# SIC: SWITZERLAND'S NEW ELECTRONIC INTERBANK PAYMENT SYSTEM*

*Christian Vital and David L. Mengle*

EDITOR'S PREFACE ***In the United States, bankers and the Federal Reserve System have attempted to control risk on large-dollar wire transfer networks by means of quantitative limits. Net debit caps, as the limit.. are called, restrict the extent to which an institution can incur daylight overdrafts on Fedwire and net debits on the CHIPS network. The Federal Reserve is now considering additional steps such as reducing caps and pricing daylight overdrafts.***

***In contrast, Switzerland took the bold step of prohibiting daylight overdrafts when it instituted its new wire transfer system, Swiss Interbank Clearing (SIC), in mid-1987. The following article, which details the Swiss experience and approach to daylight overdrafts, should be an important contribution to payment system policy discussions in the United States.***

***Of course, certain institutional features of large-dollar wire transfer in the United States are different from those in Switzerland. For example, the number of participating depository institutions is far larger on Fedwire (almost 7,000) than on the Swiss system (156). In addition, Swiss banking is far more concentrated than is banking in the United States. But even so, the Swiss experience does suggest a new alternative that could be considered for the future of wholesale wire transfer in the United States.***

## Introduction

In Switzerland, as in other countries in which the financial sector plays a prominent part, banks' funds transfer operations are characterized by large values and a high rate of turnover. An average of over 250,000 payments per day totalling more than 100 billion Swiss francs (=$68.5 billion)[1] are currently processed through the interbank payment system. The daily average turnover is over thirty times the volume of banks' deposits at the Swiss National Bank.

Until 1987 most funds transfers were carried out through the Bank Clearing System developed by the banks in the early 1950s.[2] Payment orders were sent by means of paper vouchers and magnetic tapes. The orders were forwarded to the receiving banks through a central computer center operated by Telekurs AG, a company jointly established by the banks. In the computer center, individual orders were added up to arrive at credit and debit totals for each individual bank; they were then entered in the giro (or reserve) accounts of the participant banks at the Swiss National Bank. (Banks' giro accounts are the equivalent of reserve accounts in the United States. Funds in giro accounts do not earn interest.)

The transmission and processing stages of the Bank Clearing System could extend over several days. This created uncertainty in planning and monitoring liquidity and thus involved the risk of misguided decisions. In view of today's substantial volumes of funds, such decisions could entail considerable costs.[3] Furthermore, the system could not keep pace with rising demands for bank payment services. Finally, it limited the ability to integrate the banks' in-house information systems with the external funds transfer system. Such integration was essential to streamlining the processing of payments.

The call for virtually lag-free information transmission and processing could only be met by resorting to electronic communication and processing technology. And because it was a centrally organized

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[1] All conversions of Swiss francs to dollars assume an exchange rate of 1.46 Swiss francs to one dollar.

[2] See Bank for International Settlements (1985) or Lehmann (1986) for a survey of the Swiss interbank payment system. At the end of 1987, 342 banks with a total of 2,894 branch offices participated in the Bank Clearing System. The remaining banks executed their payments through the giro system of the Swiss National Bank, through correspondent banks, or through the Postal Giro System.

[3] Fischer and Hurni (1988).

institutional framework, the Bank Clearing System seemed well suited for the introduction of an electronic funds transfer system. First steps in this direction were undertaken in the 1970s. Owing to cost factors and unsolved conceptual problems, however, the efforts failed to achieve their end. In. 1980 a study group of large Swiss banks initiated a new project under the name of "Swiss Interbank Clearing" (SIC). The new system was developed between 1981 and 1986 by Telekurs AG in cooperation with the banks and the Swiss National Bank. It began operation in June 1987. The remarks below provide an overview of the conceptual problems in interbank payment systems, the solution designed for SIC, and the experience gained with the new system during its first year of operation.

## Interbank Payment Mechanisms

*Gross settlement and net settlement systems* Funds transfer systems are susceptible to credit and fraud risks as well as to operational risks. In interbank payment systems the magnitude of the value of funds to be processed poses special credit risk problems. In this context, it is useful to distinguish between "gross settlement" systems and "net settlement" systems.[4]

In gross settlement systems payment takes place by means of an irrevocable and final transfer of deposits from the sending bank's account at the central bank to the receiving bank's account. The payment act (the transfer of the payment medium) and the settlement act (the transfer of central bank money) are linked in these systems.

In the United States, Fedwire is an example of a gross settlement system. Transfers of funds through Fedwire are final, but executing a payment order does not depend on the availability of the funds. Temporary overdrafts on accounts, also known as "daylight overdrafts," are on the order of $50 billion per day, that is, about 10 percent of the average daily value of funds processed through the system.

In net settlement systems the notification of payment received by the receiving bank represents a claim on the sending bank. The claims are accumulated up to a specified time (for example, up to the end of the day) and are subsequently settled by means of a transfer of central bank money from the net debtors to the net creditors. All payments effected during the settlement period are made subject to the final settlement transfers. They are thus also termed "provisional" payments.

In the United States, the Clearing House Interbank Payments System (CHIPS) is an example of a net settlement system. Payments made through CHIPS are subject to the condition that at the end of the day participants' net positions are settled through accounts held at the Federal Reserve Bank of New York. Should a participating bank not be in a position to meet its net liabilities, CHIPS regulations provide for the reversal of all payments executed in the course of that particular day affecting the defaulting participant. If such a situation were to occur, other participants might also become unable to pay. To date, such an eventuality has never arisen. If and when it does, the Federal Reserve System as lender of last resort might feel compelled to come to the aid of the defaulting participant by granting it credits. Total daily net credits recorded in the CHIPS system are of the same magnitude as the daylight overdrafts in Fedwire.

The Swiss Bank Clearing System was also a net settlement system. Payments made through this system were settled several times a day via participants' giro accounts at the Swiss National Bank. The accounts could be overdrawn during the day at no cost and to a practically unlimited extent. In contrast to the CHIPS system, the Swiss National Bank explicitly guaranteed settlement up to the limit of the collateral held by Bank Clearing participants with the Swiss National Bank. But the collateral, which served as the sole security against losses, was modest compared with the volume of daily overdrafts which averaged 20 to 30 billion Swiss francs ($13.7 to $20.5 billion).

*Risk aspects* Since payments in gross settlement systems are final, a receiving bank may dispose of the funds credited to its account without incurring a risk. A sending bank incurs a credit risk when it executes payments on behalf of a customer in excess of the customer's credit balance. The central bank runs a credit risk if it allows a sending bank to overdraw its reserve account. As a rule, gross settlement systems have permitted overdrafts that are both free of charge and unlimited in quantitative terms during the day (but not overnight). Measures designed to avoid or limit overdrafts are a problem insofar as they could severely disrupt payment flows (given the large volumes of funds recorded in interbank payment transactions). Further, such measures could impose a cost burden on system participants and thereby induce them to switch to alternative funds transfer networks.

[4] Not all wire transfer networks provide settlement of payments among banks. The Society for Worldwide Interbank Financial Telecommunications (SWIFT), for example, only transmits payment instructions. Actual payments take place by means of transfers of correspondent balances.

In net settlement systems like CHIPS, all payments are made subject to the condition that settlement take place at a predetermined time, usually before opening of the next business day. Despite this reservation, a participant may allow his customers to use incoming funds prior to settlement; the receiving bank thus assumes a credit risk vis-à-vis the bank ordering the payment. If a participating bank is not in a position to meet its net liabilities at the end of a day, it may affect the ability to pay of other participants, their customers, and ultimately the entire economy. The risk of such a chain reaction is known as systemic risk.

