the problem bank. The risk size can be directly affected by adjusting the limits.

In a centralized system based only on limits, the central unit must have a very strong capital position that enables it bear possible credit losses. The size of the potential loss can be affected by bank-specific limits and an aggregate limit for the whole system.

In a loss sharing system, a bank's risk of loss depends on the aggregate risks of the system vs the problem bank and the loss sharing rules. Losses can be spread among the survivors and recovered in part from the problem banks by requiring advance posting of partial collateral.

According to a commonly used loss sharing rule, losses are allocated among survivors according to set limits. An individual bank's amount at risk at any moment is the same proportion of the problem bank's total used limits granted by all the nonproblem banks as its proportion of the total (used and unused) limits granted by nonproblem banks to the problem bank. Hence, if the problem bank has utilized in full all the limits granted to it by nonproblem banks, the loss sharing system has no effect. Other possible bases for sharing losses are bank sizes and payment volumes. The objective of a loss sharing system is to reduce losses to a single bank. An effective loss sharing system requires a large number of participating banks, relatively large unused aggregate limits, and infrequent losses to be shared.

However, a loss sharing system does not eliminate systemic risk; loss sharing practices can usually cover only moderate losses. Regardless of loss sharing, a large loss can cause a chain reaction and hence a systemic crisis.

To be able to recover losses from problem banks requires advance posting of collateral or accumulation of a separate loss sharing fund. If full collateralization is required, the CCLS+LSR becomes an SNS system without counterparty risk.

In an uncollateralized central bank credit limit- based system (CBLS), the central bank assumes all of the counterparty risk on behalf of the participant banks. The central bank usually prices its uncollateralized intraday credit and thus operates as a kind of insurance company. From the banks' viewpoint this model is extremely close to a counterparty-risk-free model, viz an RTGS system.

There may be some legal uncertainty as regards settlement finality. Bilateral and multilateral nettings are not necessarily legally valid in the event of bankruptcy. Currently there is some uncertainty concerning settlement finality in Finland and elsewhere. This uncertainty increases counterparty risks. The EU directive on settlement finality (currently being implemented) will remedy this situation in respect of interbank settlements.

6 Comparison of liquidity needs and counterparty risks: the banks' viewpoint

Payment systems operate on the basis of either liquidity or counterparty risk. A system can also apply both operational modes depending on payment type or as a means of reducing risks, in which case a funds transfer is required whenever counterparty risks are exceeded.

Technical IT solutions are almost identical in systems for continuous registering of either covering funds or counterparty risks. The transactions are recorded on the basis of either the debit or credit principle. In payment systems comprising more than two parties, credit and debt positions differ according to counterparty even if total sums are identical. Payment systems counterparty risks are generally cumulative and nontransferable. The probability of counterparty risk realization depends on the overall risk level of the banking sector and bank-specific risk factors.

Generally, it is advisable to view funds transfer credit solely as an intraday phenomenon. Counterparty risks are covered at the end of the day at latest by transferring covering funds, usually in the form of central bank money. Interest-free counterparty risk is not allowed to remain overnight, so as to obviate the possibility of alternative investments in the overnight markets. The existence of shorter-term (eg hourly) markets would probably shorten the duration of counterparty risks. There is an incentive for settling payments more often if alternative investment opportunities exist in the markets.

6.1 Models with and without counterparty risk: the banks' viewpoint

In models without counterparty risk, the sending bank sends covering funds or collateral as part of the payment process. It is inherent in models with counterparty risk that the sending bank obtains the benefit of an uncollateralized and interest-free funds transfer credit from the receiving bank as part of the payment process. Covering funds are sent later.

There is no incentive for an individual bank to grant uncollateralized and interest-free funds transfer credit to another bank unless it expects to obtain similar credits/benefits by participating in the settlement or payment system. Hence models with counterparty risk always entail the principle of reciprocity, which enables banks to reduce or completely avoid the costs of intraday liquidity.

