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The Swiss Interbank Clearing System

1. Introduction

The development of the payment system infrastructure is an ongoing process. Hence, any detailed description of a specific payment system will be outdated rather quickly. Notwithstanding this potential short-term topicality, this article gives an update on the main characteristics of the Swiss Interbank Clearing System (SIC) as of the beginning of 2001.

SIC being one of the oldest Real-Time Gross Settlement (RTGS) systems – in fact, SIC is older than the term RTGS – a comprehensive literature exists on many aspects of SIC. General surveys on the architecture of SIC are given in VITAL and MENGLE (1988), MENGLE et al. (1989) and VITAL (1990, 1994, and 1996). Legal issues are covered in HESS (1988) and in MERZ (1995), while HELLER (1998) provides an extensive empirical analysis of SIC. While many details of the descriptions in these papers are still valid, others have become outdated. Against this background, the aim of this paper is straightforward: on the one hand, we try to point out the current main features of SIC. On the other hand, we would also like to review the main developments and innovations that have taken place since the early SIC days and assess their impact on the system's operational efficiency.

The rest of the paper is structured as follows. In Section 2 we discuss the legal framework that provides the basis for the Swiss National Bank's (SNB) role as overseer of SIC. The way in which the SNB carries out oversight over SIC is, for the most part, laid down in specific contractual agreements between the SNB, the participants and Swiss Interbank Clearing AG, which is the operator of SIC.[1] In Section 3, we focus on the main developments of the system and its environment that have taken place over the years. Subsequently, Section 4 deals in more detail with the basic features of the current SIC architecture. In Section 5, we provide a number of empirical facts regarding the performance of SIC. Finally, Section 6 concludes by assessing the likely future developments in the broader payment system area and their potential impact on the system's design.

2. Legal foundation and oversight

In this section, we start by reviewing the legal provisions concerning the SNB's involvement in the payment system area that can be found in the Federal Law on the Swiss National Bank. Afterwards we discuss how the SNB carries out oversight over SIC and which goals it pursues in doing

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so. In this respect, the situation in Switzerland is quite unique since the SNB does not operate its own RTGS system. SIC is operated by SIC AG, a subsidiary of Telekurs Holding.[2]

2.1 Foundations for the SNB's involvement in payment systems

In Switzerland, there are no special legal provisions governing funds transfer systems. The legal basis, which authorizes the SNB to be active in the field of payment systems, is established in Article 2 of the National Bank Law. This article describes the SNB's principal task as follows: "to regulate the country's money circulation, to facilitate payment transactions and to pursue a credit and monetary policy serving the interests of the country as a whole".
An important provision that helps the SNB to promote or facilitate payment transactions is Article 14 of the National Bank Law.[3] It empowers the SNB to operate giro (or reserve) accounts and carry out giro and clearing transactions. In so doing, the SNB enters into legal relationships that are based on contracts with its counterparties.

2.2 The SNB as overseer

Monetary agencies such as central banks usually have the responsibility for achieving and safeguarding monetary stability and, in recent years, also increasingly for financial stability. For this reason, central banks are concerned about the smooth and efficient functioning of payment and settlement systems. On the one hand, the payment system is the channel through which monetary policy is implemented. If the payment system does not function properly it will be very difficult for a central bank to transmit its monetary policy to the financial system in the desired way. A stable and sound payment system thus is a prerequisite for an effective implementation of monetary policy. On the other hand, payment systems also play a crucial role in the context of overall financial stability. A central bank's efforts to safeguard financial stability can focus a) on promoting the stability of individual financial institutions (supervision), b) on the regulation and surveillance of markets and c) on the oversight of payment and settlement systems. While banking supervision and market surveillance are often carried out – at least partially – by other regulatory authorities as, for instance, the Federal Banking Commission in the Swiss case, the oversight role is usually indisputably assigned to the central bank.
The term oversight as applied in the context of a central bank's responsibilities for payment and settlement systems has a rather broad meaning. Usually, oversight refers to the central bank's task to promote the smooth and efficient functioning of payment systems and to protect the financial system from possible domino effects which may occur when one or more participants in the payment system incur credit or liquidity problems. Basically, a central bank disposes of two sets of instruments to meet its oversight role. First, related with the role of oversight stricto sensu, the central bank monitors ongoing activities in the payment system. Second, the term oversight refers to the role of central banks in developing a regulatory framework. The regulatory framework includes important aspects such as the design of a payment system, the rules and procedures the participants of the system have to comply with or any sanctions in case of non-compliance.
The Law on the Swiss National Bank is fairly vague about the SNB's role as overseer or as operator of payment systems. Particularly, there is a lack of formal power to regulate payment systems. Therefore, two contracts were put in place in order for the SNB to carry out oversight effectively. The first contract is between the SNB and SIC AG (SIC interim solution[4]), and the second between the SNB and the participants (SIC giro contract).[5] In the following paragraphs the most important, but not all, elements of these contracts are discussed.

The core of the contract between the SNB and SIC AG is the assignment of the rights and responsibilities of both parties. The wording of this contract indicates some similarity to an outsourcing agreement. This is, for instance, captured in a paragraph stating that SIC AG provides "operational services for settlements in SIC on behalf of the SNB".

As set out in the contract, the SNB's obligations are a) to admit to SIC every Swiss bank that has signed the required contracts with the SNB and SIC AG, and b) to transfer the banks' balances from their reserve account to their settlement accounts in SIC.[6] The SNB has a wide range of rights. First, it has the right to admit non-banks to the system. For instance, the decision to grant access to SIC to brokers/dealers and to remote members came within the realm of the SNB. Second, all changes to the user manual and the technical guidelines have to be approved by the SNB. The user manual and the technical guidelines describe the design of SIC (e.g. queuing mechanism, optimization routines, priorities, contingency arrangements, among others) and the rules that all the parties have to follow during daily operations. The SNB also has the right to request changes to the user manual and the technical guidelines. Third, the SNB has to approve access and transaction fees in SIC subject to the condition that the revenues of SIC AG do not exceed its costs. Vis-à-vis SIC AG, the SNB is entitled to review the internal governance structure and the internal audit reports. The SNB can also inspect the safety of the operational facilities. Lastly, the SNB can request external audits and have incompetent personnel removed.

The responsibilities of SIC AG cover provision of smooth operations of SIC by using appropriate technology and human resources. In terms of governance, a high level board member has to be assigned the responsibility over SIC. This member has to report monthly to the SNB. The rights of SIC AG are to voice its opinion regarding the changes that are requested by the SNB. Should the fees set by the SNB lead to a financial loss, SIC AG is entitled to reimbursement by the SNB.