In gross settlement systems like Fedwire, finality of payment is guaranteed in formal terms by the relevant regulations and in actual practice by the central bank's money-creating powers. No systemic risk is inherent in such systems because participating banks do not enter into credit relationships with one another. Any credit relations arising in gross settlement systems in connection with the processing of payments are overdrafts on reserve accounts; the risks involved have to be borne by the central bank and do not affect the other participants.

Elimination of systemic risk is a decided advantage that gross settlement networks have over net settlement networks. But the practice usually followed in traditional gross settlement systems of allowing overdrafts on accounts without penalty restricts the flexibility of the central bank, as the extent of such overdrafts can only be monitored and controlled imperfectly. Moreover, gross settlement systems lack the incentives inherent in net settlement systems for a participant to take into account the solvency of other participants and to reduce credit risks by means of credit limits. It must therefore be expected that the total amount of overdrafts in a gross settlement system is greater than the total of net credits in a net settlement system under otherwise identical circumstances.

*Regulatory measures* Balance sheets drawn up according to conventional methods show the level of assets and liabilities at the end of the day. They do not show credit risks arising in the interbank payment system through daylight overdrafts and net debits because they are only incurred during the day and disappear by the end of the day. Moreover, owing to a lack of suitable data such risks can only be vaguely assessed in traditional funds transfer systems. Accordingly, in most countries supervisory authorities have so far paid little attention to such risks. One exception is the United States, where the question has been the subject of extensive studies for a number of years.[5]

In recent years the credit exposures observable in the large-dollar networks increased to such an extent that they were considered a threat to the stability of financial markets.[6] In 1986 the Federal Reserve System therefore issued a policy statement requiring Fedwire and CHIPS participants to use a system of net debit caps to restrict any further expansion (in quantitative terms) of the credit relationships resulting from payment processes.[7] Moreover, endeavors are being made to establish and ensure the finality of CHIPS payments through rules that require participants to somehow guarantee settlement.

## Main Features of the Swiss Interbank Clearing System[8]

*Demands on the system* In general, the introduction of electronic systems for interbank payment transactions has three goals:

1) creating optimum conditions for the planning and monitoring of liquidity by providing real-time information transmission and processing,
2) expediting and improving the quality of payment transactions, and
3) rationalizing the processing and settlement of payments by means of large-scale automation.

The SIC system had a fourth goal: creating a gross settlement system-a funds transfer system in which each payment is made irrevocably and finally through participants' accounts at the Swiss National Bank-that would guarantee a smooth processing of the payment flow even if no overdrafts were allowed on reserve accounts. This would make it possible to avoid the credit risks connected with overdrafts on gross settlement systems or provisional payments on net settlement systems. The solution arrived at was simple: Do not release a payment that will cause an overdraft until covering funds have arrived.

Account overdrafts can be the result of insufficient reserve account balances in relation to the participants' volume of payments or a lack of synchronization of incoming and outgoing payments.

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[5] Stevens (1984), Mengle (1985), Smoot (1985) Dudley (1986), Humphrey (1986, 1987), Mengle et al. (1987), Corrigan (1987), and Belton et al. (1987).

[6] Corrigan (1987).

[7] Belton et al. (1987).

[8] Buomberger (1987), Granziol (1986), Lehmann (1984, 1986), Meyer (1985), Müller (1986), SIC (1986), Telekurs (1987).

Given the current daily volume of payments to the tune of over 100 billion Swiss francs ($68.5 billion), prohibitively high costs would be imposed on participants if they were required to increase their non-interest-bearing reserve account balances or to coordinate the timing of incoming and outgoing payments so as to prevent any overdrafts from occurring. The experience of the United States seems to indicate quite clearly that the problem of overdrafts cannot be properly solved on the basis of caps or payment coordination by participants alone[9]. A less costly solution might result if the funds transfer system itself were to help solve the synchronization problem. The SIC attempts to relieve participants as far as possible from the synchronization task by automatically guaranteeing an optimum synchronization of incoming and outgoing payments.

In order to take due account of increasingly sophisticated customer requirements and to lower the cost of each individual payment transaction, it was further planned to send not only large-value payments through SIC but also to provide for the processing of a substantial proportion of bulk payments. Because under these conditions a total of more than 400,000 payment transactions might have to be reckoned with on peak days, it was specified that SIC should have a settlement capacity of 90,000 payments per hour.

*Components* The requirement that each payment must be settled finally and irrevocably on SIC implies that participants' clearing accounts must be the reserve accounts managed by the Swiss National Bank. But actual operation of SIC by the Swiss National Bank would have meant a fundamental change in the allocation of responsibilities among the banks, Telekurs AG, and the Swiss National Bank from the pattern existing in the Bank Clearing System. It would have been impossible for the Swiss National Bank to implement such a major project within a reasonable time because it lacked the necessary technical capabilities and experience. The major banks and Telekurs AG, however, had gained ample experience in the course of their own research and development work. For this reason, it was decided that SIC would operate on the computer systems of Telekurs AG. The objective of administering participants' reserve accounts held with the Swiss National Bank with the aid of this system was achieved by means of an agreement on the allocation of functions: Telekurs AG would operate the SIC computer center on behalf of the Swiss National Bank, while the Bank would manage the accounts.[10]

The chief components of SIC are shown in Figure 1.[11] At the center is the computer system in which participants' "SIC accounts" are administered. The computer systems of the Swiss National Bank and of the participants are linked to the SIC computer either directly or by communication computers.[12] SIC also has a magnetic tape interface with the postal checking system permitting transfers from postal checking accounts to the reserve accounts and vice versa. Moreover, magnetic tape interfaces to service applications provide for the processing of customer-related payment transactions (such as check clearing and cash dispensers) and for securities clearing with traditional net settlement methods.

In accordance with contractual agreements, participating banks' SIC accounts take the form of reserve accounts at the Swiss National Bank. In addition, every participant has a traditional reserve account which is administered on the computer system of the Swiss National Bank and bears the designation "master account." Legally, both accounts form a single unit and carry the same rights and obligations, though physically they are managed separately.

The SIC account is used for processing SIC transactions, while the master account is used for all other transactions (such as cash withdrawals). At the beginning of a clearing day the Swiss National Bank transfers balances from the master account to the SIC account. At the end of the day the total debits and credits on the SIC account are transferred to the master account so the master account again shows the full reserve balance of a participant. The participating bank decides how the balance is to be divided up between the two accounts. In so doing, it must bear in mind that payments are made from the two accounts only if there are sufficient funds in the accounts. Transfers from the master account to the SIC account and vice versa are possible at any time during the day.