The prerequisites for a system based on reciprocity are

- liquidity positions of participating banks should be relatively stable. Generally, a bank that has a surplus position throughout the day will have no incentive to participate in this kind of system, since it means that they will be continuously assuming risk vs deficit banks, which unilaterally benefit at the expense of surplus banks
- participating banks should have similar risk levels, ie for each participant the total of the counterparty risks assumed, each multiplied by the probability of its realization, should be on a par with the analogous total for credits received. Riskier banks are thus granted smaller limits. Banks with large risks must in

this case supply liquidity during the day to banks with smaller risks as limits are reached, without receiving liquidity in return, due to the higher limits

- costs of extra intraday liquidity exceed costs of counterparty risks.

In summary, models with counterparty risk can be used by a homogenous and stable banking group if liquidity costs exceed counterparty-risk costs.

Models with counterparty risk have commonly been used in situations where banks operate under a state guarantee. In financial systems where banks cannot become insolvent, there is little likelihood of a counterparty risk realization in connection with interbank credits. Awareness of and interest in funds transfer counterparty risks have increased due to the strong growth of funds transfer volumes. Previously, counterparty risks inherent in payment systems were at a much lower level. In a market-oriented environment, banks try to reduce their counterparty risks. Specialization among banks usually increases the heterogeneity of the banking system as well as the degree of imbalance in funds transfers.

6.2 The effects of loss sharing systems

Loss sharing systems can operate according to two principles: losses are either shared by the survivors or covered by a loss sharing fund set up in advance. In the latter case, a problem bank will also have contributed to the fund.

Loss sharing by survivors, eg pro rata to bank-specific limits, is a means of limiting situation-specific risks of individual banks. This practice works well if the number of participants is large, there are few risky banks, and funds transfer counterparty risks are relatively small compared to banks' risk-bearing capacity.

Setting up a loss sharing fund in advance is very similar to requiring collateral to cover counterparty risks. Thus a loss sharing fund is a means of controlling a system based on partial collateralization. The degree of collateralization of limits can be adjusted by defining the size of the loss sharing fund relative to the credit limits. When the loss sharing system covers all losses, the system corresponds closely to a collateralized SNS model.

6.3 The central unit and the participants

The central unit can be a national central bank or a private central financial institution. National central banks are examined in more detail in section 7. Private banks will willingly use the services of a national central bank if they are cost-effective (pricing of central bank credit, participation costs and transaction fees must be advantageous).

The main groups to establish private central financial institutions are the cooperative and savings bank groups. A private central financial institution usually serves a large group of small banks of equal size. As regards funds transfers, this institution acts as a clearing and settlement centre. If a private central financial institute assumes counterparty risks, they will usually be covered by a guarantee fund set up in advance. Thus, as regards counterparty risk, a private central financial institution corresponds to a loss sharing fund set up in advance. If the loss sharing fund covers the maximum counterparty risk, the system is free of counterparty risk.

6.4 Comparing the costs of liquidity and counterparty risk

For an individual bank, the cost of obtaining liquidity derives from the returns/ costs of central bank money, ie alternatives to and costs of holding liquidity, opportunity costs of using collateral and direct costs of central bank credit.

Costs of counterparty risk consist of the degree of usage of limits, the probability of risk realization, and the effects of a possible loss sharing system.

Comparison of liquidity and counterparty-risk costs is difficult and depends on the circumstances. The probability of realization of bank risk is particularly difficult to estimate. Costs can be compared indirectly by noting that, in a system with counterparty risks, banks must rely on customer-specific pricing in order to collect funds for potential risk realization. Banks have credit loss reserves to cover such potential losses. The amount of reserves must cover at least the average loss and the maximum single loss so as to prevent the bank assuming the counterparty risk from getting into trouble itself. To further reduce the likelihood of liquidity problems, credit loss reserves can be increased to cover also multiple simultaneous (or nearly simultaneous) losses. Such funds should be invested in appropriate instruments.

Of models with counterparty risk, the centralized CCLS+LSR should be compared to the RTGS model without counterparty risk, since in decentralized models counterparty risks may become substantial.

The potential benefits that an individual bank gains from participation in a homogenous and balanced CCLS+LSR based system, as compared to processing the same transaction in an RTGS system, consists of the following factors, assuming equal processing costs:

- CCLS+LSR system
  - the average sizes of counterparty risks and probabilities of realization
  - (opportunity) costs connected with a loss sharing system
  - (opportunity) costs connected with credit loss reserve
  - liquidity costs of covering funds needs in excess of the counterparty limit
- RTGS system
  - intraday liquidity/collateral need and related (opportunity) costs.

