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The Effects of Settlement Methods on Liquidity Needs: Empirical Study based on Funds Transfer Data

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THE EFFECTS OF SETTLEMENT METHODS ON LIQUIDITY NEEDS:*

EMPIRICAL STUDY BASED ON FUNDS TRANSFER DATA

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ABSTRACT

The level of intraday liquidity needed for settlement varies according to settlement methods. This paper is an empirical study based on funds transfer data in Japan of the effects of the shift from deferred net settlement (DNS) to real time gross settlement (RTGS) with liquidity-saving features (LSF) on the liquidity for settlements of payments among financial institutions. The study has revealed the following: (1) The extent to which liquidity financial institutions put into their accounts for settlement has increased due to the shift to RTGS; (2) the level of the liquidity which was not used for settlements; (3) the liquidity-saving effects of the LSF in an accommodative monetary environment under the zero-interest rate policy; (4) the extent to which the liquidity-saving effects have increased by the uniform application of LSF to different types of transactions; and (5) the extent to which the collateral requirements have declined as a result of the reduction in transactions settled on a DNS basis.

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I. Introduction

This paper is an empirical study based on funds transfer data of the effects of a change in settlement methods in payment systems on liquidity. Specifically, it focuses on 1) the conversion of large-value payments which were previously processed under the deferred net settlement (DNS) method in the Bank of Japan Financial Network System (BOJ-NET) to the real time gross settlement (RTGS) method and 2) the introduction of liquidity-saving features (LSF) to RTGS to see their impact on the liquidity of financial institutions.

The BOJ-NET is a computer network system designed to process on-line the settlement of funds and the cash legs of the Japanese government bond (JGB) transactions among the Bank of Japan and financial institutions. The system is operated by the Bank of Japan. The BOJ-NET processes a huge value of settlements exceeding 100 trillion yen per business day, and plays an important role as a basic infrastructure supporting Japan's financial transactions and economic activities. From the viewpoint of reducing systemic risk, the Bank of Japan has been working over the years to increase the safety of settlement in the BOJ-NET (Exhibit 1). First, the settlement in the BOJ-NET shifted from DNS to RTGS in January 2001. RTGS improves the safety of the payment systems, but increases the liquidity burden of financial institutions. Therefore, in order to increase the settlement efficiency while maintaining the safety of settlement through RTGS, in October 2008, the LSF was introduced to RTGS processing for funds transfers among financial institutions. Money market payments (such as call money transactions and other funds payments) which were previously processed by RTGS without the LSF in the BOJ-NET shifted to settlement using these new features. At the same time, payments that were previously processed by a private-sector DNS system, namely, the Foreign Exchange Yen Clearing System (FXYCS) payments for cross-border yen transactions (yen payments arising from foreign exchange transactions and import-export transactions), were shifted to the RTGS processing with the LSF. In November 2011, large-value retail payments (out of retail credit transfers processed by the Zengin System, those which are equal to or larger than 100 million yen per payment) were also shifted to the RTGS processing with the LSF[1]. Out of these

[1] In many countries, payment and settlement systems operated by central banks and others have also adopted RTGS processing and introduced the LSF. For the present status of payment and settlement systems in the major countries, see BIS [2011, 2012].

series of steps, the introduction of the LSF and the shift of FXYCS payments to RTGS are called the Phase 1 of the Bank's Next-Generation Real-Time Gross Settlement (RTGS-XG) project, while the shift of large-value retail payments to RTGS is called the Phase 2 of the RTGS-XG project[2].

As a result, all of the major funds settlements among the Japanese financial institutions (i.e., money market payments, FXYCS payments and large-value retail payments) are now processed by RTGS with the LSF. Among the changes in the settlement methods of these three types of transactions, the shift of large-value retail payments to RTGS had the largest impact on the liquidity of financial institutions, as they were previously processed by DNS and because their transaction values are enormous[3].

Studies on settlements, both theoretical and empirical analyses, have been made as payment and settlement systems in each country have undergone changes. In the mainstream of theoretical analyses are those which analyze the settlement behaviors of financial institutions under RTGS based on the framework of the game theory, such as Angelini [1998], Roberds [1999] and Bech and Garratt [2003]. Recent studies by Martin and McAndrews [2008], Jurgilas and Martin [2010] and Makimoto [2011] also include the LSF among the objects of analyses. Empirical analyses include Soramäki *et al*. [2007] on transactions in Fedwire in the United States, Becher, Galbiati, and Tudela [2008] on those in CHAPS in the United Kingdom and Imakubo and Soejima [2010a, 2010b] on those in the BOJ-NET.

Out of the empirical studies made so far, BOJ-PSSD [2009], Atalay, Martin and McAndrews [2010], Korsgaard [2012] and others include the LSF among their objects of analyses, but the number of such studies is not very large. To the best of this writer's knowledge, this study is the first analysis that focuses on the effects of changes in the settlement methods on the liquidity financial institutions actually made available for settlements. An analysis like this one

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[2] For details of the RTGS-XG project, see BOJ-PSSD [2006]. For the settlement trends after the introduction of Phases 1 and 2 of the RTGS-XG project, see BOJ-PSSD [2009] and Tsuchiya [2012a], respectively.

[3] The transaction value and volume of large-value retail payments average approximately 9.5 trillion yen and approximately 11 thousand transactions per business day, while on peak days they soar to approximately 42.5 trillion yen and approximately 51 thousand transactions per day.

is important for deepening the understanding on the system designs of payment systems and the efficiency of payments.

The organization of this paper is as follows. Section II analyzes the changes in the liquidity of financial institutions brought about by the shift of large-value retail payments to RTGS. Section III measures the liquidity-saving effects of the LSF. Section IV measures the liquidity-saving effects of the uniform application of the LSF to money market payments, FXYCS payments and large-value retail payments. Section V analyzes the value of collateral required to be posted for risk management purposes and actual value of collateral posted for small-value retail payments that are still processed in a DNS mode. Section VI presents conclusions.

II. The Effects of the Shift of Large-Value Retail Payments to RTGS on Liquidity

This section will first present an outline of the change in the settlement method of large-value retail payments and then analyze the resulting change in the liquidity financial institutions have put into the system to complete settlements. It will also analyze the change in the liquidity which was put into the system but not used for settlement. It will also examine the relationship between the change in the liquidity and the change in the settlement timing resulting from settlement on an RTGS basis.

A. An Outline of the Shift of Large-Value Retail Payments to Settlement on an RTGS Basis in Japan

Thanks to the Phase 2 of the RTGS-XG project (hereinafter, RTGS-XG2), more than 70 percent of all retail payments in terms of value which previously were settled in a DNS mode of the Zengin System are now directly routed to the BOJ-NET for settlement on an RTGS basis. As shown in Exhibit 2, it was found that out of an average of approximately 12.5 trillion yen in total retail payments per business day, approximately 9.5 trillion yen are now settled in an RTGS mode. On the last business day of each month, when the value of payments reaches its peak, about 42.5 trillion yen out of the total retail payments of 56.6 trillion yen are now settled in an RTGS mode. Small-value retail payments (those which are less than 100 million yen per payment) are still processed in a DNS mode even after the implementation of RTGS-XG2.

The processing in an RTGS mode of large-value retail payments is conducted on "Queuing and Offsetting Accounts" (Q/O accounts) in the BOJ-NET. The Q/O accounts were established in October 2008 for the introduction of the LSF functionality, as the special accounts used exclusively for RTGS with the LSF. At that point, the Q/O accounts were used for the RTGS settlements of money market payments and FXYCS payments. As the RTGS mode has been applied to large-value retail payments since November 2011, the settlement on Q/O accounts has increased by an average of 20 percent in terms of value, and on the last business day of the month, when large-value retail payments are concentrated, has increased by more than 50 percent (Exhibit 3). The shift to the RTGS mode of payments of such huge values is thought to have effects on the liquidity financial institutions put into their accounts for settlement. This point will be analyzed hereafter in this section.

B. Liquidity Financial Institutions Put into Their Q/O Accounts for Settlement

If there are balances in the Q/O accounts at the end of a business day, they are automatically transferred back to the home accounts of financial institutions. Hence, on each business day, all financial institutions are required to transfer the liquidity necessary for the settlement of money market payments, etc. during that business day from their home accounts to their Q/O accounts. Therefore, the peak value of funds each financial institution transfers to its Q/O account can be regarded to be the liquidity it puts into the system for the settlement of payments. Such liquidity can be regarded as the liquidity for the settlement of money market payments and FXYCS payments for the period prior to the implementation of RTGS-XG2 and the liquidity for the settlement of large-value retail payments, money market payments and FXYCS payments for the period after its implementation. The aggregate of such liquidity and the net settlement value in a DNS mode[4] can be regarded to be the liquidity financial institutions put into the system for the settlement of all three types of payments (i.e., all retail payments, money market payments and FXYCS payments). A comparison of the values of liquidity for the periods before and

[4] This value equals the net settlement value for all retail payments settled in a DNS mode for the period prior to the implementation of RTGS-XG2, and the value of small-value retail payments (those which are less than 100 million yen per payment) settled in a DNS mode for the period after the implementation of RTGS-XG2.

after the implementation of RTGS-XG2 will make it possible to observe the effects on financial institution's liquidity of the shift of large-value retail payments to settlement on an RTGS basis.