*Processing of payments* SIC is a credit transfer system. That is, it does not in principle allow debit transactions. Payment transactions entered by the Swiss National Bank on the instructions of a participant are an exception, but take place only in unusual

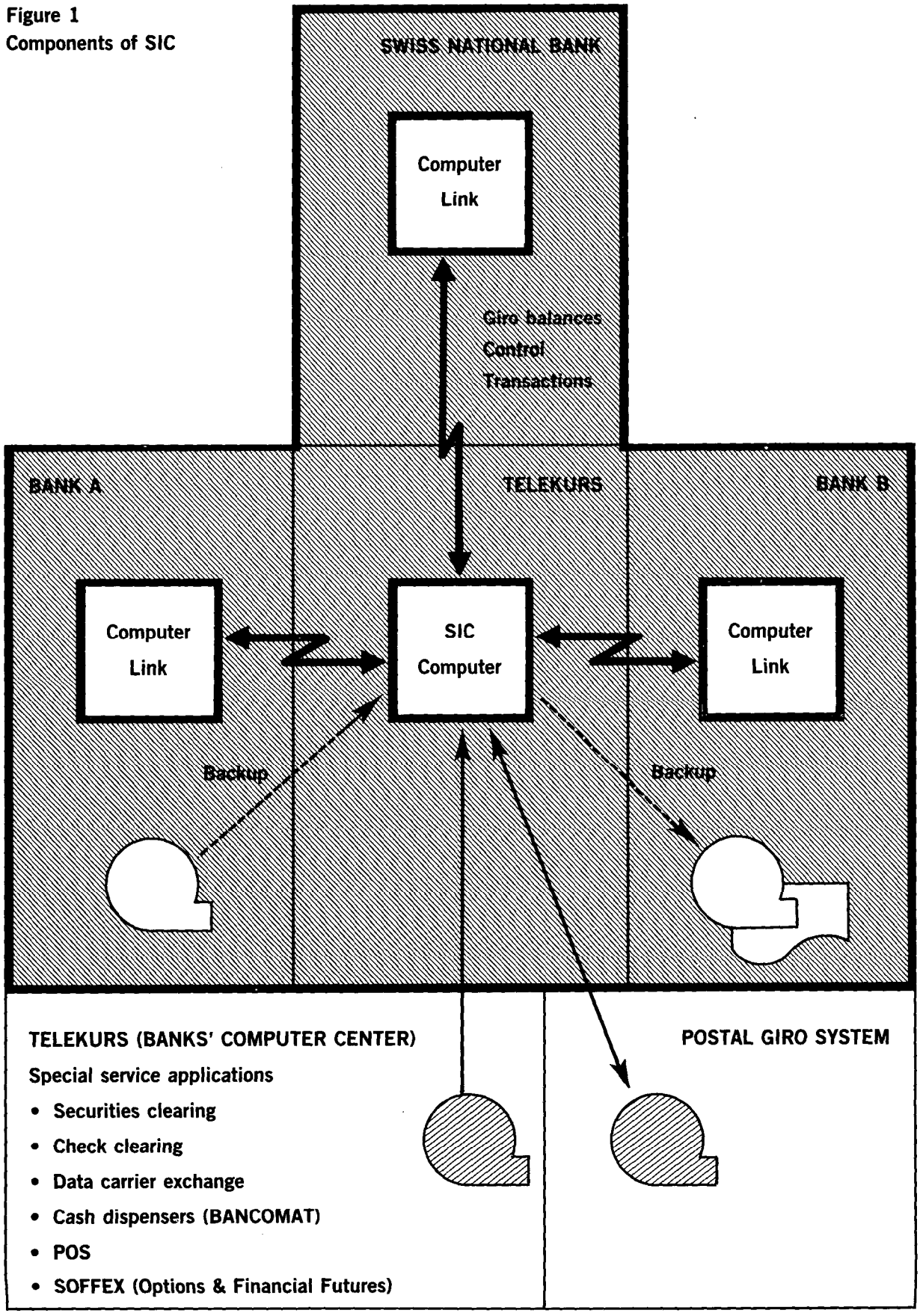
[9] "Since there probably are limits as to how far efforts to reduce daylight overdrafts can go, the current daylight overdraft control program would have to be augmented by some combination of clearing balance requirements for major users of Fedwire and explicit charges for daylight credit . . ." Corrigan (1987), p. 31. See also Belton et al. (1987).

[10] See Hess (1988) on the contractual basis.

[11] See Telekurs (n.d.) on the hardware concept.

[12] See Birchler (1987) on the communication concept.

Figure 1
Components of SIC



circumstances such as computer breakdowns. In addition, payments for the special services shown in Figure 1 are settled by debit transactions.

The planned volume of transactions makes high demands on the processing capacities of the participating banks' systems and the SIC computer system. SIC therefore provides a 24-hour service on bank working days. Payment orders may be entered around the clock, either through the network or on magnetic tape, for settlement on the day of input or on one of the following ten bank working days. Payment orders not due for settlement on the day of input are stored in the "pre-value date file" and are automatically executed on the due date. Settled payments are delivered to the recipient through the network, on magnetic tape, or on paper. The magnetic tape and paper interfaces are reserved primarily for backup purposes.

The processing of payments to be settled on the day of input is shown in Figure 2. The payment message entered by Bank A is first "validated" by SIC. That is, the system checks whether the message complies with the formal requirements listed in the SIC standards, whether it has not already been input (double entry check), and whether it is compatible with the master data stored for the bank. If the validation result is positive the sending bank receives an "OK" message and the payment message continues to be processed. Otherwise the sending bank receives an "NOK" message (not OK) and the payment message must be entered again. Validated payment messages are then passed on to the SIC settlement mechanism. This is the central component that automatically ensures synchronization of incoming and outgoing payments.

A payment order is settled, that is, the account of the sending bank ordering the payment (Bank A) is debited and the account of the receiving bank (Bank B) is credited if there are sufficient funds ("cover") in the sending bank's account to be debited. If desired, the sending bank is advised of the result of the check by means of an "EX" or a "NEX' (executed or not executed) message. Settled payments are delivered to the receiving bank, which in turn has to acknowledge receipt to the SIC system.

If sufficient cover is not available the payment order is transferred to a "waiting queue" and kept pending until sufficient funds have accumulated in the clearing account as a result of incoming payments. Once sufficient funds are available the settlement process is initiated automatically. The sequence of settlement is determined by the "first-in-first-out" (FIFO) principle, that is, by order of input.[13] No daylight overdrafts can occur.

It is possible that some payments cannot be settled by the end of the day owing to lack of cover. In such an event the payments involved are cancelled during end-of-day processing and must be entered again by the sending bank on the following day.

The settlement of a payment is final and irrevocable. The receiving bank can thus dispose of the incoming amounts without incurring any risk. But unlike settled payments, payment transactions stored in the waiting queue or in the pre-value-date file may be cancelled by the sending bank at any time. The purpose of allowing cancellation is to discourage receiving banks from releasing pending payments (similar to provisional payments on CHIPS) prior to settlement.[14] That is, receiving banks are less likely to allow customers access to provisional funds if there is a possibility the payment could be cancelled before settlement.

*Inquiries* A bank participating in SIC can monitor any settled incoming and outgoing payments or payments stored in the waiting queue and pre-value-date file that concern it. Similarly, it can monitor the actual balance in its SIC account and the balance including any payments not yet settled for all valid value dates. All information entered in the system is thus immediately available to the participant concerned.

The Swiss National Bank has access to the same information, but for all SIC accounts. For individual payment messages, access is restricted to settlement-related data (sending and receiving bank, amount, date).