Assuming identical investment in liquid instruments of the funds required for loss sharing, credit loss reserves or liquidity needs, the models differ in a narrow day-specific comparison as regards the remaining costs of counterparty risk and the need for extra intraday liquidity (in addition to funds reserved for loss sharing and credit losses). The result will be highly situation-specific and dependent on the liquidity and costs of risks in each case.

It can be generally stated that if counterparty limits are extremely low, the systems are equivalent, since most transactions require gross settlement due to the low limits. If counterparty limits are extremely high, the overall risks are considerably greater. Collateral tied up in loss sharing systems and credit loss reserves will be sufficient for the needs of an RTGS system. In a static single-period (one-day) analysis, the RTGS model is superior in both extreme situations. However, it can be assumed that there are situations with reasonable counterparty limits in which the CCLS+LSR would be superior.

However, a bank's liquidity position and costs should be examined over more than one period. A bank needs liquidity in all models at the end of the day at latest. Liquidity needs are difficult to estimate, since they depend on the payments of individual customers. Thus a bank should prepare in advance for fluctuations in its end-of-day liquidity position. Liquidity can usually be used throughout the day, which means that a bank has liquid funds available for RTGS transfers throughout the day. In a dynamic analysis covering a number of settlement periods (days), the RTGS model turns out to be superior in all cases where the intraday liquidity need caused by payment flows is at the same level as the overnight (inter-settlement) liquidity need, since there are no risk costs. A CLS+LSR model can only be superior where the intraday (intrasettlement-period) variation is so much greater than the liquidity need for inter-settlement periods that the costs of additional liquidity in the RTGS model exceed the risk costs of the CLS+LSR model.

Several theoretical studies have compared different settlement models, especially the RTGS model and the CLS models. The results vary according to the model structure and the level of cost and risk factors[15].

6.5 Liquidity 'hoarding' and optimal payment practices

In a continuously operating system a situation may arise where one participant attempts to minimize its momentary liquidity need by systematically delaying its outgoing payments (hoarding liquidity) and waiting for other banks to pay first. This may be advantageous to the individual bank if it has occasional peaks of liquidity need exceeding the average. These peaks may arise due eg to structural factors in payment systems (see section 3.4 for more detail).

When the payments are subject to definite time limits, this kind of delay may result in a situation where all participants wait until the last moment, thus creating a rush at the end of the period. This situation can easily cause problems in systems and generate the risk of late payments.

Systems and payment practices[16] should be developed by
changing structural properties that cause rush and liquidity peaks so as to even out liquidity needs

- requiring that transactions be entered into a queuing system early enough for the queuing system to be able to clear peak rushes by optimizing liquidity eg via netting queues
- requiring from each participating bank minimum start-of-day liquidity relative to its payment volume
- higher pricing of transaction processing for rush hours
- applying, as necessary, clear sanctions for late payments and settlements.

Interest bearing investment outlets for liquid funds during the day, eg in hourly markets, create an incentive for banks and large customers to delay payments to the last possible moment in order to maximize interest earnings. The long run trend seems to be toward more exact planning for intraday liquidity needs.

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[15] See eg Angelini (1994), Angelini – Giannini (1993), Freixas – Parigi (1997), Kobayakawa (1997), Schoenmaker (1995).

[16] See also BIS (1997, p 19).

7 The central bank viewpoint

7.1 The role of the central bank

The role of central bank in a payment system includes the following tasks:

a. provision of a current account facility that enables banks to make payments with central bank money within the payment systems
b. provision of settlement services in connection with the current account facility, eg RTGS transfers, net clearing and transactions queuing
c. provision of intraday and longer-term liquidity credit, usually collateralized (genuine credit), as well as the possibility of using possible reserve deposits for making payments during the day
d. enabling the conversion of securities into central bank money via repo transactions (genuine commercial agreement)
e. broad oversight of the systems and related activities so as to avoid liquidity and systemic risks, ie to stabilize payment systems. In respect of liquidity and systemic risks, the central bank may at its discretion act as lender of last resort
f. participation in the development of payment systems infrastructure and operations, in cooperation with other participants.