Based on this line of thought, when a comparison of liquidity financial institutions put into their Q/O accounts in the periods before and after the implementation of RTGS-XG2 was made, it was found that the liquidity increased sharply from approximately 15 trillion yen before the implementation[5] to approximately 23 trillion yen after the implementation[6] (Exhibit 4). The patterns of distribution of liquidity financial institutions put into their Q/O accounts show that after the implementation of RTGS-XG2, the pattern of distribution as a whole has shifted to the right side of the chart (Exhibit 5). Moreover, both before and after the implementation, there was a long tail to the right-hand side of the chart. This can be attributed to the fact that immediately before the end of a quarter, financial institutions transfer high levels of liquidity to their Q/O accounts, because money market payments, which are usually in large values, are settled at this time. After the implementation of RTGS-XG2, the tail to the right has become thicker. This can be attributed to an additional factor that since the settlements of large-value retail payments are concentrated on the last business day of each month, financial institutions put in a high level of liquidity in their Q/O accounts[7].

In this manner, with the implementation of RTGS-XG2, the liquidity financial institutions put into their Q/O accounts for payments has increased sharply. It should be noted, however, that financial institutions do not necessarily transfer the minimum value of liquidity needed to complete settlements. There are portions of liquidity which are not used for settlements. For example, some financial institutions conduct their operations in such a way that large values of liquidity are transferred to their Q/O accounts at one time, instead of transferring liquidity to their Q/O accounts as the needs for it arise.

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[5] Average value of liquidity per business day for the period from November 15, 2010 to March 31, 2011. The same holds true hereafter.

[6] Average value of liquidity per business day for the period from November 14, 2011 to March 30, 2012. The same holds true hereafter.

[7] It is thought that before the implementation of RTGS-XG2, since large-value retail payments were also settled in a DNS mode, even on the last business day of the month, when retail payments are concentrated, the level of necessary liquidity was held down.

Therefore, it is not appropriate to view the liquidity put into the Q/O accounts for settlements as the liquidity needed for settlements. Especially in an environment of extremely low interest rates, such as the one which has prevailed in recent years, this trend will intensify.

C. Liquidity That Was Not Used for Settlement

Therefore, this study will define liquidity needed for settlement as the aggregate for all financial institutions of "each financial institution's peak value of net outgoing payments (the maximum value of intraday net outgoing payments) calculated on the basis of the time in which the payment was 'settled'." This is considered to be the minimum level of liquidity each financial institution was required to have in its Q/O account to complete the payments which were actually settled. Subtracting this "liquidity which was necessary for settlement" from the "liquidity which was transferred to the Q/O accounts for settlement," which was described earlier, would reveal the level of "liquidity which was not used for settlement."

Exhibit 6 shows the liquidity which was not used for settlement. Its value was approximately three trillion yen before the implementation of the RTGS-XG2 and approximately eight trillion yen after its implementation. It shows that abundant liquidity was put into the Q/O accounts prior to the implementation of RTGS-XG2 and that even more abundant liquidity was put in after its implementation. This situation can be attributed to the fact that in an accommodative monetary environment in which the cost of liquidity is extremely low, financial institutions are rigorously respecting market practices (industry guidelines) for payments,[8] and for large-value retail payments, banks

[8] An outline of the market practices (industry guidelines) for each type of payments is as follows.

Large-value retail payments: Banks should complete settlements early in the day by making an effective use of the special time zone for retail payments which is established on the last business day of each month in the BOJ-NET (the opening hour of the BOJ-NET is brought forward by 30 minutes from the normal opening hour to create a special time zone at 8:30 - 9:00 a.m., in which the submission and settlements of large-value retail payments are made) (the early settlement rule on the last day of the month). Banks should transfer adequate levels of liquidity so that the time needed for the transmission among bank branches can be completed in less than an hour (one-hour rule).

Money market payments: The borrowers should make the repayment no later than 10:00 a.m. on the date of repayment (repayment-first rule). The lenders should settle same day

are transferring more liquidity than they did before at the opening of the BOJ-NET. The reasons for these include that (1) banks want earlier settlements to maintain services to the customers who initiated the credit transfer; (2) as transactions include many customer payments for same-day settlement, it is difficult for the treasury department to accurately capture the transaction value in advance; and (3) processing of forward-dated instructions and other payments tend to be concentrated in the period immediately after the opening of the BOJ-NET.

Because of these factors, the liquidity which was not used for settlement is not small in value. In other words, they suggest that there is room for financial institutions to reduce the liquidity they put in their Q/O accounts without delaying the settlement timing of each payment[9].

D. Liquidity Put in the Q/O Accounts for Settlement and the Average Settlement Time

Exhibit 7 shows the relationship of the value of liquidity transferred to the Q/O accounts and the average settlement time. The **x** marks in the Exhibit plot the daily values of liquidity financial institutions transferred to the Q/O accounts for settlements and the daily average settlement time before the implementation of RTGS-XG2. The **+** marks plot the same combination after its implementation. A comparison of the plotting reveals that the implementation of RTGS-XG2 has brought the average settlement time to earlier in the day by approximately two hours[10]. On the other hand, as it was observed earlier, the liquidity which financial institutions put in their Q/O accounts for settlements has increased.

The implication is that there could be a way to reduce the liquidity

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transactions within an hour of the contract, and antedated transactions no later than 10:00 a.m. (one-hour rule).

FXYCS payments: Participants should send and settle 65 percent of the daily volume and 55 percent of the daily value by 11:00 a.m. (throughput rule).

[9] The situation is not uniform across financial institutions. For example, Tsuchiya [2012b] points out that the values of liquidity put in the Q/O accounts vary greatly by sector of financial institutions.

[10] The completion of settlements earlier in the day is largely attributed to the shift of large-value retail payments from DNS (at 16:15 hours on ordinary days and at 17:15 hours on the last business day of the month) to RTGS.

transferred to the Q/O accounts while maintaining smooth processing of settlements. For example, by more precisely estimating the liquidity needed for settlements and more precisely managing liquidity accordingly, liquidity to be transferred to the Q/O accounts could be reduced. The □ marks in the Exhibit represent the same average settlement time, but on the horizontal axis they have been shifted from the levels of liquidity transferred to the Q/O accounts to the levels of liquidity actually needed for settlements. If it is possible to transfer liquidity to the Q/O accounts at the levels represented by □ marks in the Exhibit, it would restrain the margin of increase in liquidity resulting from the adoption of the RTGS while maintaining the improved safety of settlements[11].

III. Effects of Liquidity-Saving Features

As described thus far, at present, all of the major payments among financial institutions in Japan are settled based on the RTGS with LSF functionality. In this section, a brief description of the LSF introduced to the BOJ-NET in October 2008 will be presented, followed by the measurement of effects of the LSF based on actual transaction data.

A. An Outline of the Liquidity-Saving Features in the BOJ-NET

The LSF in the BOJ-NET consist of centralized queuing and offsetting mechanisms. "Queuing" allows payment instructions to be held pending within the system if a participant sends a payment instruction but does not have sufficient funds to complete the transaction. Previously in the BOJ-NET, such payment instructions were rejected by the system. "Offsetting" mechanism searches among the newly entered and queued payment instructions for a set of instructions that can be settled when taking into account incoming funds as a source of liquidity, and settles the selected instructions simultaneously. The bilateral offsetting algorithm searches for a pair of offsetting instructions when certain events occur, including when a new payment instruction enters a system or when there is a change in the Q/O account balances. The multilateral offsetting algorithm attempts to find a

[11] As the liquidity at the □ marks was calculated ex post facto based on actual values of settlements, in practice it is difficult to reduce liquidity precisely to these levels. In practice, these levels plus some buffers would be the targets for liquidity reduction.

group of offsetting transactions from all queued instructions at five fixed times each day. The Exhibit 8 shows an outline of the features.

Prior to the introduction of the LSF, the RTGS (the conventional RTGS) required that in order to settle payments, the balances in the Q/O should be greater than the amounts of payments specified by the instructions that come into the system. The RTGS with LSF functionality, on the other hand, allows the submission of payment instructions regardless of the balances in the Q/O accounts thanks to "queuing," increasing the opportunities to use incoming funds as a source of liquidity needed for settlement.