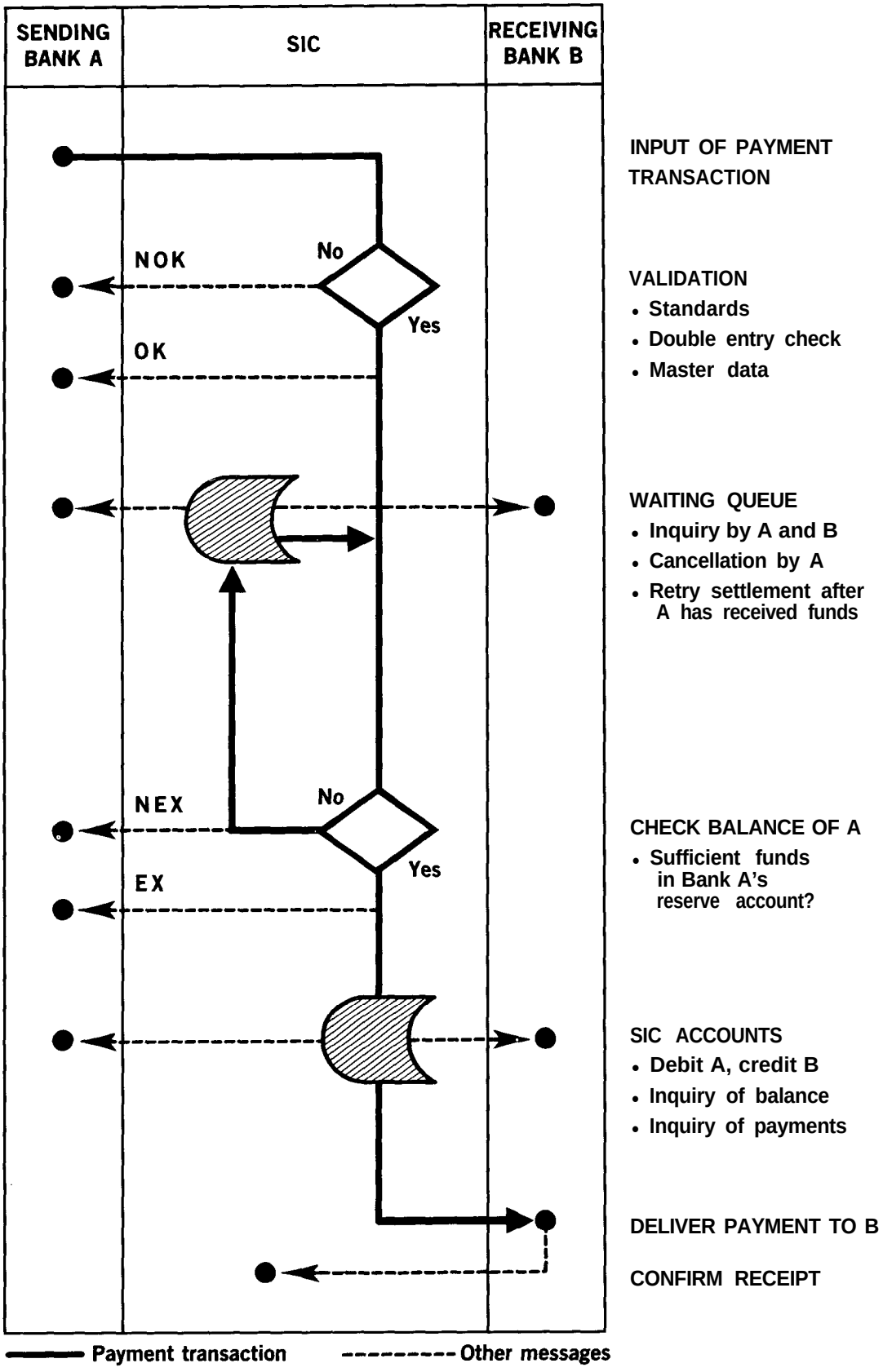
*Daily schedule* A SIC day begins at around 6 p.m. and ends at approximately 4:15 p.m. of the following bank working day. Between 6 p.m. of the first working day and 3 p.m. of the following day the entering of payment messages is not restricted.

At 3 p.m. "Cutoff One" takes place. Any payments entered after Cutoff One for same-day settlement automatically have their value date changed to the next day. The sole exceptions are "cover payments," which may be entered until "Cutoff Two" (4 p.m.) for same-day settlement. The intervening hour between Cutoff One and Cutoff Two is intended to

13 The settlement mechanism described applies to all SIC payment transactions including payments between two branches of the same bank.

14 Incentives of this kind are also reduced to a minimum by the rule that payments are not delivered to the recipient immediately after being entered but are withheld until settlement has taken place.

Figure 2
Processing of Payments for Same-Day Settlement



permit participants whose payments have not been carried out prior to Cutoff One owing to lack of cover to procure the funds necessary for settlement. After Cutoff Two only cover payments entered by the Swiss National Bank are accepted for same-day settlement until end-of-day processing begins. This is a backup measure in case a participating bank is not able to enter cover payments itself because of technical difficulties.

At around 4:15 p.m. end-of-day processing begins. All pending transactions are cancelled and the total credits and debits on each SIC settlement account are transferred to the master accounts. A new SIC day begins at approximately 6 p.m.; the settlement process for the new day starts with the transfer of reserve account balances from the master accounts to the SIC settlement accounts at approximately 7:30 p.m.

It cannot be ruled out that a participant might fail to enter all its transactions for same-day settlement prior to Cutoff One because of, say, technical difficulties. Nor can it be ruled out that payments may remain in the waiting queue due to lack of cover until end-of-day processing begins. In either case considerable costs may arise, both for the participant concerned and other participants, in the form of interest on delayed payments. If the amounts involved are substantial and if there is any possibility of the problems finding a solution within a reasonable time, a postponement of cutoff times and of end-of-day processing will be considered.

*Security and reliability measures*[15] In addition to measures for limiting credit risks, the architecture of an interbank payment system includes measures to protect against fraud and operational risks. In particular, operational difficulties can set off chain reactions that may jeopardize payment processing and therefore the timely fulfillment of obligations running into billions of Swiss francs. Understandably, then, an interbank payment system must provide a high degree of security and reliability.

There are two types of security measures to protect against infiltration, falsification, and tapping of messages by unauthorized third parties. First, authentication protects message transmission between participants and the SIC computer by means of a mathematical procedure that verifies the authenticity and integrity of a transaction. Second, encryption is available to prevent messages from being tapped. Encryption is not compulsory, but all participants are advised to use it.

With regard to operational reliability, there are backup facilities in the SIC computer center and in a remote backup center to serve as standbys in the event of failures of the SIC computer system or the central network equipment. But SIC encompasses not only the central SIC system, but more than 150 participant computer systems as well. While the reliability of data processing and communication facilities has reached a high standard in recent years, a system with such a large number of complex components cannot be expected to operate without any failures at all. The robustness of the overall system thus depends largely on the availability of suitable backup facilities in the event of breakdowns.

If time were needed to recover from failures of a participant's computer system or of the central system, cutoff could be postponed. In addition, any participant who is unable to communicate with SIC can resort to an exchange of data by means of magnetic tapes. In the event of serious disruptions provision is made for the Swiss National Bank to input large-value payments or totals of payments into the SIC system or enter them through the master accounts.

## Introduction of SIC[16]

SIC was developed between 1981 and 1986 and was subjected to extensive tests from September 1986 to May 1987. The introduction of such a system could be costly and could involve high risks, since it would not be possible to test such a complex facility for every detail under all conceivable circumstances. Moreover, participating banks would have to install their systems and have them functioning on schedule. Finally, the banks would have to reorganize operational procedures that had become firmly established over the years.