The second important element of the SNB's oversight activity over SIC is its contract with the participants. By signing this contract, the participants agree to follow the rules and procedures of the user manual and the technical guidelines. The user manual and the technical guidelines explain in detail how SIC works. Hence, they help the participants to understand what risks they bear by participating in the system and which tools the system provides for managing these risks.

3. From past to present: Major innovations and changes

In this section we shall first have a look at the circumstances that led to the introduction of SIC in 1987. Since SIC has experienced a number of changes and enhancements over the years, we shall proceed by reviewing the major milestones in the history of SIC. For this purpose, we shall briefly discuss the linkages that were established with other systems, the specific reasons that have led to a more open access policy and the recent introduction of intraday liquidity.

3.1 The introductory phase

The development of SIC dates back to the year 1980, when a working group of major Swiss banks initiated the project. When the development of a new large-value interbank funds transfer system had been decided, the common goals set by the Swiss banking community and the SNB were twofold: First, improving the reliability and efficiency of the interbank payment system and, second, reducing the substantial risks incurred daily both by the banks and by the central bank when processing interbank payments. At that time, paper and magnetic tape based batch systems were in operation. Therefore, the banks and the SNB finally agreed to develop SIC, an RTGS system

that avoids daylight overdrafts on the participants' reserve accounts.
SIC operations started in June 1987. For security reasons, the introduction of SIC took place step-by-step over a one-year period. For instance, while only twelve banks participated from the very beginning, more than 150 banks were connected to the system by the end of the introductory phase.
Initially, from the system's architecture point of view, the design was rather simple. The three main building blocks consisted in the non-allowance of intraday overdrafts, a queuing mechanism and the strict "first in - first out" (FIFO) rule for payments processing and settlement. However, in 1990, to give participating banks' more flexibility for their payments management, the strict FIFO rule was relaxed by introducing different priorities that may be attached by the sending banks to individual payments.

3.2 Linkages with other systems

In March 1995 a link between SIC and the securities settlement system SECOM of the SIS SEGAINTERSETTLE (formerly SEGA) was established. The link allows a delivery-versus-payment mechanism in securities settlement by settling both the cash and the security side on a trade-by-trade (gross) basis.[7] This eliminates the principal risk in securities transactions.
When the Swiss Stock Exchange switched from an open outcry system to an electronic trading platform in 1996, the new trading system SWX was linked to both SIC and SECOM. This linkage allows straight-through-processing from the deal to the settlement. The connection between SWX, SECOM and SIC is described in more detail in the Appendix (see also HELLER 1997).
Ever since the early stages of planning, it has been envisaged to eventually provide for the settlement of various interbank payment services in SIC and thus to submit them to cover control. In May 2000, this process was completed by the integration of the settlement of checks. Other interbank payment services that are settled in SIC comprise data media exchange (DTA), direct debits (LSV), cash withdrawals at ATMs, EFTPOS transactions (ec-direct) and purchases with prepaid cards (CASH), as well as cash flows resulting from the financial futures and options exchange Eurex. Interbank claims which arise from these services are settled as debit payments on a gross basis at regular intervals – generally once a day – on the participants' SIC accounts.

3.3 Liberalization of access policy

Originally, participation in SIC was limited to banks domiciled in Switzerland and subject to supervision by the Federal Banking Commission. The only exceptions to this rule were domestic clearing organizations. Over the years, this policy has been increasingly challenged by developments in domestic and international financial markets. On the one hand, non-bank intermediaries have increasingly gained ground in financial markets and thus questioned the dominant role of banks in this area. On the other hand, globalization of markets has brought about not only ever-increasing payment volumes, but also stronger competition among financial centers and associated cooperation and mergers between stock exchanges. In the wake of these developments, conventional access policies have become outdated since these would particularly make cross-border projects such as the Continuous Linked Settlement system (CLS) virtually impossible.[8]
Against this background, the SNB decided in 1998 to substantially liberalize its SIC access policy. For instance, it is now possible for supervised securities dealers such as non-banks to become SIC participants.[9] More importantly, however, remote access to SIC is also granted to international joint ventures and clearing organizations, as well as the associated banks, provided these make a sizeable contribution to the reduction of systemic risks or are of major significance for the

Swiss financial center. For reasons of legal and operational security, this regulation only applies to joint ventures, clearing organizations, banks and non-banks from countries which have at least the same standards as Switzerland with respect to banking supervision, the fight against money laundering and the telecommunications infrastructure. At the end of 2000, 55 out of 306 SIC participants were so-called remote members.[10]

3.4 Introduction of intraday liquidity

Until recently, SIC was one of the few pure queuing systems. The SNB did not allow any overdrafts nor did it provide any collateralized intraday credits. Despite the well-known argument that an RTGS-system without any form of intraday liquidity would imply substantial liquidity costs for participating institutions, SIC operations generally ran fairly smoothly. Due to a liquid money market and sophisticated liquidity management by some market participants, the banks were able to gradually reduce their reserve balances. However, as from October 1999 the SNB has been placing interest-free intraday liquidity at the banks' disposal. This change in policy was motivated mostly by an increase in time-critical payments. In particular, the future introduction of the CLS system for settling foreign exchange transactions will trigger an additional need to settle potentially very large payments without delay. Also, intraday liquidity from the central bank has the benefit of leading to shorter queues and earlier finality.

The above-mentioned link between SIC and SECOM allows a very efficient and completely secure mechanism for granting intraday liquidity by means of intraday repos. Moreover, the use of intraday repos enhances the attractiveness of the repo-platform for small domestic and to foreign financial institutions.[11] This, in turn, raises the number of potential counterparties for the SNB's regular money market operations and thus facilitates the implementation of monetary policy. In the light of the Swiss money market structure, which is characterized by the dominance of a small number of large commercial banks, this argument is of particular importance.

For the time being, there are two time windows during which banks may draw on intraday liquidity: at the beginning of a SIC value day at 6 p.m. and at 8 a.m.[12] Moreover, between 8 a.m. and 2.45 p.m. banks obtain further intraday credits on request. Repayment is currently automatically triggered at 3 p.m., i.e. one hour and 15 minutes before the system closes for the day. However, the option of repaying intraday credits earlier will be introduced in the course of spring 2001. If an intraday credit is not repaid in time, a penalty rate exceeding the Lombard rate (see below) by 200 basis points is applied.