Though there is little difference between points c and d as regards practical liquidity management, in some countries their applicability is affected by legislation. Central banks may require full collateralization of credit or they may assume counterparty risk in granting uncollateralized credit. Presently there is a clear difference in the intraday credit granting policies of central banks. European central banks grant unpriced intraday credit but require full collateralization, whereas the US central bank, the Federal Reserve, grants uncollateralized credit at its discretion, subject to limits and risk-based pricing.

In most countries, funds held in central bank accounts are used to cover interbank payments in domestic payment systems. Settlement using central bank money is final and risk-free. Intraday credit, liquidity credit and repo transactions are the principal means of providing sufficient liquidity for handling settlements in payment systems.

As regards payment systems, national central banks focus on providing central bank money for risk-free final settlements and on the broad oversight of payment systems.

7.2 Credit risks in the CBLS model

In the CBLS model the central bank grants intraday credit to cover the liquidity needs of payment systems. The central bank can provide liquidity without assuming risk by requiring that intraday credit limits be collateralized. A second option is to grant uncollateralized intraday credit, usually within limits, in accord with the CBLS model. In granting uncollateralized credit, the central bank will need to price the credits so as to cover the bank-specific risks, ie by charging bank-specific risk premia. From the banks' viewpoint the central bank CBLS model is totally risk-free. At worst, a risk realization will mean that in the future the banks will have to pay more for central bank credit.

The central bank can choose from among three different theoretical pricing policies[17]:

- pricing credits above risk costs
- pricing credits on a par with risk costs
- pricing credits below risk costs.

In practice, it is difficult to know ex ante which alternative will be realized, but one option must be chosen as a point of departure for pricing.

Pricing intraday credits above risk costs generates profits for the central bank. If such credits are markedly more expensive to banks than eg alternative repo arrangements, banks will resort to alternative funding and the central bank's role will become that of provider of services to crisis banks and backup system for exceptional situations. The greater the overpricing, the more likely the emergence of interbank liquidity markets.

Pricing intraday credit on a par with risk costs means that the central bank is able to cover long-run realized credit risk. Precise determination of this level is difficult in practice. A banks' interest in using central bank credit in this case will be determined by general liquidity conditions in the markets, cost levels of alternative solutions, level of bank-specific risks, and the administrative costs associated with the various options. Since banks have a tendency to somewhat underestimate their counterparty risks, due to eg moral hazard, they often judge the central bank's pricing of risk costs to be excessive.

Pricing intraday credit below risk costs means that the central bank must cover credit losses with other income. Pricing below risk costs makes central bank credit an advantageous source of liquidity. If the price of intraday credit is extremely low, banks will not need to regulate their liquidity during the day; balancing the overnight position will be sufficient.

The effects of risk premia on the use of uncollateralized central bank credit depend on the size of the premia. Since alternative solutions, such as repo transactions, do not entail risk premia, it is probably more advantageous to high-risk-premia banks to use alternative solutions, except in exceptional situations. By charging high risk premia, the central bank can reduce its own risk. On the other hand, the probability of risk realization is higher in exceptional situations, in which case a risky bank will use costly central bank credit only as a last resort. Thus the central bank must actively check its limits in an exceptional situation in order to contain its risks. This may give a clear signal to the markets that will exacerbate the situation for the crisis bank and increase the risks associated with the central bank credit that has been granted to the crisis bank. Bank-specific pricing also requires bank-specific monitoring by the central bank.

Simultaneous use of models with and without risk is possible eg if the central bank offers banks their choice of either unpriced collateralized or priced uncollateralized intraday credit limits, including the extent of usage of each. In this case, the central bank must price the uncollateralized credit at least on a par with risk costs in order to make it worthwhile to make such an offer. The higher the price of uncollateralized credit, the greater the degree to which its use will be limited to exceptional situations.

Finally, in granting intraday credit with risk, the central bank must choose between opposing options, which depend on pricing policy and price level: 'In

[17] Theoretical studies of the pricing of intraday credit include Rossi (1995) and Schoenmaker (1995).

what form will credit be offered to banks in exceptional situations or to what extent are interbank payments to be subsidized via cheap intraday credits?'.