B. Measurement of the Effects of the Liquidity-Saving Features

Here, the liquidity needed under the conventional RTGS and that needed under the RTGS with LSF will be calculated and compared to measure the effects of the LSF.

First, taking note of the fact that the conventional RTGS required the liquidity in the amount of transaction when a payment instruction is received, the liquidity required under the conventional RTGS is defined as "the sum of all financial institutions' peak net outgoing payments, each of which is calculated on the basis of the time when the payment instruction was 'sent'"[12]. The liquidity needed under the RTGS with LSF was defined as "the sum of the peak net outgoing payments of all financial institutions, each of which was calculated on the basis of the time when the transaction was 'settled.'" This sum is the same as "the liquidity needed for settlements" measured in Section II.

Exhibit 9 is a time-series chart of the differential between the two. During the periods of analysis, the differential hovered at around one-three trillion yen. This clearly shows that even under the present accommodative monetary environment, the LSF is having certain liquidity-saving effects. After the implementation of RTGS-XG2, however, the liquidity-saving effects have slightly diminished. This is thought to reflect the impact of the fact that as

[12] The peak net outgoing payment was calculated under the assumption that each transaction was settled when it was transmitted. Specifically, without considering whether each transaction has queued or settled, its value was added as the value of outgoing/incoming at the time of payment/receipt of the transaction, to calculate the value of net outgoing payments and then obtain the intraday peak value for each financial institution. The sum of the intraday peak values for all financial institution was then obtained.

banks wished their large-value retail payments to be settled promptly, they sharply increased the liquidity they put in their Q/O accounts[13].

IV. Liquidity-Saving Effects of Settling Different Types of Transactions in a Single Account

Thanks to the RTGS-XG project, large-value retail payments, money market payments and FXYCS payments are now all settled using a single account, namely the Q/O account. This means that the liquidity for settlement is shared by these three types of transactions, which can be settled simultaneously using the LSF functionality. As a result, the LSF can find more combinations of transactions which can be settled compared with cases in which different types of transactions are settled using separate accounts. As it also increases the opportunity in which liquidity is recycled across different types of transactions among financial institutions, its liquidity-saving effects are considered to be greater.

Therefore, by comparing the liquidity needed when settlements are made using different accounts with that needed when all transactions are settled using a single account, the liquidity-saving effects of settlements on a single account are measured. Here, the values of the peak net outgoing payments of each type of transactions are added together to obtain the value of liquidity needed when different types of transactions are settled in different accounts.

Exhibit 10 is a time-series chart of the liquidity-saving effects. The liquidity-saving effects were approximately one trillion yen before the implementation of RTGS-XG2, but increased to almost three trillion yen after its implementation. This is because RTGS-XG2 widened the use of the Q/O accounts from two types of transactions (i.e., money market payments and FXYCS payments) to include large-value retail payments. This is thought to have increased the opportunities for the application of the LSF and also for recycling of liquidity.

Exhibit 11 shows the liquidity levels needed when settlements are made using different accounts broken down by type of transactions. It shows how

[13] The increase in the liquidity put into the Q/O accounts raises the ratio of transactions which are instantly settled one-on-one and also reduces the queuing time of existing transactions (i.e., money market payments and FXYCS payments), thus reducing the differential between the transmission time and settlement time.

liquidity-saving effects are generated. First, it shows that the liquidity needed for the settlement of money market payments is enormous. This is because in money market transactions, the settlement values are large, and on top of it, because of the market practices (industry guidelines), such as the repayment-first rule, there is a gap between the timing of submission of transactions by borrowers and that by lenders, which is likely to have an impact. On the other hand, for large-value retail payments and FXYCS payments, outgoing payments and incoming payments tend to occur simultaneously, reducing the peak net outgoing payments. In fact, the settlement value of large-value retail payments on the last business day of the month is almost equal to that of money market payments, but the peak net outgoing payments of the former do not increase very greatly. When the liquidity-saving effects of settlements on a single account are viewed in a time-series, they show that they move in a manner similar to that of the settlement value of large-value retail payments. This can be attributed to the fact that since the settlements of money market payments and those of large-value retail payments are concentrated in the same time zone, there is a great deal of offsetting between outgoing and incoming payments. These findings suggest that the concentration of settlements within the same type of transactions or among different types of transactions within a certain time zone increases the liquidity-saving effects. Therefore, it suggests that the market practices (industry guidelines) which lead to the concentration of transactions within a certain time zone have liquidity-saving effects.

V. Changes in the Cost of Collateral Incurred by Deferred Net Settlement

RTGS-XG2 has shifted large-value retail payments to an RTGS mode, but small-value retail payments of less than 100 million yen per transaction are still settled in a DNS mode. For risk management, the retail payments system has a mechanism to control the maximum level of exposure that a participant can pose to the system. That is, banks must post collateral that covers the sender net debit cap (the maximum difference between the outgoing and incoming payment values) which they set themselves to the Japanese Banks' Payment Clearing Network (Zengin-Net), which operates the retail payment system, and send small-value transactions to the Zengin System (the online system which calculates the DNS settlement values) within that limit.

In order to confirm the effects on the liquidity which financial institutions transfer to the system resulting from the implementation of RTGS-XG2, it is necessary to also take into account the effects on the cost of collateral associated with retail payments settled in a DNS mode. Here, the changes in the sender net debit cap and the peak net outgoing payments resulting from the implementation of RTGS-XG2 will be examined[14].

As sender net debit cap is no longer necessary for large-value retail payments following the implementation of RTGS-XG2, some banks have been lowering the cap. As a result, the aggregate of the caps has declined (Exhibit 12). Before the implementation of RTGS-XG2, the aggregate sender net debit caps were stable at around 12-13 trillion yen except primarily for the last business day of the month[15], but after its implementation, they declined by nearly two trillion yen between November 2011 and March 2012. At the same time, while the sender net debit caps were raised temporarily on the last business day of the month prior to the implementation of RTGS-XG2[16], the frequency and the values of such raises have fallen clearly after the implementation. The peak net outgoing payments of small-value retail payments have also declined sharply after its implementation.

The ratio of the peak net outgoing payments to the sender net debit cap was about 15 percent on ordinary days and 30-40 percent on the last business day of the month prior to the implementation of RTGS-XG2, but after its implementation, these figures have dropped to about three percent on ordinary days and 10-15 percent on the last business day of the month (Exhibit 13). As the sender net debit cap is determined based on various factors including each bank's policy for maintaining smooth processing of retail payments transactions and its use of collateral, it is not possible to say at what level it is appropriate.

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[14] For the changes in the DNS settlement values, see Exhibit 4.

[15] During the latter half of March 2011, due to a system disruption at a major bank in the aftermath of the Great East Japan Earthquake on March 11, net outgoing payments at other banks increased (due to the decline in the outgoing payments at the troubled bank). As these banks raised their sender net debit caps to maintain smooth processing of payments, the aggregate of sender net debit caps for all banks during the latter half of March 2011 is larger than normal.

[16] Banks are allowed to temporarily raise their sender net debit cap by posting additional cash collateral to the Zengin-Net a day in advance or during the day on which the cap is raised.

Nevertheless, it is possible to point out that the allowance between the peak net outgoing payments and the sender net debit cap has expanded since the implementation of RTGS-XG2.

Next, to see how close to the sender net debit cap the peak net outgoing payments get, Exhibit 14 shows the distribution of the ratios of peak net outgoing payments to the sender net debit cap of banks on the last business day of the month[17], when these ratios typically are high. After the implementation of RTGS-XG2, in all ranges above 10 percent, the ratios are clearly lower than those before its implementation. This indicates that at the level of individual banks, the allowance between the peak net outgoing payments and the sender net debit cap is expanding at many banks.

Hence, it is possible to see that the implementation of RTGS-XG2 has been contributing to the reduction in the cost of the collateral for small-value retail payments. At present, the margin of such reduction is small, but this is probably because of the small cost of collateral under an accommodative monetary environment and the effects of banks' conservative management of payments immediately after the change in the system. In the future, the aggregate of sender net debit caps is expected to decline with changes in the monetary environment and as banks gain more skills in the management of payments under the new arrangement.

VI. Conclusions

This paper is an empirical analysis of the effects of settlement methods on liquidity of financial institutions based on actual funds transfer data. Specifically, it focuses on the shift to an RTGS mode of large-value funds payments, which were previously settled in a DNS mode, and the introduction of liquidity-saving features (LSF) to the RTGS.