4. Architecture of SIC

In this section we review the current SIC design, i.e. the whole set of rules and regulations that aim at ensuring smooth operation of the system. We shall start by discussing a few general characteristics and then take a closer look at liquidity management issues.

4.1 General characteristics

Technical aspects

SIC is an RTGS system that provides the sequential processing of payments and settlement via the banks' reserve accounts at the central bank. It is an online system operating around the clock on all bank working days; while payments can be entered at any time and up to five days before the value date, settlement is effected during a 22 hour cycle. Executed payment transactions are final, i.e. unconditional and irrevocable. The message flow structure corresponds to a V-architecture: the sending bank dispatches a payment message in the SIC system; only after settlement does SIC send

the payment message with confirmation of the settled payment to the receiving bank.[13]
With respect to the system's capacity, several concepts have to be distinguished. First, capacity in terms of entering payments (including validation) is limited to about 150,000 transactions per hour. However, once these payments are entered, up to 700,000 transactions per hour can be settled. Finally, the capacity for sending out messages of settled payments to receiving banks is about 250,000 transactions per hour. Thus, given the fact that payments can be entered around the clock, these figures allow the extrapolation that theoretically about 3.6 million transactions per day could be settled in SIC.
In case of technical problems at either an individual participant's level or the system's level, a number of back-up procedures exist that provide for the possibility of timely settlement of payments. In particular, there are several measures to maintain operability of the central SIC computer at SIC AG. For instance, emergency generators exist in case of a breakdown of the external power supply. A hot stand-by site is located about 20 km from the main site. Further, in an emergency or in case of serious software problems, there is the additional alternative of switching to the so-called Mini-SIC, an offline batch application that can be run on any mainframe computer.

Account structure

A specific feature of SIC is the account structure. As mentioned in Section 2.2, each participant's reserve account is split into a SIC account and a master account. At the beginning of a SIC day, all reserve balances are held on the master account. To start the settlement cycle, funds are transferred (by the SNB) to the SIC accounts. Since cash withdrawals and retail payments between banks and Postfinance are settled on the master account, banks usually leave a certain amount of reserves on their master account. During the SIC-day, settlement of interbank funds transfers occurs on the SIC accounts. Funds can be moved at any time from one account to the other. Finally, at the end of the day, total credits and debits of the SIC accounts are transferred to the master accounts. These end-of-day giro balances on the master account are relevant for accounting purposes.

Timing of the settlement cycle

The settlement cycle begins at about 6 p.m. with the initial transfer of giro balances from the participants' master accounts to their SIC accounts. From this moment on, payments can be settled until 4.15 p.m. of the following bank working day. Until 3 p.m. an unlimited number of transfer orders for same-day settlement may be entered. Further, payments that are not yet settled and are pending in the queue may be cancelled at any time before 3 p.m. by the sending bank without consulting the receiving bank.
At 3 p.m. "clearing stop 1" occurs. After clearing stop 1, pending payment orders may be cancelled only with the consent of the receiving bank. Furthermore, payment orders entered for same-day settlement are automatically marked for settlement on the following day. Exceptions to this rule are cover payments stemming from money market transactions, which may be entered for same-day settlement until "clearing stop 2", which takes place at 4 p.m. The last time window between clearing stop 2 and end-of-day processing at 4.15 p.m. is exclusively reserved for payments entered by the SNB.
During end-of-day processing any payments that have not been settled are cancelled. Removed payments must be re-entered by the sending bank and provided with a later settlement date. For any payments that are cancelled during end-of-day processing the receiving bank is entitled to charge the sending bank with interest for arrears exceeding the current money market rate by 500 basis points.

Queuing and settlement mechanism

The transfer of funds in SIC is subject to the strict condition that the bank issuing the transfer order holds adequate balances on its SIC account. In the event of insufficient coverage, the transfer order is automatically held pending until covering funds have accumulated in the account through incoming payments. The system automatically retries to settle pending payments.
From an individual participant's perspective, the settlement sequence of payments is in the first place determined by a priority that the sending bank assigns to any payment order. Within a specific order of priority, the FIFO rule applies.[14] Queue management is limited to the possibilities of canceling and re-entering payment orders.
From the system's perspective, the settlement sequence is as follows: In a first step, for each account the next payment of the highest existing priority is determined. If there are sufficient funds available this payment is marked as a "settlement candidate". Since there are many different accounts, it is very likely that there is a large number of settlement candidates. Therefore, as a second step, among all the settlement candidates the algorithm selects the one that has the earliest input time. This payment is then settled.[15] Having settled the settlement candidate or – if possible – a package of payments, the settlement algorithm starts again with the first step, and so on.

4.2 Liquidity management

It is an undisputed fact that RTGS systems offer a powerful mechanism for limiting settlement and systemic risks in the interbank settlement process because they can effect final settlement of individual funds transfers on a continuous basis during the processing day. However, at the same time it is also generally accepted that RTGS systems are relatively costly in terms of liquidity needs and that they are prone to gridlocks in case of insufficient liquidity on settlement accounts. Thus, a pivotal requirement for any RTGS system is the efficient use of liquidity both from an individual bank's point of view and the system's point of view.
In the following, we shall analyse several features that allow the efficient use of liquidity in SIC. We will start by discussing the different available components of liquidity. Then we will proceed by presenting the means aimed at ensuring an efficient liquidity management in the course of the day and the system's incentives to prevent gridlocks.

Components of liquidity

Payments are settled on the basis of reserve account balances. For an individual participant there are basically four sources of such balances: (1) reserve balances that are held overnight at the central bank, (2) credit extensions provided by the SNB, (3) incoming payments from other participants in the course of the processing day and (4) borrowing from other banks through the interbank money market. While the first two components influence aggregate liquidity available in the system (outside money), the other two merely have an impact on the distribution of liquidity among participants.
The level of overnight reserve balances in the banking system is determined by the SNB's open market operations. The SNB may influence aggregate overnight reserve balances by means of repo transactions with maturity of one day or longer, by concluding foreign exchange swaps and by trading in foreign exchange and securities. Banks hold overnight balances mainly to meet their liquidity requirements. However, it has to be emphasized that many banks usually hold substantial excess reserves.[16]
The SNB provides the banks with two forms of credit extensions. First, as discussed in Section 3.4, the SNB places interest-free intraday liquidity at the banks' disposal. Second, overnight money in the form of collateralized Lombard loans serves as

short-term bridging liquidity. Banks may draw Lombard loans at any time up to their Lombard limit, i.e. the amount of collateral they have deposited with the SNB.[17] However, to prevent banks from using Lombard loans as a permanent source of refinancing the Lombard rate exceeds the market rate for call money by 200 basis points. Thus, Lombard loans are usually only drawn towards the end of a day if a bank has any remaining unsettled payments and if it cannot itself procure the necessary funds in the money market.