In order to limit the risks involved in the introduction of the system and also because it was hardly to be expected that all participants would be able to complete all the preparations and conversions by a certain date, it was decided to introduce the new system step by step within the space of a year. The introduction was to be gradual in regard to both number of links and volume of transactions. But this led to the problem of payments accumulating on the accounts of participants not yet linked to the system. Potentially, this could cause settlement to come to a virtual standstill. The problem was solved by requiring that all "large" payments (exceeding one million Swiss francs) be processed through SIC as

[15] See also Walder (1987).

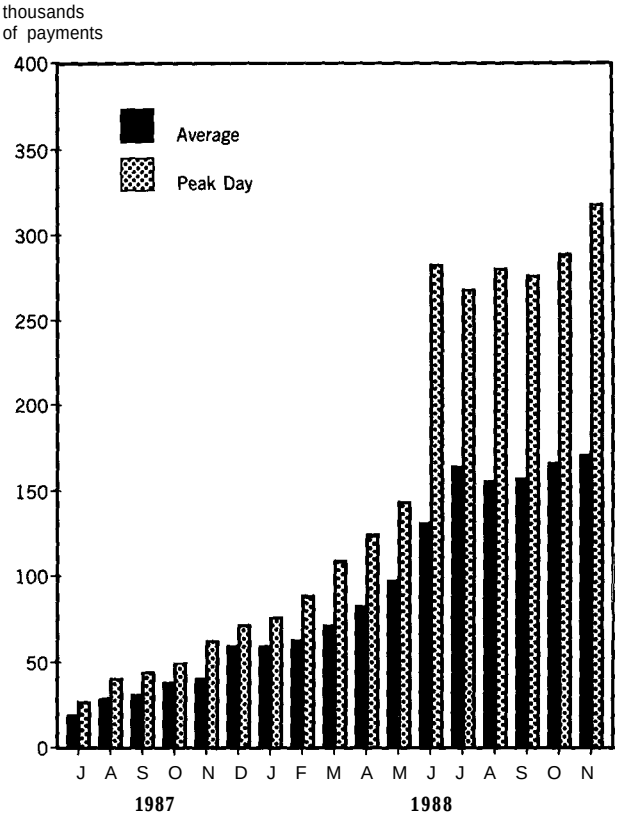
[16] For a first progress report see Vital (1987).

soon as it began operation. The Swiss National Bank assumed responsibility for entering such payments on behalf of any institutions not yet linked to the system.

SIC began operation on 10 June 1987. During the following months of operation the functional viability of the overall system was established. If one were to take into account the system's complexity and that its development meant breaking new ground, the introduction may be regarded as smooth and successful. As was to be expected, a few technical difficulties did occur both in the central system and with a number of participants. Each day, however, the settlement books were properly closed. No conceptual shortcomings were revealed in the course of the practical operations of the SIC system. The technical problems that did arise showed that the backup plans provided the necessary immunity from operational disruptions.

It was further revealed in the first few months that the SIC settlement mechanism worked satisfactorily. Transaction volume fluctuated between 60 and 140 billion Swiss francs ($41.1 to $95.9 billion) every day during that time. Even so, reserve account overdrafts, which had amounted to between 20 and 30 billion Swiss francs daily in the old Bank Clearing System, were permanently eliminated at one stroke when SIC came into operation without causing any disruptions in the interbank payment flow.

**Figure 3**
**Number of SIC Payments Per Day**
**July 1987-November 1988**




## Experience since the Introduction of SIC[17]

*Participants and payment volumes* When SIC began operation on 10 June 1987, eight participating institutions were linked to the system. On that first day, 13,300 payments totalling 80 billion Swiss francs ($54.8 billion ) were processed. By the end of November 1988 the number of participants linked on-line to SIC had risen to 156. (In comparison, CHIPS has 136 participants and Fedwire serves almost 7,000 depository institutions.) Further, the number of transactions per day approached 170,000 and the maximum peak day volume had increased to over 300,000 payments (Figure 3). But the expansion of average daily *value* of payments over the same period seems less dramatic in comparison because large payments, which account for the major part of the volume of funds, have been executed through SIC from the very first day (Figure 4). Still, peak day volume surpassed 200 billion Swiss francs for the first time in November 1988.

SIC will completely replace Bank Clearing in January 1989. If a bank not linked on-line to SIC wishes to make a payment through SIC, it does so through a correspondent linked to SIC.

*Distribution of payment size* While all large (one million Swiss francs or more) payments have been processed through SIC since June 1987, the proportion of small (up to 5,000 Swiss francs) payments has increased in terms of number of transactions as more participants have been added to SIC. In September 1987 small payments constituted almost SO percent of transactions, but by November 1988 their proportion had grown to about 77 percent. At the same time, the proportion of large payments had fallen from 23 percent to about 5 percent of the total number of transactions.

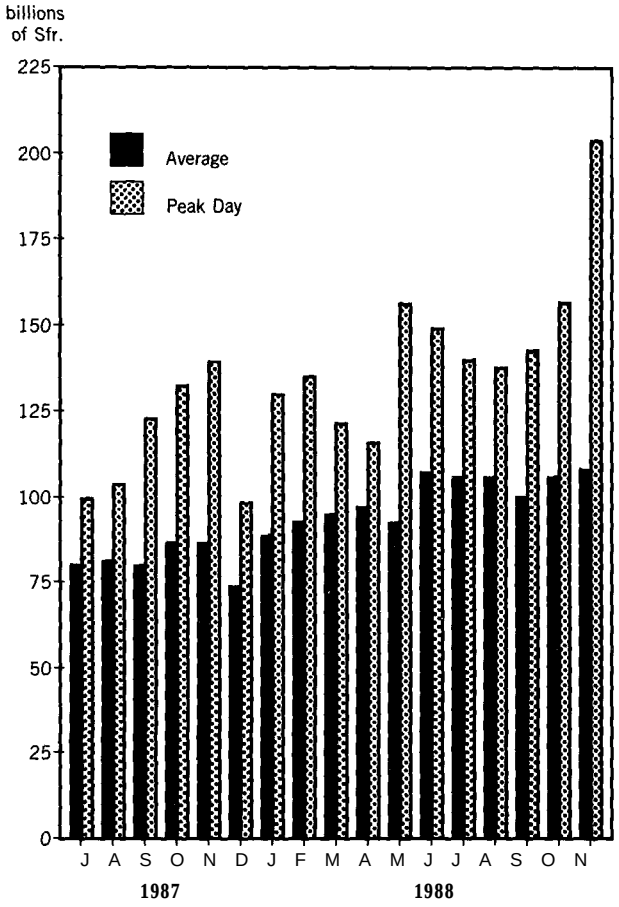
But in terms of value, only large payments are of any importance. Further, the distribution of values of payments has not changed markedly over time. Specifically, in September 1987 large payments comprised about 99 percent of total payment value, while by November 1988 the proportion had only fallen slightly to just under 98 percent.

[17] The Appendix treats the subject of this section in more detail.

**Figure 4**

**Value of SIC Payments Per Day**

**July 1987-November 1988**




On United States holidays, SIC payment volumes in terms of value fall to levels of less than 10 percent of average daily volumes. This shows that large payments derive chiefly from foreign exchange transactions. It also shows that comprehensive risk analyses and risk measures must take into account the interdependence of the various national funds transfer systems.