The major findings of the analysis are as follows. 1) With the shift to the RTGS mode of large-value retail payments, the liquidity financial institutions transfer to their Q/O accounts has increased sharply. 2) As a result, there is a large value of liquidity which was not used for settlements, which means that there is room for reducing the liquidity put into the system. 3) Although financial institutions are making available large values of liquidity for

[17] Due to the relatively low volume of retail payments, the data for the last business day of December were excluded.

settlement due to the present accommodative monetary environment, the LSF is having certain liquidity-saving effects. 4) The uniform application of the LSF functionality to different types of transactions has significantly increased its liquidity-saving effects. At the same time, the study of the situations in which liquidity-saving effects arise has verified that the market practices (industry guidelines) that concentrate transactions to specific time zones have liquidity-saving effects. 5) For a large volume of small-value retail payments, which are still settled in a DNS mode, the value of required collateral has declined significantly. It was also confirmed that the values of collateral financial institutions actually post have also declined.

In the present accommodative monetary environment, it appears that many financial institutions regularly make available large volumes of liquidity for settlements. In the future, however, when the monetary environment and other factors will change, prompting financial institutions to be more sensitive to the cost of liquidity, the liquidity which will be made available for settlement as well as the timing of the submissions of payment instructions are expected to change. Such changes will also influence the liquidity-saving effects of the LSF. In order to deepen the understanding on the design and building of payment systems and on the safety and efficiency of large-value payments, it is hoped that empirical studies responding to future changes in the environment will be accumulated.

References

Angelini, Paolo [1998], "An Analysis of Competitive Externalities in Gross Settlement Systems," *Journal of Banking and Finance*, Vol. 22, No. 1, pp. 1-18.

Atalay, Enghin, Antoine Martin, and James McAndrews [2010], "Quantifying the Benefits of a Liquidity-Saving Mechanism," Federal Reserve Bank of New York Staff Reports, No. 447.

Bank for International Settlements (BIS) [2011], "Payment, Clearing and Settlement Systems in the CPSS Countries – Volume 1," Committee on Payment and Settlement Systems Publication, No. 97.

Bank for International Settlements (BIS) [2012], "Payment, Clearing and Settlement Systems in the CPSS Countries – Volume 2," Committee on

Payment and Settlement Systems Publication, No. 105.

Bank of Japan, Payment and Settlement Systems Department (BOJ-PSSD) [2006], "Japan's Next-Generation RTGS," Bank of Japan Research Papers.

Bank of Japan, Payment and Settlement Systems Department (BOJ-PSSD) [2009], "BOJ-NET Funds Transfers after the Implementation of Phase 1 of the Next-Generation RTGS Project," Bank of Japan Review, No. 2009-E-04.

Bech, Morten L., and Rod Garratt [2003], "The Intraday Liquidity Management Game," *Journal of Economic Theory*, Vol. 109, No. 2, pp. 198-219.

Becher, Christopher, Marco Galbiati, and Merxe Tudela [2008], "The Timing and Funding of CHAPS Sterling Payments," *Federal Reserve Bank of New York Economic Policy Review*, Vol. 14, No. 2.

Imakubo, Kei, and Yutaka Soejima [2010a], "The Transaction Network in Japan's Interbank Money Markets," *Monetary Economic Studies*, Vol. 28, Institute for Monetary and Economic Studies, Bank of Japan, pp. 107-150.

Imakubo, Kei, and Yutaka Soejima [2010b], "The Microstructure of Japan's Interbank Money Market: Simulating Contagion of Intraday Flow of Funds Using BOJ-NET Payment Data," *Monetary Economic Studies*, Vol. 28, Institute for Monetary and Economic Studies, Bank of Japan, pp. 151-180.

Jurgilas, Marius, and Antoine Martin [2010], "Liquidity-Saving Mechanisms in Collateral-Based RTGS Payment Systems," Federal Reserve Bank of New York Staff Reports, No. 438.

Korsgaard, Søren [2012], "Auto-Collateralization as a Liquidity-Saving Mechanism," *Journal of Financial Market Infrastructures*, Vol. 1, No. 1, pp. 3-27.

Makimoto, Naoki [2011], "Ginkoukan Shikin Kessai Network ni okeru Saiteki Kessai Koudou to Ryudousei Setsuyaku Kouka (The Optimal Settelment Behaviour and the Effect of Liquidity-Saving Features in an Interbank Funds Transfer Network)," *Kin'yu Kenkyu (Monetary Economic Studies)*, Vol. 30, No. 1, Institute for Monetary and Economic Studies, Bank of Japan, pp. 75-124 (in Japanese).

Martin, Antoine, and James McAndrews [2008], "Liquidity-Saving Mechanisms," *Journal of Monetary Economics*, Vol. 55, No. 3, pp. 554-567.

Roberds, William [1999], "The Incentive Effects of Settlement Systems: A Comparison of Gross Settlement, Net Settlement, and Gross Settlement with

Queuing," Bank of Japan IMES Discussion Paper Series, No. 1999-E-25.

Soramäki, Kimmo, Morten L. Bech, Jeffrey Arnold, Robert J. Glass, and Walter E. Beyeler [2007], "The Topology of Interbank Payment Flows," *Physica A: Statistical Mechanics and its Applications*, Vol. 379, No. 1, pp. 317-333.

Tsuchiya, Saiki [2012a], "Jisedai RTGS Dai2kitaiou Jisshigo no Kessai Doukou (BOJ-NET Funds Transfers after the Implementation of Phase 2 of the Next-Generation RTGS Project)," Bank of Japan Review, No. 2012-J-11 (in Japanese).

Tsuchiya, Saiki [2012b], "Ryudousei Setsuyaku Kinoutsuki RTGS ka ni okeru Gyoutaibetsu, Torihikibetsu no Shikin Kessai Doukou ni tuite (BOJ-NET Funds Transfers by Sector and Type of Transactions under an RTGS with Liquidity-Saving Features)," Bank of Japan Research Papers (in Japanese).

Exhibit 1 The Process of the Shift of Large-Value Payments to RTGS

A. History

Time	Major events
1990's -	Japan: Financial system uncertainties → Awareness of the need for the reduction of systemic risks Overseas: Improvement of payment and settlement systems in major countries for the reduction of systemic risks
January 4, 2001	Shift to RTGS of the Bank of Japan current deposit and the cash legs of Japanese government bond settlements → **Liquidity-raising costs and risk of settlement delays due to "gridlocks" can be an issue (Issue I).**
January 15, 2001	Committee on Payment and Settlement Systems, Bank for International Settlements, "Core Principles for Systemically Important Payment Systems," . . ."The system should provide prompt final settlement on the day of value, preferably during the day (=best practice) and at a minimum at the end of the day (=minimum standard)." → **The FXYCS and retail payments in the Zengin System meet the above minimum standard. However, best practice is not yet achieved (Issue II).**
2003-2009	(Securities Settlement Systems) Shift to RTGS (DVP) of the settlements of dematerialized CP, corporate bonds, investment trusts, etc.
October 14, 2008	Implementation of Phase 1 of RTGS-XG → **Introduction of LSF functionality ("queuing" and "offsetting") in the BOJ current deposit settlements (to address issue I)** → **Full shift of FXYCS payments to RTGS (to address issue II)**
November 14, 2011	Implementation of Phase 2 of RTGS-XG → **Shift of large-value retail payments to RTGS (to address issue II)**

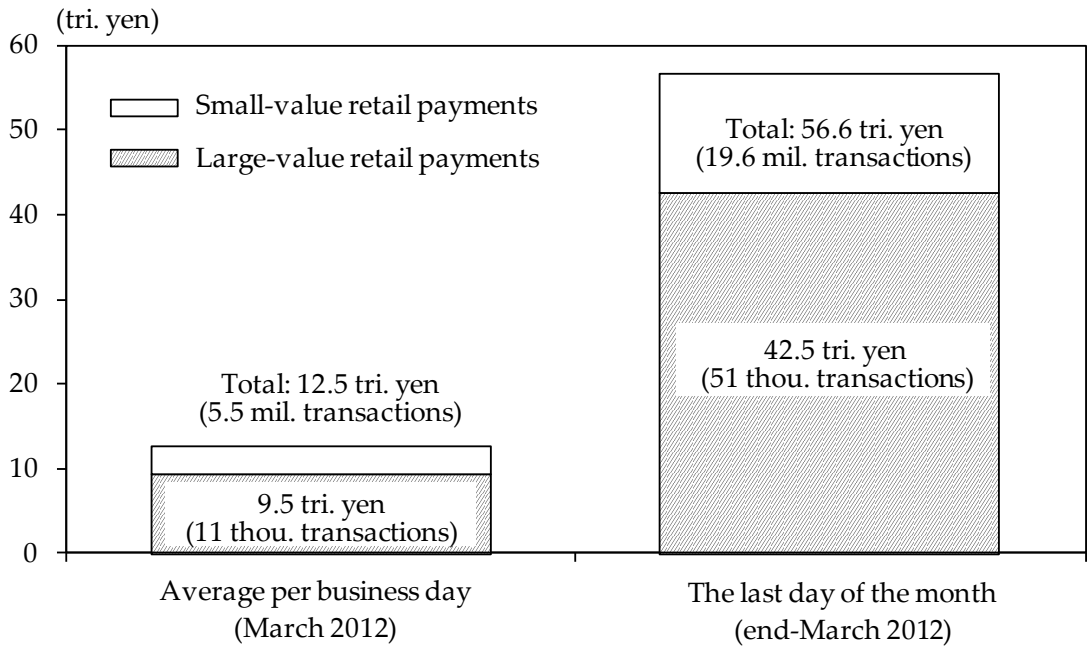
B. Status of Settlement Methods (Payment Systems)

<table>
<tr><th></th><th>Before RTGS-XG</th><th>After Phase 1</th><th>After Phase 2</th></tr>
<tr><td>Money market payments</td><td>RTGS</td><td rowspan="2">RTGS with LSF</td><td rowspan="3">RTGS with LSF</td></tr>
<tr><td>FXYCS payments</td><td rowspan="2">DNS</td></tr>
<tr><td>large-value retail payments</td><td>DNS</td></tr>
</table>

Note: FXYCS and large-value retail payments were previously processed by private-sector DNS systems.