7.3 The effects of collateral policy

The central bank's collateral policy may affect the markets[18] if the collateral plays a significant role in obtaining liquidity. If collateral needs are large and the range of eligible collateral fairly narrow, certain types of securities will need to be acquired for use as collateral. As the demand for such securities increases, an issuer may lower the rate of return and hence obtain a collateral premium. By accepting a wider range of securities, the central bank can reduce such side-effects and spread the market effects over a larger group of securities. The cost effects on banks of collateral requirements is then reduced, since the rate of return on eligible securities increases due to the wider competition. Extension of the range of eligible collateral means that the central bank must do more appraising of collateral.

It is more advantageous to banks that the range of assets acceptable to the central bank as collateral be as extensive and diversified as possible, since this increases the likelihood that a bank will be able to use as collateral those securities it has acquired in its normal business operations.

If the central bank accepts bank certificates of deposit as collateral, the probability of systemic risk may increase. Such acceptance affords banks a good opportunity to finance each another's operations. A bank in need of liquidity can obtain central bank credit indirectly via another bank, which posts the bank paper at the central bank as collateral. In a crisis situation the banks become dependent on each other. A crisis may long remain hidden, since a crisis bank, having used up its eligible collateral, may issue securities so as to obtain liquidity via other banks. The effect on systemic risk will depend on other counterparty risks between banks and on banks' risk management systems.

7.4 The effects of a minimum reserve system

The minimum reserve system used in Finland and many other countries operates on the basis of averaging. The reserve deposits may fluctuate daily during the reserves maintenance period, but the average balance must meet the minimum requirement.

In Finland, as elsewhere, reserve deposits can be used as a source of intraday liquidity within the central bank's current account facility. From the standpoint of the payment systems, these reserves are a cost-free source of liquidity, since they are determined on the basis of banks' funding items. The cost burden to banks depends on the magnitude of the requirements and the interest paid on reserve deposits.

A minimum reserve system reduces payment system risks in two ways. First, the use of a minimum reserve requirement favours the use of an RTGS system by the central bank, since it offers a liquidity source absent opportunity benefits/costs. There is no need for banks to use solutions that entail counterparty-

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[18] See Folkerts-Landau p. 16 and Folkerts-Landau,Garber, Schoenmaker p. 36.

risk costs due to the availability of lower price liquidity. Secondly, a minimum reserve system based on averaging reduces the probability of realization of systemic risk by reducing banks' interdependence in evening out overnight liquidity fluctuations.

7.5 Models with and without counterparty risk and system stability

From the standpoint of broad oversight, payment systems must be evaluated in terms of stability and efficiency. In models without counterparty risk, realized bank risks are left to be borne primarily by the crisis banks. In models with counterparty risk, bank risk is transferred to other participants and may cause the crisis to be spread via the payment systems. Therefore, models without risk are more stable and problem management is easier, especially in crisis situations. The danger of systemic risk is clearly larger in a system with counterparty risk.

In models with counterparty risk, a participant that assumes such risk must price funds transfer services so as to eventually accumulate a risk fund sufficient to cover realized risks on average. However, estimating these risks is very difficult. As regards oversight, bank-based systems entail a moral hazard problem in addition to the estimation problem. Are the banks pricing their funds transfer services high enough to cover the risks? Are all banks operating with sufficient risk margins? There is a danger that some banks will assume that in a crisis the central bank or other authorities would intervene and would thus, for competitive reasons, underprice their risks. The danger of systemic risk is obvious, especially if large banks underestimate their risks.

In a payment system model without counterparty risk there is less need for intervention. Counterparty risks are smaller and cannot spread via the payment systems. Due to the lower probability of central bank intervention, banks must estimate counterparty risks more carefully, which induces them to take fewer risks. Hence the banks' own risk monitoring becomes more efficient[19].

In a risk-free system, the sending bank must obtain sufficient liquidity. In a system with risk, it is the receiving bank or the central bank that will be obliged to carry the primary burden of risk costs. In a risk-free system, settlement costs fall directly on the sending bank and the customer, which gives them an incentive to operate as efficiently as possible.