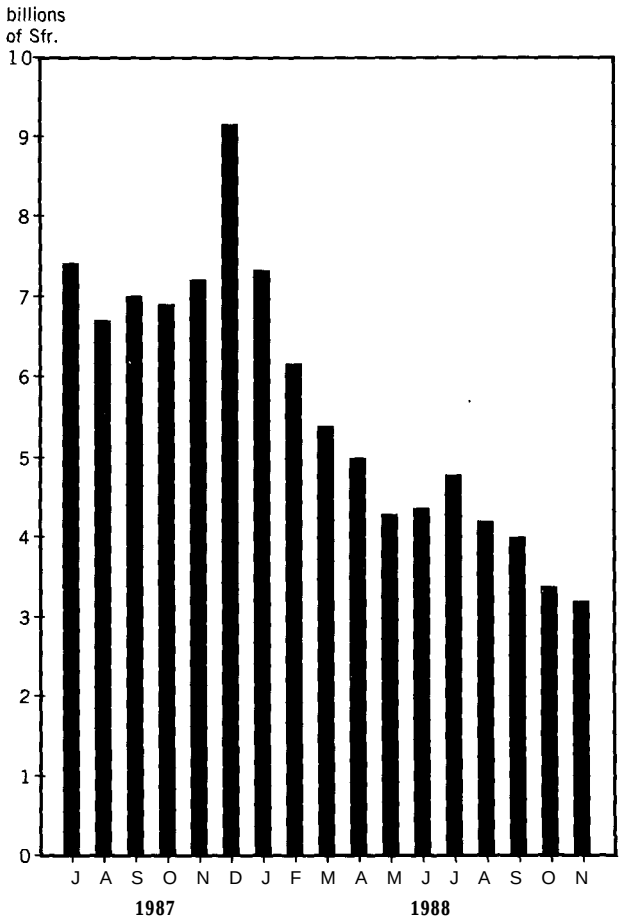
*Use of reserve account balances* It is difficult to determine the effect of SIC on the demand for reserve account balances because new liquidity regulations took effect on 1 January 1988.[18] Essentially, reserve requirements in Switzerland are now fulfilled by banks holding cash along with deposits with the Postal Giro System. Thus the deposits banks hold with the Swiss National Bank are for all practical purposes excess reserves. The results are shown in Figures 5 and 6. The level of reserve account balances held by SIC participants with the Swiss National Bank declined from over 7.0 billion Swiss francs in January 1988 to 3.2 billion Swiss francs by November 1988 (or from $4.8 billion to $2.2 billion). The ratio of daily value of SIC payments to the level of reserve account balances (that is, daily turnover) increased during the same period from approximately twelve to well over thirty.

*Changes in input and settlement times* Since the introduction of SIC input behavior has changed in favor of earlier times of input as additional participants have been linked to the system and payment volumes have expanded. Further, on 1 April 1988 a new transaction price stucture was introduced. The receiving bank pays a flat fee for each message received, and the fee does not change during the day.

**Figure 5**

**Reserve Balances of SIC Participants**

**July 1987-November 1988**



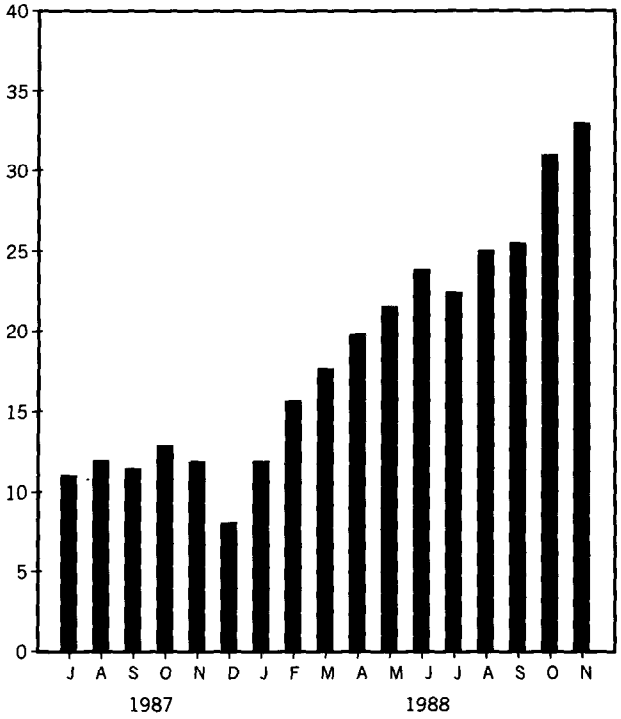

Note: Balances are monthly averages of daily figures.

[18] Birchler (1988).

**Figure 6**

**Turnover of Reserve Balances of SIC Participants Per Day**

July 1987-November 1988




Note: Turnover is the ratio of average daily payment value to average daily reserve balances.

In addition, the sending bank is charged a two-part price for each transaction, and each part increases at specified times during the day. One part of the price is based on time of input, the other on time of settlement. For example, a payment entered and settled before 8 a.m. would carry the lowest price, while a payment entered before 8 a.m. but not settled until after 8 a.m. would carry a higher price. The highest price would be charged for payments input and settled after 2 p.m.

By charging sending banks lower prices for payments entered and settled early in the day, it was hoped that participants would enter their payments a little sooner and thereby contribute to improved coordination of incoming and outgoing payments. While the new prices may have helped the move to earlier input times, settlement times have not become appreciably earlier. In fact, as reserve balances are reduced the settlement times are increasingly squeezed toward the end of the day.

*Speed of processing* Outgoing payments have to wait for incoming payments unless the bank synchronizes payments in such a way that available reserve account balances are sufficient for immediate settlement. The "waiting time" is the intervening period between the receipt of a payment by SIC and its settlement. If sufficient funds are available to settle a payment, the waiting time is about 30 seconds. If sufficient funds are not available, payments can be stored in the waiting queue for minutes or even hours.

The speed with which processing takes place in SIC depends on the value distribution of the payment flow, the level of participants' reserve account balances, and the degree of synchronization of incoming and outgoing payments. Speed may be increased for a given payment flow by raising the level of reserve account balances, by improving coordination between outgoing and incoming payments, or by exchange of intraday funds among the participants. But such measures involve costs that must be weighed against the advantages of a higher processing speed.

In November 1988, approximately 30 percent of all transactions were settled within ten minutes and approximately 55 percent within two hours of having been entered. This is a decrease from the corresponding figures of 43 percent and 79 percent a year earlier. More noticeable has been the drop in payments settled within five hours of input. While 99 percent of payments were settled within five hours, in November 1987, the proportion had **declined to** about 85 percent by a year later.

In electronic funds transfer systems that execute payment orders unconditionally, payments are processed without any significant delays. In the SIC system, in contrast, delays of up to a few hours may occur. This is the price to be paid for avoiding account overdrafts in the payment process. Compared with the Bank Clearing System, however, processing through SIC is much quicker. Consequently, delays have never been mentioned as a shortcoming of SIC.

*Payment gridlock* Related to use of reserve balances and speed of processing is the issue of payment gridlock, a situation in which no payments move over a system because they are all awaiting incoming funds for cover. Gridlock becomes more likely as reserve balances fall. The level of SIC reserve balances at which gridlock becomes a frequent problem depends on the number and value of large payments and the input behavior of participants. The question is: Are there incentives that prevent the transaction demand for reserves from dropping to the gridlock level? If not, then SIC could conceivably degenerate into a

system with input in real-time but settlement in batch mode at the end of the day unless administrative measures were taken to force participants to hold sufficient reserves.