Management information system

As in any liquid payment system incoming transfers from other banks are a main source of liquidity for an individual bank. Accurate information on incoming and outgoing payments is thus a major concern for an efficient liquidity management. For this reason, the Management Information System provides SIC participants with real-time access to all data relating to their own account. Cash managers can thus continuously track current account balances and the amount of pending incoming and outgoing transfers. The information on pending payments becomes increasingly important towards the end of a SIC day, when liquidity managers have to decide whether and to what extent money market transactions are to be effected in order to have sufficient funds for carrying out pending payments or to bring reserve account balances in line with the desired level.

Another measure that facilitates liquidity management mainly towards the end of the day is the requirement of the receiving bank's consent to cancel a pending payment after clearing stop 1. This rule enhances the reliability of the information available to cash managers on their liquidity position in the SIC system late in the day. Moreover, since after clearing stop 1 only payments stemming from interbank money market transactions may be entered into the system the time window between 3 p.m. and 4 p.m. can be used by liquidity managers to assure that all payments settle timely and to adjust liquidity positions to desired end of day levels.

Measures to prevent or resolve gridlocks

As mentioned above, gridlocks are frequently associated with RTGS systems. A gridlock occurs if the failure of some transfers to be executed prevents a substantial number of other transfers from other participants from being executed. Gridlocks can occur either if aggregate liquidity is insufficient or if overall liquidity is adequate but poorly distributed among participants.

A measure adopted in SIC that aims at preventing gridlocks in the first place is the progressive fee structure that has been applied since 1990 (Table 1). Besides the principle of cost recovery the fee structure is notably conceived to make input and settlement of payments at an early point in time worthwhile. Due to progressive fees, participants have an incentive to enter and settle their payments as early as possible. Moreover, it becomes more expensive to wait for incoming payments and thus to profit unfairly from opportunity-cost-bearing reserve funds of other banks. Further, different fees are applied to small and large amounts, the latter consisting of 100,000 francs or more. The fee structure provides an incentive for an early input and settlement of small payments, which represent the bulk of SIC transactions. This, in turn, prevents the demand for settlement capacity to peak towards the end of a settlement day, i.e. at times when the occurrence of gridlocks would be a major concern.

Due to the progressive fee structure and the fact that payments larger than 100 million francs are generally split into a number of tranches, gridlocks have never been a major problem in SIC – even before the introduction of intraday liquidity. Should gridlocks nonetheless occur, they may be resolved simply by cancelling payment orders that are blocking settlement and by re-entering them in several smaller portions.[18]

Table 1: Fee structure for the sending bank in 2000 (in CHF)*

	less than CHF 100,000.–		more than CHF 100,000.–	
	Input	Settlement	Input	Settlement
Before 8 a.m.	0.02	0.04	0.02	0.04
8 a.m. to 11 a.m.	0.03	0.08	0.03	0.08
11 a.m. to 2 p.m.	0.11	0.15	0.24	0.84
After 2 p.m.	0.40	0.40	1.00	2.00

*The receiving bank pays a flat fee of CHF. 0.06 per payment.

5. Empirical assessment

In this section, we shall present some data on payment flows in SIC. The purpose of this empirical part is twofold. First, an in-depth analysis of payment flows facilitates understanding of how some of the described institutional characteristics, for instance the queuing mechanism, work in reality. Second, the analysis gives evidence of how participating banks have continuously adjusted their behavior to the changing environment.

5.1 Transaction volume and turnover

As Figure 1 indicates, the daily volume of transactions processed in SIC has more than tripled since 1988. While on average about 596,000 transactions were settled in 2000, on peak days,

Figure 1: Transaction volume, 1988–2000

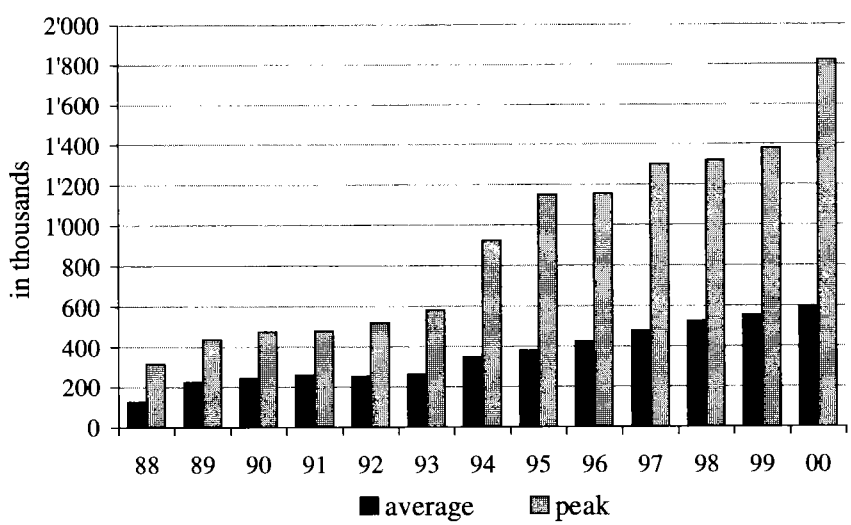
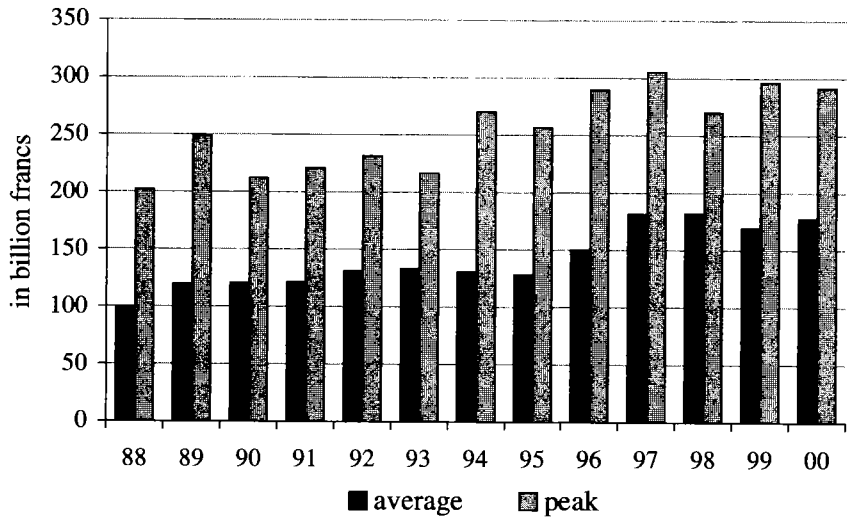


Figure 2: Turnover, 1988–2000



more than one million payment orders were carried out. On the busiest day of December 2000, some 1.8 million payments were settled. In terms of turnover, the increase has been less pronounced. However, on an average day in 2000, 178 billion francs were transferred through SIC and on peak days even about 300 billion francs (Figure 2). For comparison, in 1999 Swiss nominal gross domestic product amounted to about 390 billion francs.