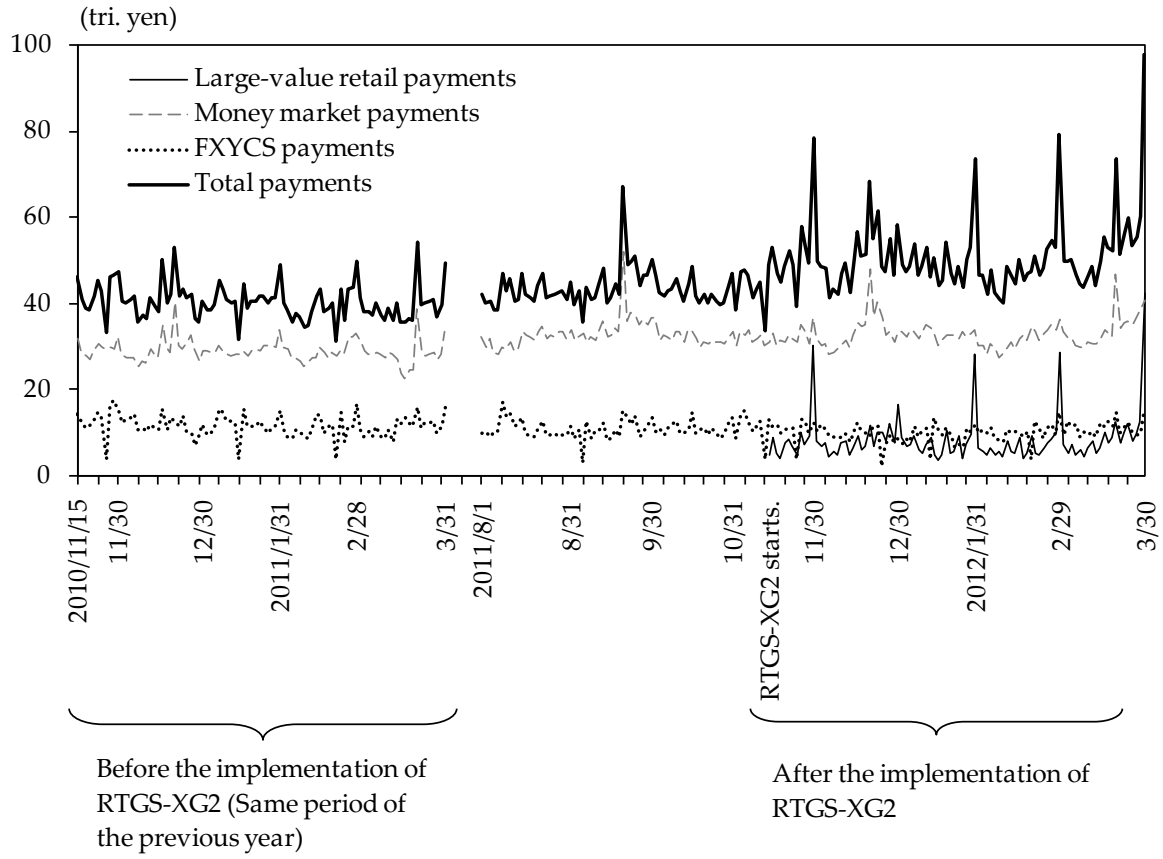
Source: Bank of Japan

Exhibit 2 Value and Volume of Retail Payments



Source: Japanese Banks' Payment Clearing Network (Zengin-Net)

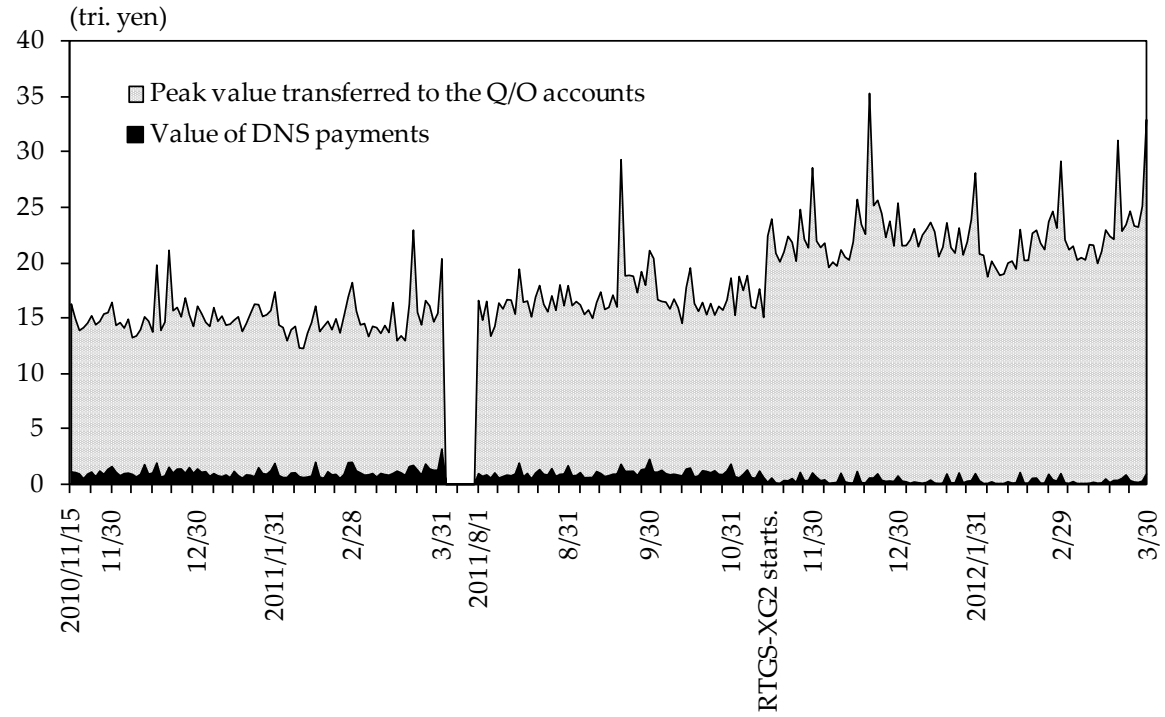
Exhibit 3 Payment Value by Type of Transactions



Note: The values are settlements (payments) in the Q/O accounts. Each instruction is counted once, i.e., the payment of money and the receipt of money are not counted separately. The same holds true hereafter.