Which is more efficient - obtaining liquidity or bearing counterparty risk? It is difficult to give a general answer to this question, since it always depends on the situation and the counterparty. The answer also depends inter alia on the risk level of the banking system, liquidity costs, rates of return on eligible collateral, settlement needs of the payment systems, as well as the structures of the banking and payment systems. In a smoothly operating money market, liquidity costs are close to the minimum level of risk costs. In high-risk banking systems, counterparty risks clearly exceed liquidity costs.

If banks take excessive funds-transfer risks on the assumption that society and the central bank would intervene in a crisis situation, this may induce a payment system solution that appears to be more advantageous in the short run and for which the costs will eventually be borne by the society via crises. Thus it is in the interest of society and the central bank to reduce payment system risks and to

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[19] See eg Folkerts-Landau, Garber, Schoenmaker (1996, p 27).

favour solutions without counterparty risks so as to reduce systemic risk and moral hazard problems and increase market discipline. Along with regulation, society may encourage systems without risk via pricing, collateral policy and minimum reserve requirements.

The central banks' view on payment systems counterparty risks has changed, since these risks have been increasing continuously as banking sector regulation has been rolled back and operating environments have become more market-oriented. With authorities' safety nets shrinking, counterparty risks must be reduced in order to reduce systemic risk. Operating on the basis of market forces must not jeopardize the functioning of the whole financial system or its key part.

A report on netting systems prepared by the central banks of the G-10 countries under the aegis of the BIS, the Lamfalussy report[20], prescribes minimum standards for a netting system. Accordingly, netting system participants should have a clear understanding of the risks involved and it should be possible to execute netting even in the case of liquidity problems on the part of the largest participant. The ability to bear the largest credit risk is a necessity in order that this type of netting system be capable of surviving any bank-specific crisis. The report recommends that netting systems should also be able to weather simultaneous disturbances in several banks.

[20] BIS (1990).

8 The effects of developmental trends on settlement systems

Payment systems, which are constantly evolving, are presently in a stage of rapid development. The main factors in this development are increasing operational speed, internationalization, electronification and integration. Payment system risks and the management thereof are under discussion in many countries[21]. This development will also affect settlement practices. Some of these changes are described at a general level in the following.

Common operating hours of central banks. Central banks have begun to lengthen their operating hours[22]. This may lead to intermarket transfers of liquidity. Liquidity is obtained from the central bank on the most advantageous terms considering the transfer costs. Unpriced or advantageous intraday central bank credit may also tempt banks to assume exchange risk in order to earn overnight interest on few-hour deposits in other markets. A possible crisis for an international bank could end up being borne by the final bank, which is the Federal Reserve, since its intraday credits are used to close positions in other countries.

Common operating hours and market integration will probably require unification of central banks' liquidity supply practices.

Continuous 24-hour operations. All signs point to a gradual shift to continuous operation of money markets and payment systems. In a system operating 24 hours a day, the importance of common settlement breaks will diminish. Banks will prepare their (interim) financial statements independently at times that are most suitable to them.

The intraday nature of central bank credit looses its significance in continuous-operation environment, as banks have a continuous need for central bank liquidity. In a continuous operation, central bank limits must be priced in the same way as overnight credit is priced at present.

Shorter interest periods. Traditionally, interest has been calculated on a daily basis. This has been due largely to computational considerations, especially when interest is calculated manually. Modern IT technology enables interest calculations for shorter periods (eg hourly) or even continuously. Faster payment systems and a shift to continuous, 24-hour operations will require shorter interest periods. It is difficult to envisage that the minutes right around midnight would turn out in the long run to be more precious than any other minutes.

More frequent interest calculations will mean that final settlement will also need to be executed at shorter intervals. Banks are not willing to grant each other counterparty limits without interest over the interest period. The potential advantages of payment systems with counterparty risk vs risk-free systems will thus decline over the long run.

International operations may shift payment system risks. Payment systems with counterparty risk can shift their payment system risks across borders. Banks risk levels may vary considerably across countries. Pricing counterparty risks at the international level is more difficult than in the domestic environment.

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[21] See eg BIS (1997), Folkerts-Landau, Garber – Schoenmaker (1996) Giannini – Monticelli (1997) , Matsushita (1997) and Leinonen – Saarinen (1998).