5.2 Size and types of payments

As there is no lower limit for SIC payments – except zero, of course – a wide range of amounts is settled in SIC. The composition of payments according to their size in 2000 is shown in Table 2. It is evident that the bulk of payments is smaller than 5,000 francs. In terms of turnover, however, these small-value payments are negligible. Medium-size payments between 5,000 and 1 million francs account for about 17 percent of the total

Table 2: Percentage share of different payment sizes in transaction volume and turnover in 2000

	Transaction Volume	Turnover
less than 5,000 francs	81.0	0.2
5,000 up to 100,000 francs	14.4	1.3
100,000 up to 1 mio. francs	2.9	2.9
1 mio. up to 100 mio. francs	1.6	53.3
100 mio. francs and more	0.1	42.3

Table 3: Percentage share of different payment types in transaction volume and turnover in 2000

	Transaction Volume	Turnover
Customer payments	86.0	5.0
Cover payments	1.1	12.7
Service payments	10.7	13.8
Bank-to-bank payments	2.2	68.5

transaction volume. These payments generate about four percent of transfers in terms of turnover. Consequently, almost the entire turnover is caused by a small number of payments that are larger than one million francs.

Payments can also be broken down according to type of payments. Generally, one can distinguish between the following four types of SIC payments:

- customer-related payments (transferor and transferee are non-bank customers)
- cover payments (sender and receiver are SIC participants),
- service payments and
- bank-to-bank payments (payments in which at least one of the parties is a bank that is not a SIC member).

According to Table 3 customer-related payments account for about 86 percent of the transaction volume in SIC. But since customer-related payments are usually small-value payments, the amount in francs of these payments tends to be small. Cover payments generate 13 percent of the turnover. These payments are mostly related to interbank transactions such as money market transactions.

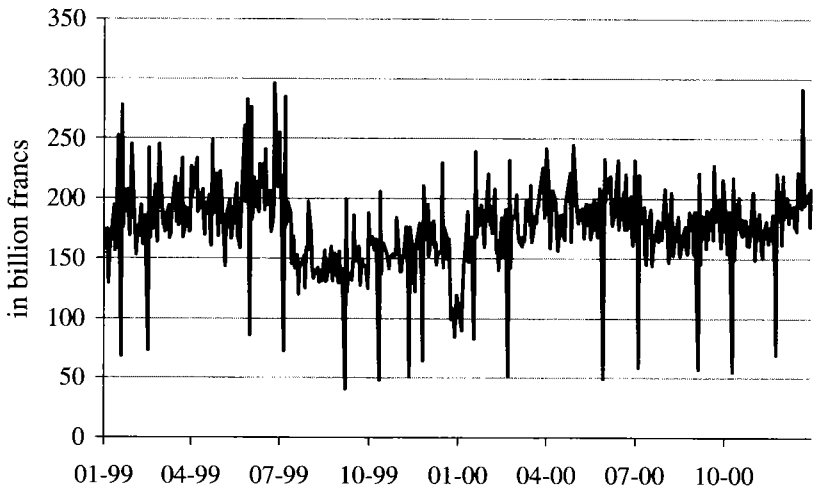
Service payments are mainly related to the cash leg of securities transactions that are settled via the SIC-SECOM linkage and the settlement of obligations stemming from interbank payment services such as data media exchange or direct debiting. As Table 4 demonstrates, the share of service payments in terms of turnover has been in-

Table 4: Service payments (in percent of turnover), 1995–2000

	1995	1996	1997	1998	1999	2000
SECOM*	2.24	3.31	3.71	4.91	4.90	5.92
Eurex**	–	–	0.03	0.15	0.13	0.11
Repos***	–	–	–	1.35	4.52	6.99
DTA****	–	–	–	0.27	0.51	0.51
LSV****	–	–	–	0.05	0.10	0.11
Others*****	–	–	0.07	0.20	0.14	0.23
Total	2.24	3.11	3.81	6.93	10.30	13.87

* SWX payments initiated by SECOM are settled in SIC since March 27, 1995.
** Eurex payments are settled in SIC since June 27, 1997 (formerly SOFFEX).
*** Repos are settled in SIC since April 8, 1998.
**** Data media exchange and direct debit payments are settled in SIC since June 27, 1998.
***** Other retail payment instruments, e.g. ATM cash withdrawals, automated refueling machine and POS transactions, are all settled in SIC since June 23, 1999.

Figure 3: Daily turnover 1999–2000



creasing continuously. This increase can be attributed to two causes. First, as mentioned in Section 3.2, a growing number of interbank payment services have been integrated in SIC in the course of the last few years. Second, in 1998 the repo platform was introduced. The sharp increase in repo transactions is mainly related to the fact that repos have become the main instrument of the SNB's monetary policy operations.

More than two-thirds of the turnover can be assigned to bank-to-bank payments. These payments stem mainly from correspondent banking business and indicate the importance of cross-border payments. For instance, Figure 3 underlines the importance of foreign exchange transactions in SIC. It shows the daily turnover in million francs during 1999 and 2000. All of the troughs in turnover are the result of bank holidays in the United States. On these days, there is no settlement of the Swiss franc leg of US dollar-Swiss franc foreign exchange transactions. The peaks in turnover on days after these bank holidays indicate a catch-up effect in foreign exchange settlement. Similarly, further peaks usually occur on the day following Swiss holidays such as Easter or Whit-Monday. Figure 3 also shows a decline in turnover in the second half of the year 1999. This drop is mainly due to the consolidation of SIC accounts of Union Bank of Switzerland and Swiss Bank Corporation after their merger. The decline in turnover towards the end of 1999, however, reflects lower market activity in anticipation of potential Y2K-related disturbances.