Source: Bank of Japan

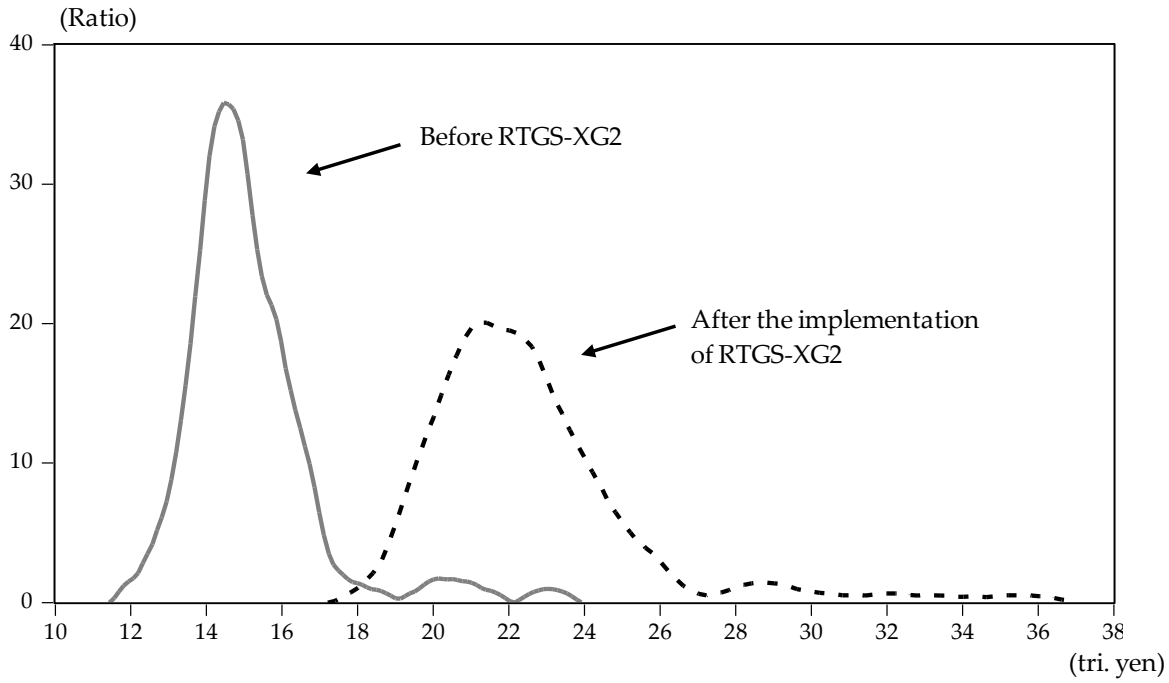
Exhibit 4 Liquidity Transferred to Q/O Accounts



Note: Peak value transferred to the Q/O accounts denotes the aggregate value for all financial institutions of "the peak value transferred to the Q/O account by each financial institution."

Source: Bank of Japan

Exhibit 5 Distribution of Liquidity Transferred to Q/O Accounts

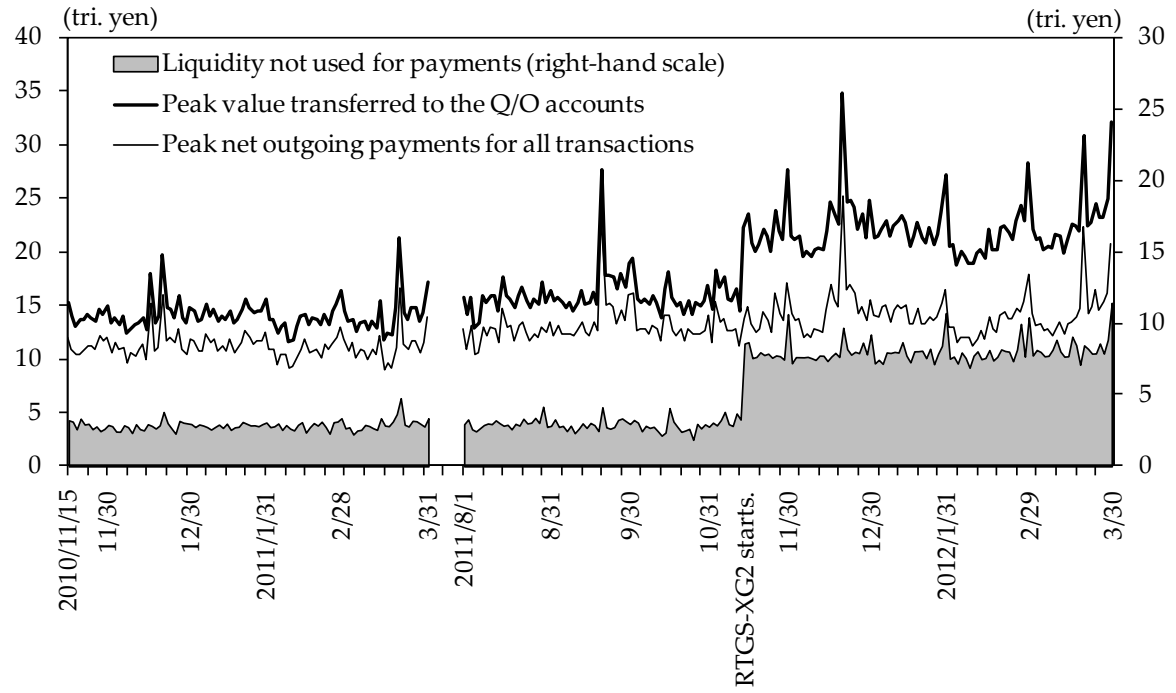


Notes: 1. The data before the implementation of RTGS-XG2 are from November 15, 2010 through March 31, 2011, and those after the implementation are from November 14, 2011 through March 30, 2012.

2. The distribution patterns in the chart are based on Kernel density estimation.

Source: Bank of Japan

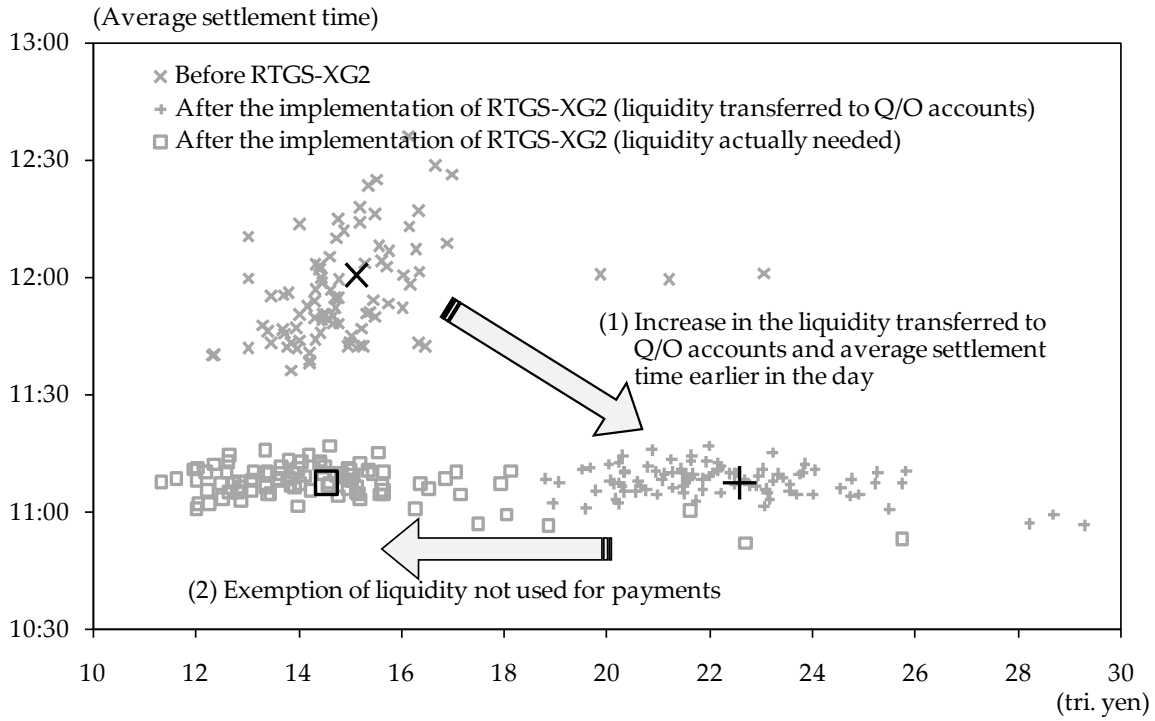
Exhibit 6 Liquidity Transferred to Q/O Accounts and Liquidity Needed for Payments



Note: The peak net outgoing payments for all transactions denote the aggregate for all financial institutions of "each financial institution's peak net outgoing payments for all transactions (large-value retail payments, money market payments and FXYCS payments)."

Source: Bank of Japan

Exhibit 7 Liquidity for Settlement and Average Settlement Time



Notes: 1. The chart plots the liquidity and the average settlement time on each business day during the survey period. The survey period before RTGS-XG2 is from November 15, 2010 through March 31, 2011 and that after the implementation of RTGS-XG2 is from November 14, 2011 through March 30, 2012.

2. The average settlement time is weighted average. The settlement time of each transaction is weighted by the value of settlement.

3. Bold marks denote the average values during each of the survey periods.

4. Figures for the four business days in which the average settlement time was at or after 13:00 in the period before RTGS-XG2 and those for the three days in which the liquidity needs exceeded 30 trillion yen in the period after the implementation of RTGS-XG2 are not plotted.