[22] Opening hours eg in Switzerland are 22.5 hours, in the US 18 hours and in Europe 11 hours (after the launch of the euro), BIS (1997).

National central banks will be interested in reducing payment system risks in cross-border funds transfers in order to limit the scope of banking crisis solutions to the domestic situation. In this case multinational banks and systems present problems, which increases the pressure for international cooperation between authorities.

Conditional payments (PVP). In foreign exchange dealing, banks usually transfer payments to each other via two different account-keeping banks and/or the central bank. This creates a settlement risk[23] when there is no certainty of the other participant making the payment. To reduce risks, a payment-versus-payment (PVP) based system is being planned, in which a special clearing bank[24] or the central bank would supervise the simultaneous and final execution of payments to participants in risk-free central bank money.

Whether these future changes will be effected depends particularly on international developments in the wholesale markets. Realization of different kinds of risk will probably accelerate the reduction of payment system risk levels.

Investment payments (DVP): Securities and money market operations are usually based on the delivery-versus-payment (DVP) principle. Securities and payments are delivered simultaneously. Securities depositories see to it that ownership of securities and money are transferred simultaneously so as to reduce counterparty risks. As market participants operate in numerous markets and stock exchanges, there will in the future be a need to change over to payment and securities settlement systems that operate in real time on a transaction-by-transaction basis in order to achieve sufficiently rapid, reliable and flexible operations.

In conclusion, one can say that payment systems and banking services are approaching a turning point from the daily timetable to continuous, 24-hour operations. For payment systems, this will mean real-time continuous operations. This will allow the assumption of more counterparty risk, but liquid assets can also be invested profitably. Thus continuous real-time operations will most likely use immediate RTGS delivery methods for the settlement of large-value payments, as this enables participants with surpluses to best utilize their liquidity position. As regards small-value payments, economies of scale will for the time being favour time designated mass processing of batches several times a day.

[23] See BIS (1996) for more details.

[24] To decrease the clearing risk connected with foreign exchange dealing, the international banks involved are currently setting up a bank called the CLS-bank, which will operate the Continuous Linked Settlement (CLS) system. According to plans, the system will be operational in 2000. See eg Mundt (1997) for more details.

Appendix 1. Settlement practices of Finnish banks[1]

Systems without counterparty risk

	Net settlement system	Gross settlement system
Time-designated processing	TDNS Guaranteed net settlement of FCSD (financial markets) PMJ-3 Net transfers in foreign payments (usually) ECHO	TDGS Gross transfers in foreign payments (usually)
Continuous processing	SNS CLS	RTGS BoF-RTGS-1

HYBRID BoF-RTGS-2 Continuous settlement of FCSD (financial markets)

Systems with counterparty risk

	Credit-based system without risk limits	Credit limit- based system with risk limits	Limits + loss sharing
Decentralized counterparties	DCS POPS-1 PMJ-1	DCLS POPS-2 PMJ-2	DCLS + LSR EBA-clearing
Centralized counterparty	CBCS Internal settlement of cooperative and savings bank groups	CBLS	CCLS+LSR

CLS	Continuous linked settlement; a settlement system for foreign exchange trade (planned start-up in 2000)
EBA-cl.	International ECU/euro-clearing system; Finnish banks to join
ECHO	International settlement system for foreign exchange transactions; Finnish banks may join
PMJ-1	Finnish banks' payment system, original form without risk limits
PMJ-2	Finnish banks' payment system plus bilateral limits for funds transfer credits (12/98)
PMJ-3	Finnish banks' future payment system with interbank settlement prior to final crediting of customer accounts, 8-12/99
POPS-1	Banks' on-line express transfer and cheque systems without funds transfer credit limits; largest transactions exceeding gross limit are RTGS transferred
POPS-2	Banks' future on-line express transfer and cheque systems, with bilateral credit limits (5/98)
BoF-RTGS-1	Bank of Finland's original current account facility
BoF-RTGS-2	Bank of Finland's current account facility with queuing and queue netting facilities

[1] See eg Saarinen (1996) and Herrala (1977a and 1997b) for more details.

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