5.3 Reserve balances and turnover ratios

Before the introduction of SIC, one of the controversial issues concerned the amount of reserve balances that would be needed for operating the new system. Given the strict cover control and the lack of any form of intraday liquidity at that time, the estimates regarding the "minimum reserve balances" necessary for a smooth operation of SIC ranged from 5 to 10 billion francs. These estimates soon turned out to have been overly pessi-

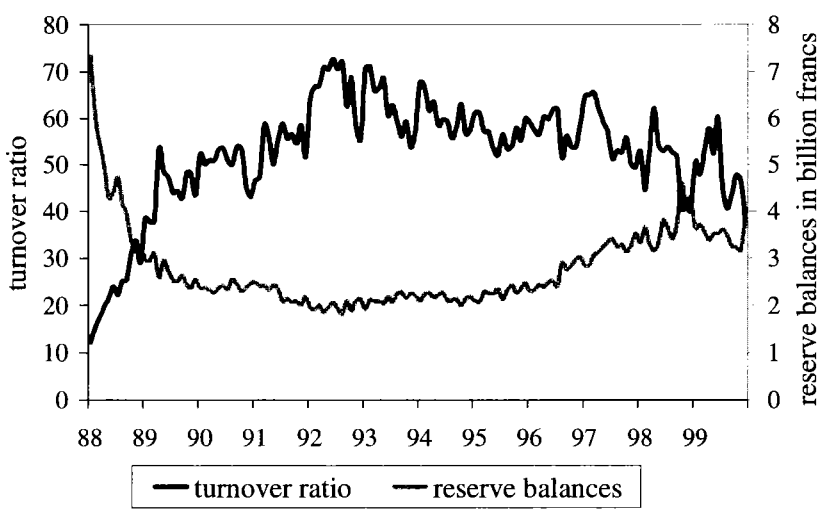
mistic. Indeed, in the early nineties, in spite of soaring turnovers the level of reserve balances held by SIC participants reached minimum values of about 2 billion francs without impinging on the smooth operation of the system.

The so-called reserve turnover ratio is an interesting measure for the efficiency of an RTGS system. This ratio states how many times per day one franc of reserve balances is recycled for payment purposes. To put it in another way, the turnover ratio reflects the amount of reserves used to settle a given flow of transactions.

Figure 4 depicts how reserve balances and turnover ratios have evolved over the years. The main trends in these figures can be explained as follows. Banks try to minimize their (overnight) reserve balances since they carry no interest and hence reflect an opportunity cost. At the same time, banks also have a stake in the smooth functioning of the payment system. Since under otherwise identical circumstances a reduction of reserve balances would result in increasing settlement delays, these two goals imply a trade-off. To a certain extent participants can reduce this trade-off by increasing the degree of synchronization between incoming and outgoing payments, by splitting up large payments in tranches, by changing their input sequence and by being more active in the money market, in short: by improving their liquidity management. The sharp decline in giro balances and the concomitant increase in turnover ratios in the late eighties are mainly due to these adjustments. The slight drop in turnover ratios after 1992 can be attributed to a more expansionary monetary policy by the SNB, which resulted in lower interest rates and therefore smaller opportunity costs of holding reserve balances.

With the introduction of intraday liquidity in October 1999 the turnover ratio has lost much of its indicative power for the system's efficiency. Aside from (overnight) giro balances that banks hold for other purposes than settling payments (especially liquidity requirements), it is now conceivable that all payments be settled without any giro balances at all.

Figure 4: Reserve balances and turnover ratios, monthly averages 1988–1999



5.4 Impact of intraday liquidity

Even though intraday liquidity has been introduced only recently and despite the fact that only a few banks have so far regularly engaged in intraday repo transactions with the SNB, some preliminary conclusions concerning the impact of this policy change on the speed of settlement can be drawn. The effect of intraday credits is most obvious if one looks at the number of payments that are held pending in the queue in the course of the day. Figures 5 and 6 depict at what times payments are entered and settled in the course of the day for two different periods. Figure 5 shows that in the first three quarters of 1999, payments in the queue file had reached a peak of almost 60 percent of total daily turnover by noon. In comparison, in 2000, i.e. after the introduction of intraday liquidity, the queue file was substantially smaller throughout the day and reached a peak of about 40 percent of total daily turnover (Figure 6).[19]

The increased speed of settlement can also be seen in the amount of time payments spend in the queue before they are settled. Prior to the introduction of intraday liquidity, less than 20 percent of payments in terms of overall turnover were settled within ten minutes. In 2000 the corresponding figure was 31 percent. In terms of transaction volume, the figures are, respectively, 72 percent before and 84 percent after the introduction of intraday liquidity.

Another interesting measure of speed of settlement are so-called Gini coefficients.[20] With respect to payment systems, the Gini coefficient indicates how many percent of the daily turnover (transaction volume) are settled when x percent of the total turnover (transaction volume) are entered into the system. The average relation between entered and settled payments is drawn in Figure 7 for the year 2000. Each point on the curve indicates the share of payments entered and settled at a specific time. In particular, each square