Source: Bank of Japan

Exhibit 8 An Outline of Liquidity-Saving Features (LSF)

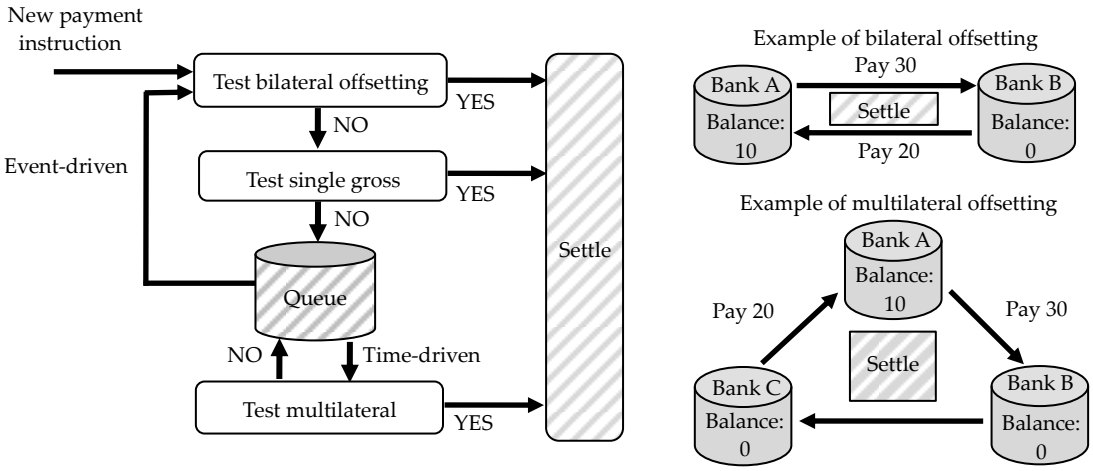
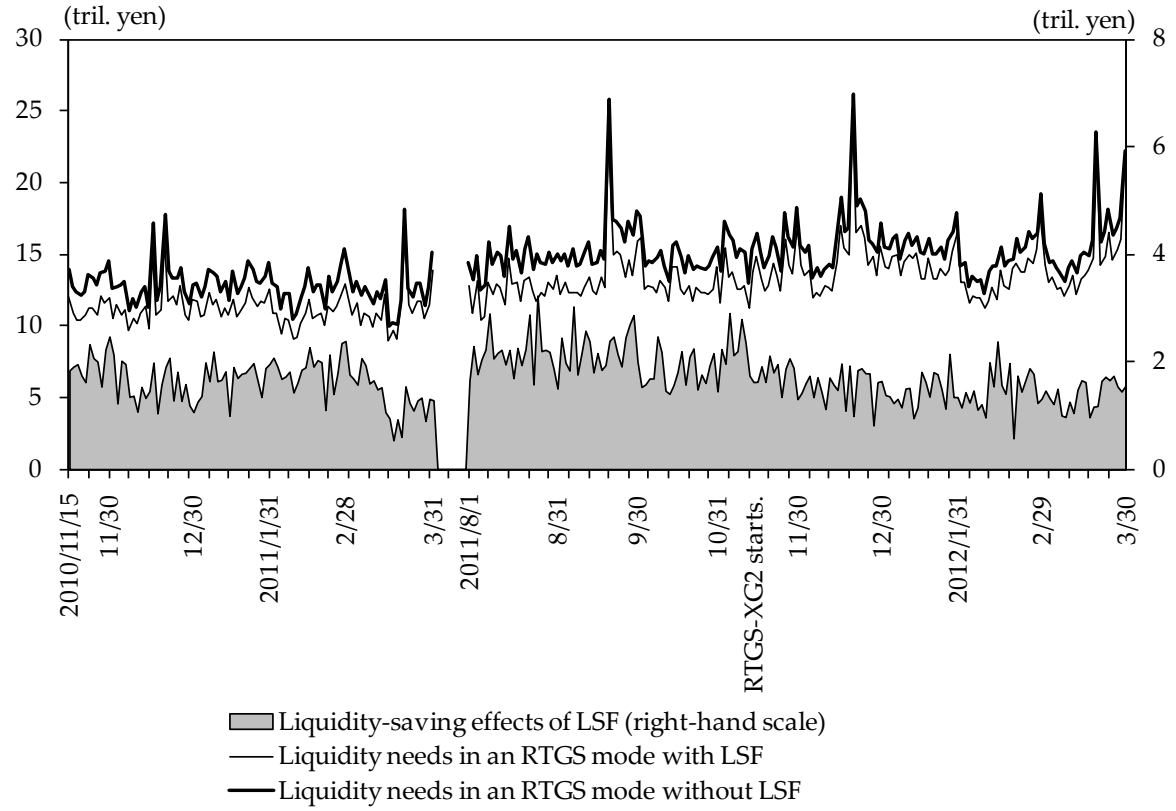


Exhibit 9 Effects of Liquidity-Saving Features

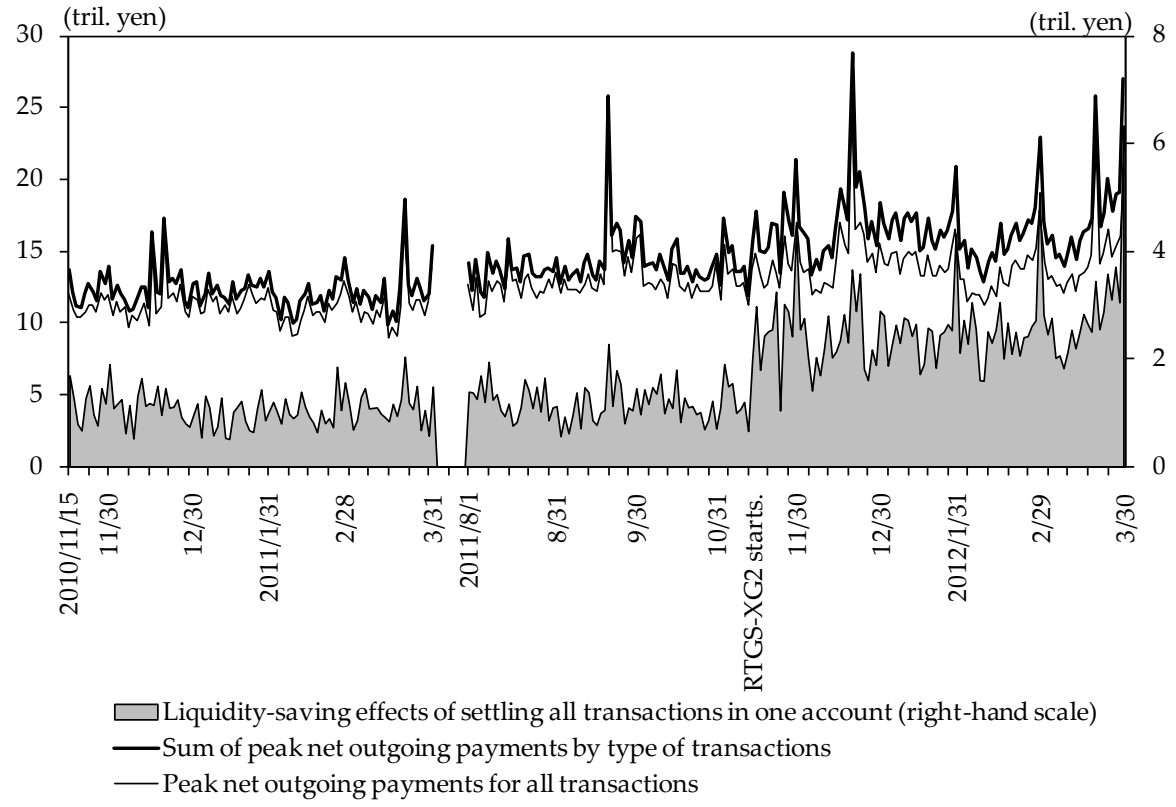


Notes: 1. "Liquidity needs in an RTGS mode without LSF" denotes the aggregate for all financial institutions of each financial institution's peak net outgoing payments calculated on the basis of 'instruction submission time' of the transaction.

2. "Liquidity needs in an RTGS mode with LSF" denotes the aggregate for all financial institutions of each financial institution's peak net outgoing payments calculated on the basis of 'settlement time' of the transaction.