But there are factors that should prevent reserves from dropping to levels that threaten gridlock. First, since payments are not delivered to receiving banks unless settlement has occurred, receiving banks and their customers may exert pressure for higher reserve balances. Second, the costs associated with the squeezing of settlement times toward the end of the clearing day-or, in the extreme case, the costs associated with a gridlock-should deter banks from allowing their reserve balances to decline to unsafe levels. In addition, the Swiss National Bank's lending policies and the way in which rules (such as delays of cutoffs) are enforced will help shape banks' reserve demand.

## Overall Assessment

SIC is a centralized gross settlement system created to process interbank payment transactions with no daylight overdrafts and therefore no systemic risk or Swiss National Bank intraday credit risk.

Experience shows that the objectives of implementing the system have been achieved: First, it provides an infrastructure that supports liquidity planning and monitoring in real time. Second, it expedites and improves the quality of payment transactions, Finally, it rationalizes the processing of payments by means of the unretarded transmission and processing of information.

Compared with the traditional Bank Clearing System, SIC offers considerable advantages both to participants and to the Swiss National Bank. Experience has shown that at least in Switzerland the main problem arising in connection with gross settlement systems, the elimination of account overdrafts, can be solved. Liquidity problems cannot be avoided even with this system. It does ensure, however, that in such cases the Swiss National Bank has the flexibility to decide whether or not it wishes to provide support as lender of last resort.

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## APPENDIX: Survey of SIC Transactions

The growth of SIC transactions and of participation are shown in Table I. The large spread between daily average volume and peak day volume is attributable to the bulk payment transactions that are concentrated at the end of the month. By November 1988, peak day value of transactions passed 200 billion Swiss francs. Table II shows that the distribution of both number and value of payments transacted through SIC has been very uneven. While small payments have grown as a percentage of number of transactions, large payments have predominated in terms of value from the beginning of the system.

Tables III and IV give an overview of input behavior and the settlement of daily SIC payment flows from September 1987 to October 1988 in the form of monthly averages of daily figures. Table III lists percentages of daily volume in terms of the number of entered and settled payments for various times of the day. Table IV lists the corresponding percentages in terms of value. The tables show that

**Table I**

**SIC PARTICIPANTS AND TRANSACTIONS**

**July 1987-October 1988**

| Year Month | Number of on-line participants | Number of Transactions | | | Value of Transactions[1] | | |
|---|---|---|---|---|---|---|---|
| | | Monthly total | Daily figures | | Monthly total | Daily figures | |
| | | | Average | Peak day | | Average | Peak day |
| 1987 | | | | | | | |
| J | 17 | 391,169 | 17,007 | 22,797 | 1,870 | 81 | 99 |
| A | 34 | 522,863 | 24,898 | 40,278 | 1,722 | 82 | 103 |
| S | 55 | 615,255 | 27,966 | 43,276 | 1,773 | 81 | 123 |
| O | 73 | 822,221 | 37,374 | 50,624 | 1,917 | 87 | 132 |
| N | 82 | 918,249 | 43,726 | 62,358 | 1,824 | 87 | 139 |
| D | 95 | 1,247,903 | 56,723 | 72,029 | 1,603 | 73 | 97 |
| 1988 | | | | | | | |
| J | 105 | 1,118,389 | 55,919 | 76,839 | 1,774 | 89 | 130 |
| F | 112 | 1,279,421 | 60,925 | 88,258 | 1,953 | 93 | 136 |
| M | 125 | 1,645,989 | 71,565 | 106,255 | 2,187 | 95 | 120 |
| A | 133 | 1,568,299 | 82,542 | 122,442 | 1,862 | 98 | 115 |
| M | 149 | 1,930,068 | 96,503 | 144,945 | 1,843 | 92 | 154 |
| J | 154 | 2,885,069 | 131,140 | 281,352 | 2,328 | 106 | 147 |
| J | 155 | 3,423,815 | 163,039 | 267,350 | 2,213 | 105 | 140 |
| A | 156 | 3,398,110 | 154,460 | 279,369 | 2,322 | 105 | 136 |
| S | 156 | 3,428,466 | 155,839 | 274,943 | 2,205 | 100 | 143 |
| O | 156 | 3,475,424 | 165,496 | 288,955 | 2,207 | 105 | 154 |
| N | 156 | 3,729,613 | 169,528 | 318,816 | 2,345 | 107 | 203 |

[1] Billions of Sfr.

Table II

## VALUE DISTRIBUTION OF SIC PAYMENT FLOW

**(Proportions in terms of number and value)**

| Year Month | Size of Payment Transactions (Sfr) | | | | | |
|---|---|---|---|---|---|---|
| | 1-4,999 | | 5000-999,999 | | 1 million and above | |
| | Number | Value | Number | Value | Number | Value |
| 1987 | | | | | | |
| S | 49.8 | 0.02 | 27.3 | 1.2 | 22.9 | 98.9 |
| O | 54.1 | 0.03 | 25.7 | 1.4 | 20.2 | 98.6 |
| N | 59.0 | 0.03 | 26.1 | 1.6 | 14.9 | 98.4 |
| D | 63.1 | 0.06 | 26.2 | 2.0 | 10.7 | 97.9 |
| 1988 | | | | | | |
| J | 60.7 | 0.05 | 24.7 | 1.6 | 14.6 | 98.3 |
| F | 62.5 | 0.05 | 24.1 | 1.6 | 13.4 | 98.4 |
| M | 65.9 | 0.06 | 22.3 | 1.6 | 11.8 | 98.3 |
| A | 68.6 | 0.07 | 21.7 | 1.7 | 9.8 | 98.3 |
| M | 72.1 | 0.09 | 19.7 | 1.8 | 8.2 | 98.1 |
| J | 74.5 | 0.11 | 18.4 | 1.8 | 7.1 | 98.1 |
| J | 76.6 | 0.14 | 17.9 | 2.1 | 5.5 | 97.8 |
| A | 77.1 | 0.13 | 17.2 | 2.0 | 5.8 | 97.9 |
| S | 77.5 | 0.14 | 17.4 | 2.0 | 5.1 | 97.8 |
| O | 77.4 | 0.15 | 17.3 | 2.1 | 5.3 | 97.8 |
| N | 76.8 | 0.14 | 17.8 | 2.1 | 5.4 | 97.8 |