Figure 5: Payments in the course of the day, January – September 1999

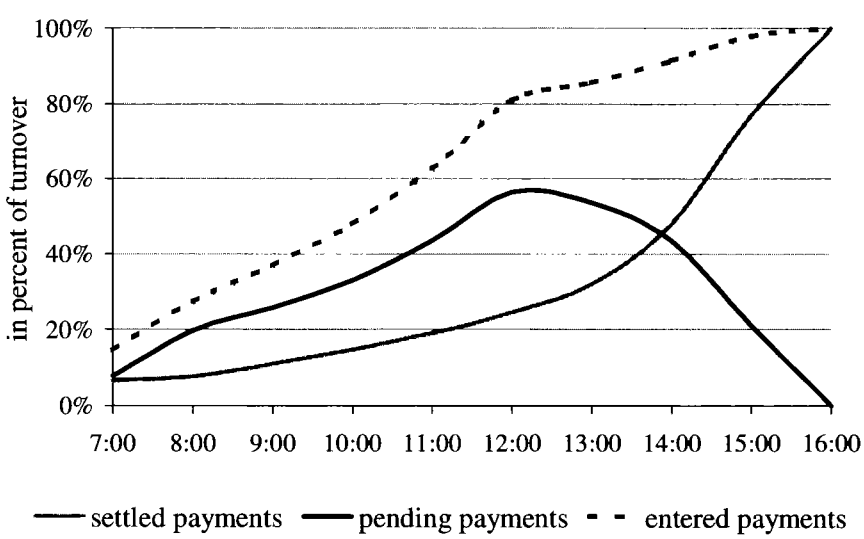
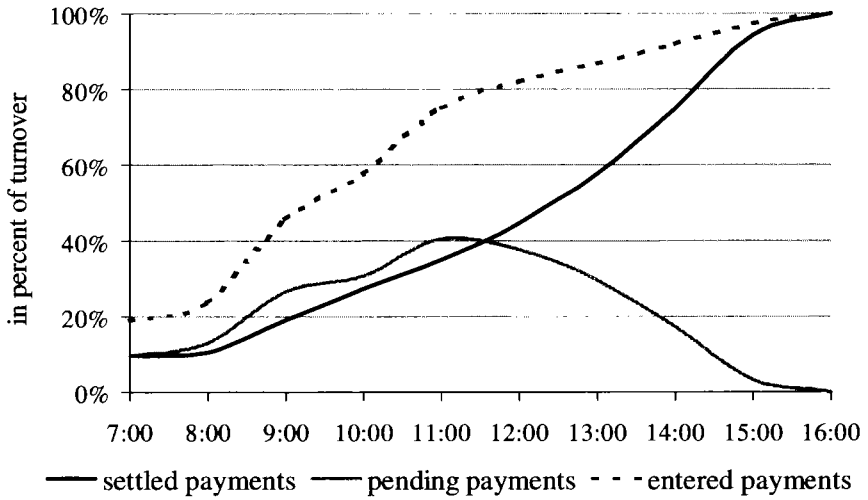


Figure 6: Payments in the course of the day, 2000

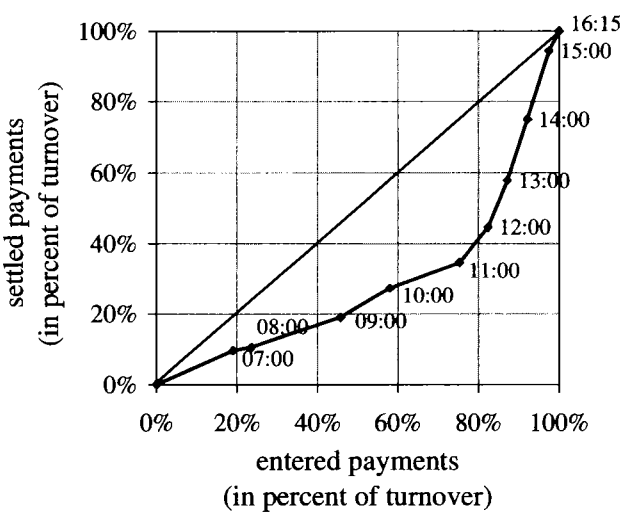


on the curve indicates one additional hour of operation. For instance, in the examined period, by 7 a.m. 19 percent of the daily turnover were entered in SIC while about 10 percent were settled.

Similarly, more than 80 percent of the daily turnover was entered in the system by 12 a.m., but only about 50 percent were carried out.

The Gini coefficient is defined as the ratio of the surface below the curve to the surface below the diagonal in Figure 7. If all payment orders were settled immediately when they are entered (as for

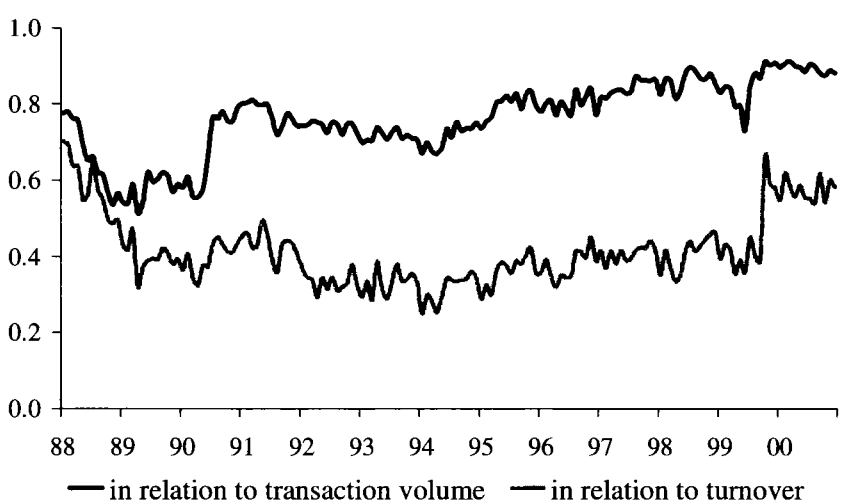
Figure 7: Gini coefficient, 2000



instance in a system with unlimited overdrafts), the curve would move along the diagonal and the Gini coefficient would be equal to one. In general, the shorter the queues, the closer the coefficient to one. At the other extreme, the Gini coefficient is zero if all orders are entered before the first one is settled (as for instance in a deferred net settlement system). On the one hand, the Gini coefficient can be interpreted as a measure of congestion in the payment system. On the other hand, the Gini coefficient may also be interpreted as an indicator of liquidity risk in the system. Because banks cannot be sure that pending payments will effectively settle, incorporating them into their liquidity management implies some liquidity risk. With regard to systemic risk reduction the central bank thus may consider a Gini coefficient of (close to) one as optimal.

Figure 8 shows Gini coefficients since 1987 on the basis of monthly averages. The coefficients in terms of transaction volume are higher than the ones in terms of turnover. This fact is in line with the observation that the bulk of small payments is entered and settled during the night while a small number of high value payment orders is kept fairly long in the queue. But how can we explain the observed pattern of Gini coefficients over time? The initial decrease of both coefficients means that congestion increased during the first two years of operation. This is due to the fact that banks substantially reduced their giro balances while simultaneously more and more payments were transferred through SIC. A striking point is the remarkable jump of the coefficient in terms of volume in 1990. The reason for this shift was the introduction of the new pricing scheme that encouraged early entry and settlement of small-value payments (see also discussion in Section 3.4). The slight increase in both coefficients as of 1993 can be explained mainly by a less restrictive stance of monetary policy that led to increasing giro balances and, in turn, reduced congestion in SIC. Finally, the soaring coefficients in the last quarter of the year 1999 are the result of the introduction of intraday liquidity.

Figure 8: Gini coefficients, monthly averages 1987–2000



6. Conclusion

In 13 years of operation, SIC has proved to be a reliable and efficient interbank funds transfer system. In particular, the intraday finality of payments is regarded as an important means of managing the risks associated with large-value payments. Our experience confirms that participants have dynamically adjusted their behavior to opportunities offered and restrictions imposed in SIC. Specifically, participants have optimized their liquidity management and adjusted their input timing in order to benefit from the progressive fee structure that favours early input and early settlement of payments.

As discussed in this paper, SIC has undergone many changes over the years. At least partially, these changes have been made as a reaction to, or in anticipation of, broader developments in the domestic and international payment and settlement system area. It is therefore safe to assume that the future will bring new challenges both for the system's design and even for its long-term viability. For instance, the introduction of CLS will certainly lead to a dramatic decrease in turnover. At the same time, CLS will make high demands on the system's capability of reliably settling time-critical payments.

Further, the consolidation process in the European clearing and settlement landscape that was largely sped up by the European Monetary Union has also triggered a lively discussion among Swiss market participants about future improvements to the payments infrastructure. Current proposals include trendy notions such as the development of a more purpose-driven system, i.e. the introduction of different service levels for different kinds of payments, offsetting algorithms or multi-currency capability. However, no decisions have been taken as of yet.

Appendix: The SWX-SECOM-SIC linkage

The following example illustrates the way in which the three systems SECOM, SWX and SIC are linked with one another in order to guarantee delivery-versus-payment in securities settlement. Assume that Bank A buys 100 securities for 20,000 francs on the electronic stock exchange from Bank B. Immediately after conclusion of the deal SWX sends the two parties a confirmation and the relevant information to SECOM, where this transaction data is kept until settlement. As a rule, securities transactions are currently settled three days after the trade has been concluded. On the settlement day, SECOM checks whether Bank B holds at least 100 of the securities sold in its deposit with the Central Securities Depository SIS. If that is the case, 100 securities are reserved and a payment instruction to SIC is automatically released. SIC then checks whether Bank A has sufficient balances on its SIC account. Should Bank A in fact hold at least 20,000 francs in reserve balances, this amount is credited to Bank B's SIC account. At the same time, SIC notifies SECOM that the payment has been carried out. SECOM then transfers the reserved securities from the deposit of Bank B to the deposit of Bank A and advises both parties of the successful settlement.

Footnotes

[1] The Swiss Interbank Clearing AG is hereinafter called SIC AG.

[2] Telekurs Holding is a joint stock company owned by the Swiss banking community.

[3] The National Bank Law is currently under revision. Following an international trend, the group of experts suggests in the current draft that the legal basis for the SNB's role as overseer and operator of payment systems should become more formal.

[4] As the wording suggests, the interim solution was originally considered to be only of a transitory nature. The target solution envisaged in 1987 was for the SNB to eventually become the operator of SIC. In the target solution SIC would only settle large value transactions, while small value payments were to be cleared in a separate netting system that would be developed and operated by Telekurs. However, since the interim solution with only one payment system has proved to be satisfactory to all parties, the target solution has never been pursued.

[5] A third contract has been concluded between SIC AG and the participants (SIC supplementary contract).

[6] A reserve account at the SNB is split into a SIC account and the traditional reserve account which, in the payment system context, is called "master account". The SIC account is used for processing SIC transactions, while the master account is used for all other transactions, such as cash deposits and withdrawals and the settlement of retail payments between banks and Postfinance.

[7] For more information on delivery-versus-payment mechanisms see BANK FOR INTERNATIONAL SETTLEMENTS (1992).

[8] CLS Bank, currently scheduled to go live in October 2001, will provide a payment-versus-payment mechanism to settle foreign exchange transactions. Analogously to a delivery-versus-payment mechanism, payment-versus-payment eliminates principle risk in the settlement of foreign exchange transactions by simultaneous (gross) settlement of both legs of a transaction. Initially, CLS Bank will settle the following currencies: Australian dollar, Canadian dollar, Euro, Japanese yen, pound sterling, Swiss franc and US dollar.

[9] The Stock Exchange Act, which became effective on the 1st of January 1998, lays down that securities dealers must apply for a license and be supervised by the Federal Banking Commission.

[10] Of the 55 remote members, 52 were German, one French, and two British.

[11] The repo-platform, also called Eurex repo, is the trading platform for Swiss franc repurchase agreements with maturity from overnight up to 12 months. The importance of the repo-platform is enhanced by the fact that repos are the SNB's major monetary policy instrument.

[12] To be more precise, the first intraday repos are concluded at 4 p.m. but the liquidity is only provided after the beginning of the new SIC value day (a SIC value day starts around 6 p.m. on the previous calendar day, see Section 4.1).

[13] For more information on message flow structures and various other issues concerning RTGS systems see BANK FOR INTERNATIONAL SETTLEMENTS (1997).

[14] The queuing mechanism in SIC is not equipped with any automated optimization routines that include some form of netting or similar routines; rather, the settlement sequence of payments always corresponds to the order in which transfer instructions are entered.

[15] For reasons of performance the system always tries to settle a package of other payments that are pending in the queue of this particular account. Such a package is determined according to the following rules: all payments of the package must be of the same priority as the settlement candidate; the oldest payment order must not be entered much later than the settlement candidate (about two minutes); and the package must not contain more than a specified number of payments (say 20 payments).

[16] Swiss banks can meet their liquidity requirements by holding cash, postal checking accounts and/or reserve balances at the SNB. Banks that are mainly active in retail business often hold substantial amounts of cash that sometimes even exceed their liquidity requirements. Before the introduction of intraday liquidity, for these banks – and to some extent also for other banks – holding excess liquidity in the form of overnight reserve balances was important for payment purposes. Although it is too early to draw final conclusions about the effects of intraday liquidity on the banks' demand for overnight reserve balances, it is reasonable to assume that demand for excess reserves has decreased.

[17] The decision on the amount of the Lombard limit is left to each bank. Some banks maintain a zero Lombard limit.

[18] In principle, a gridlock can also be resolved by borrowing funds from banks not involved in the gridlock or by taking out Lombard credits from the SNB. In practice, the method of breaking up payments into smaller portions has proved effective.

[19] During the period from October to December 1999 the peak was even below 40 percent. However, since banks held substantially more reserve balances due to

Y2K provisions, it is not possible to discern the impact of intraday liquidity during this period.

[20] Gini coefficients are usually used in measuring income and wealth inequalities. For instance, Gini coefficients can be calculated based on the knowledge of how many percent of the population own how many percent of total wealth.

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