Table III

## NUMBER OF PAYMENTS BY TIME OF DAY

**(Percentage share of total)**

| Year Month | Time of Day | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 08:00 a.m. | | 10:00 a.m. | | 12:00 a.m. | | 02:00 p.m. | |
| | Input | Settlement | Input | Settlement | Input | Settlement | Input | Settlement |
| 1987 | | | | | | | | |
| S | 27.3 | 2.1 | 44.2 | 24.5 | 72.1 | 49.6 | 90.3 | 81.2 |
| O | 26.8 | 7.4 | 42.1 | 20.0 | 69.0 | 48.6 | 89.0 | 79.0 |
| N | 26.1 | 10.5 | 41.6 | 23.4 | 69.3 | 49.3 | 89.1 | 81.5 |
| D | 29.3 | 19.5 | 45.1 | 37.2 | 70.1 | 62.3 | 89.1 | 82.4 |
| 1988 | | | | | | | | |
| J | 29.4 | 14.1 | 44.0 | 26.9 | 69.8 | 55.5 | 88.0 | 82.7 |
| F | 29.7 | 14.2 | 45.1 | 28.0 | 70.4 | 57.2 | 89.3 | 84.5 |
| M | 31.0 | 15.4 | 45.7 | 27.5 | 69.7 | 53.2 | 88.5 | 82.7 |
| A | 32.2 | 15.7 | 46.7 | 28.6 | 71.5 | 56.8 | 88.3 | 82.4 |
| M | 33.3 | 14.1 | 48.1 | 24.7 | 72.1 | 50.7 | 88.9 | 76.8 |
| J | 41.9 | 17.7 | 54.5 | 26.5 | 73.6 | 45.9 | 89.0 | 73.2 |
| J | 49.6 | 22.4 | 60.3 | 33.7 | 76.1 | 57.1 | 90.1 | 78.8 |
| A | 49.5 | 18.8 | 61.4 | 29.2 | 78.5 | 55.0 | 92.5 | 86.5 |
| S | 49.3 | 19.4 | 59.8 | 30.4 | 77.9 | 52.1 | 91.7 | 80.2 |
| O | 47.2 | 18.1 | 58.1 | 27.2 | 76.9 | 45.1 | 92.1 | 75.2 |
| N | 48.0 | 18.2 | 59.4 | 27.9 | 78.0 | 43.5 | 92.5 | 70.7 |

**Note: Monthly average of daily figures.**

**Table IV**

## VALUE OF PAYMENTS BY TIME OF DAY

**(Percentage share of total)**

| Year Month | Time of Day | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 08:00 a.m. | | 10:00 a.m. | | 12:00 a.m. | | 02:00 p.m. | |
| | Input | Settlement | Input | Settlement | Input | Settlement | Input | Settlement |
| 1987 | | | | | | | | |
| S | 30.2 | 3.8 | 54.2 | 29.5 | 81.4 | 56.9 | 95.1 | 89.6 |
| O | 29.0 | 8.1 | 50.6 | 24.4 | 79.5 | 56.7 | 94.6 | 88.7 |
| N | 33.7 | 13.8 | 54.8 | 29.0 | 80.6 | 55.8 | 95.3 | 90.0 |
| D | 37.6 | 26.4 | 59.0 | 46.9 | 83.4 | 74.4 | 95.1 | 92.2 |
| 1988 | | | | | | | | |
| J | 36.1 | 17.4 | 56.1 | 32.4 | 83.5 | 65.3 | 96.1 | 91.7 |
| F | 35.8 | 16.2 | 57.5 | 31.6 | 82.8 | 67.4 | 96.0 | 93.2 |
| M | 36.7 | 15.3 | 58.0 | 30.2 | 83.5 | 62.8 | 96.4 | 93.1 |
| A | 33.5 | 14.5 | 55.3 | 27.4 | 82.6 | 62.4 | 95.6 | 90.1 |
| M | 34.7 | 11.2 | 56.7 | 19.6 | 82.9 | 51.1 | 95.5 | 82.2 |
| J | 37.7 | 13.5 | 56.1 | 24.1 | 81.2 | 52.7 | 95.2 | 78.2 |
| J | 42.4 | 20.5 | 60.7 | 34.8 | 82.3 | 56.7 | 94.0 | 80.4 |
| A | 46.1 | 15.7 | 63.1 | 30.0 | 84.5 | 60.7 | 95.7 | 88.5 |
| S | 47.1 | 14.5 | 64.9 | 29.2 | 85.5 | 55.9 | 95.0 | 82.8 |
| O | 47.9 | 13.9 | 63.7 | 24.3 | 85.2 | 47.9 | 95.9 | 76.4 |
| N | 48.1 | 14.2 | 63.3 | 22.3 | 83.1 | 42.8 | 94.6 | 65.5 |

**Note: Monthly average of daily figures.**

almost half of all payments are entered before 8 a.m. on the settlement day, either at night or on previous days in the form of payment orders with pre-stated value dates. But up to that time less than half these payments have actually been settled. By 2 p.m. (one hour prior to Cutoff One) over 90 percent of the transaction volume and almost 95 percent of the value have been input, although only about 70 percent of the transactions have been settled.

Waiting time is the period between receipt of a payment by SIC and its settlement. Figures A. 1 and A.2 show percentage shares of the overall volume in terms of number and value for different waiting time classes. Since the processing speed observed during normal working hours is of primary interest, all payments settled before 8 a.m. are considered to have a waiting time of zero.

Figure A. 1 shows that approximately 30 percent of all transactions are settled within ten minutes and approximately 55 percent within two hours of having been entered. Some transactions may remain in the waiting queue for several hours. The figures for value of transactions are lower (Figure A.2). Processing time for large payments is a little longer than that for small payments. Note that the percent of transactions taking more than five hours to settle increased during the second half of 1988. This corresponds to the decline in reserve balances held with the Swiss National Bank.

**Figure AI**

**Time Lag Between Input and Settlement of the SIC Payment Volume**

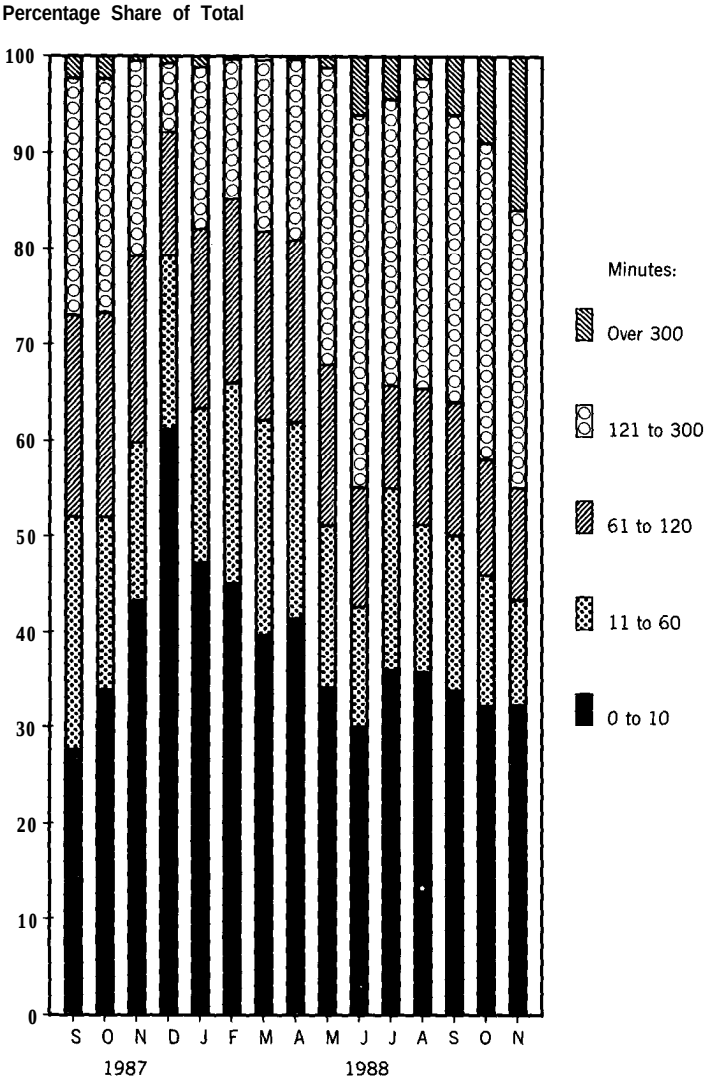


**Figure A2**

**Time Lag Between Input and Settlement of the SIC Payment Value**