Source: Bank of Japan

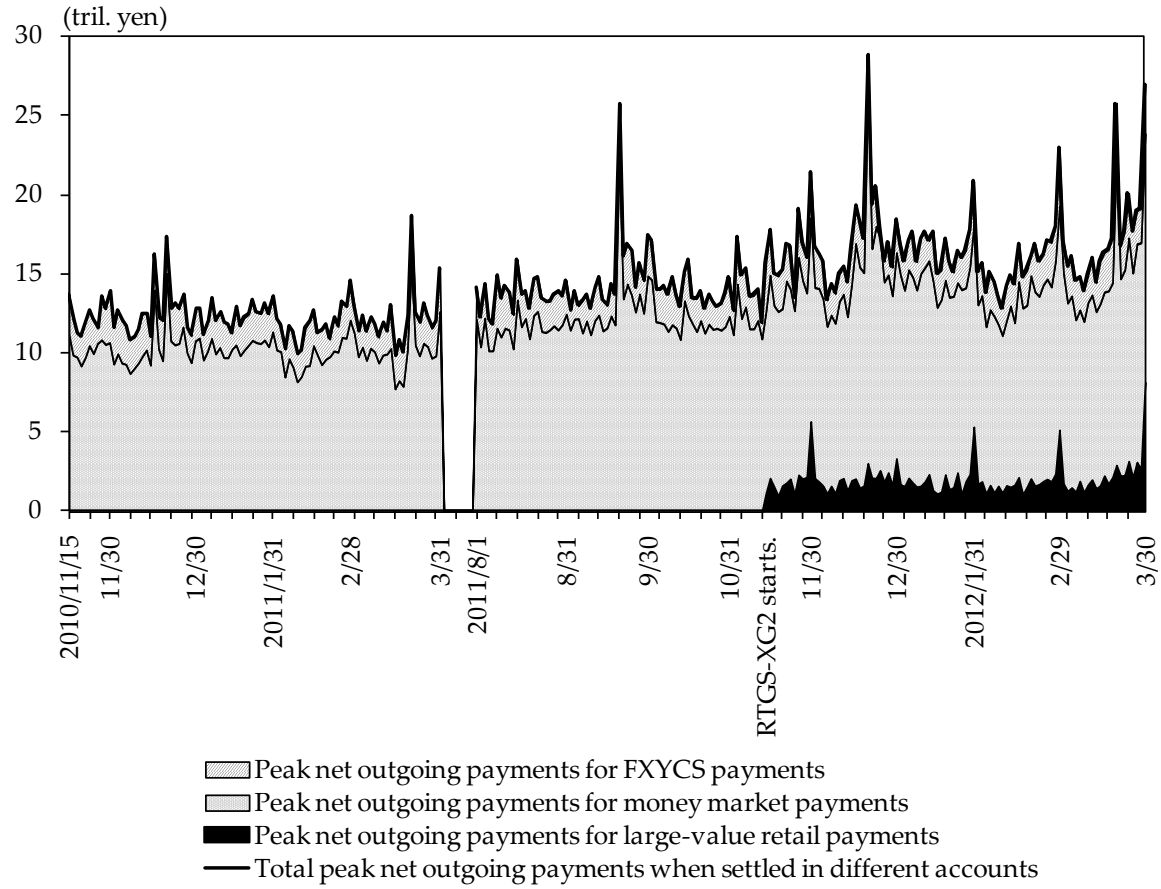
Exhibit 10 Liquidity-Saving Effects of Settling All Transactions in a Single Account



Note: The sum of peak net outgoing payments by type of transactions was obtained by "calculating the peak net outgoing payments by type of transaction (large-value retail payments, money market payments and FXYCS payments) of each financial institution" and aggregating them for all transactions.

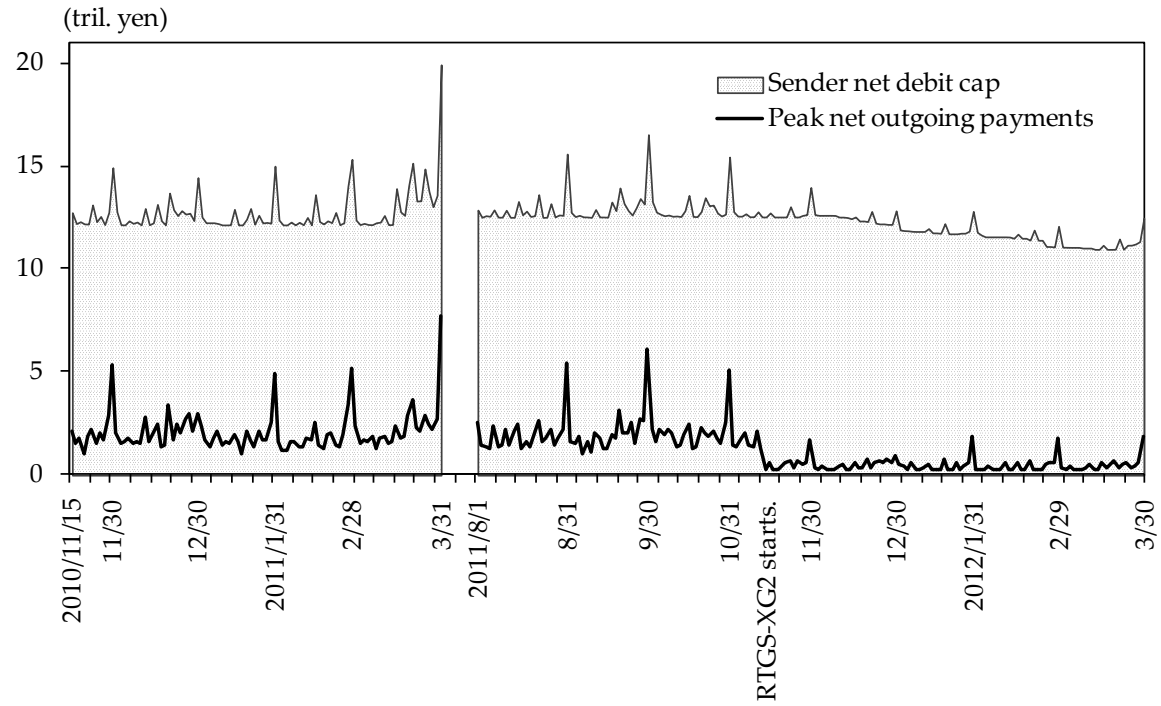
Source: Bank of Japan

Exhibit11 Liquidity Needs by Type of Transactions when Different Types of Transactions are Settled in Different Accounts



Source: Bank of Japan

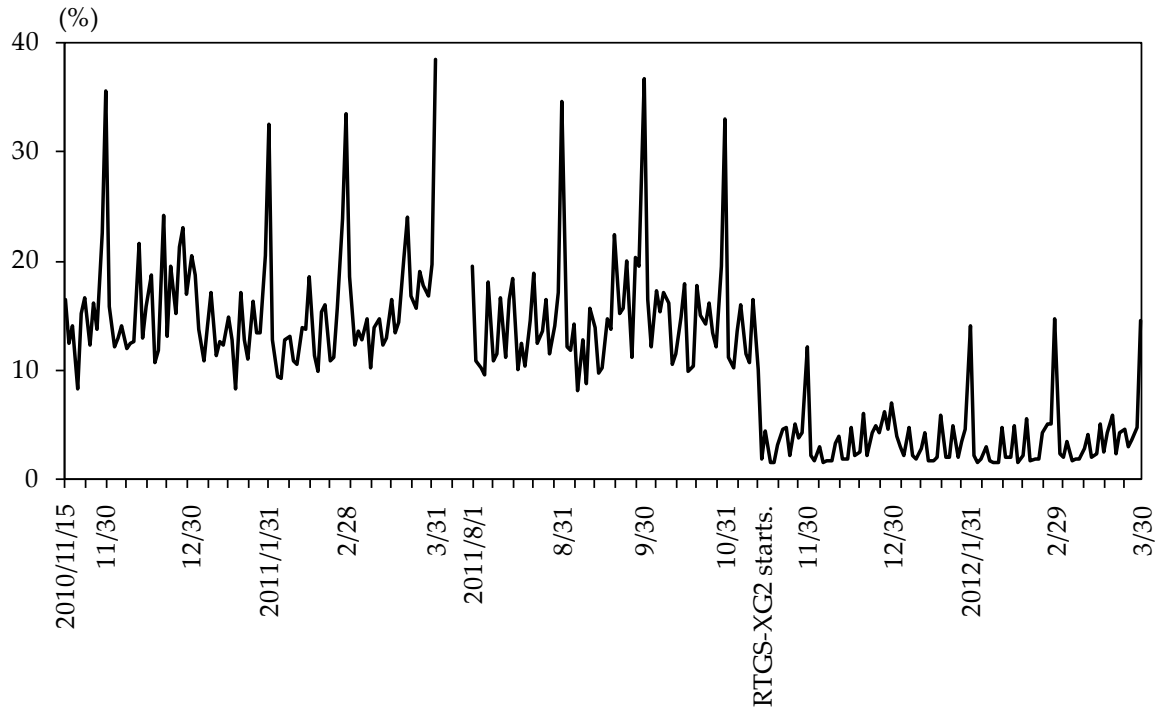
Exhibit 12 Sender Net Debit Cap and Peak Net Outgoing Payments for Retail Payments



Notes: 1. Sender net debit cap includes temporary increases made by posting cash collateral.
2. Aggregates for all banks of each bank's sender net debit cap and net outgoing payments for retail payments

Source: Japanese Banks' Payment Clearing Network (Zengin-Net)

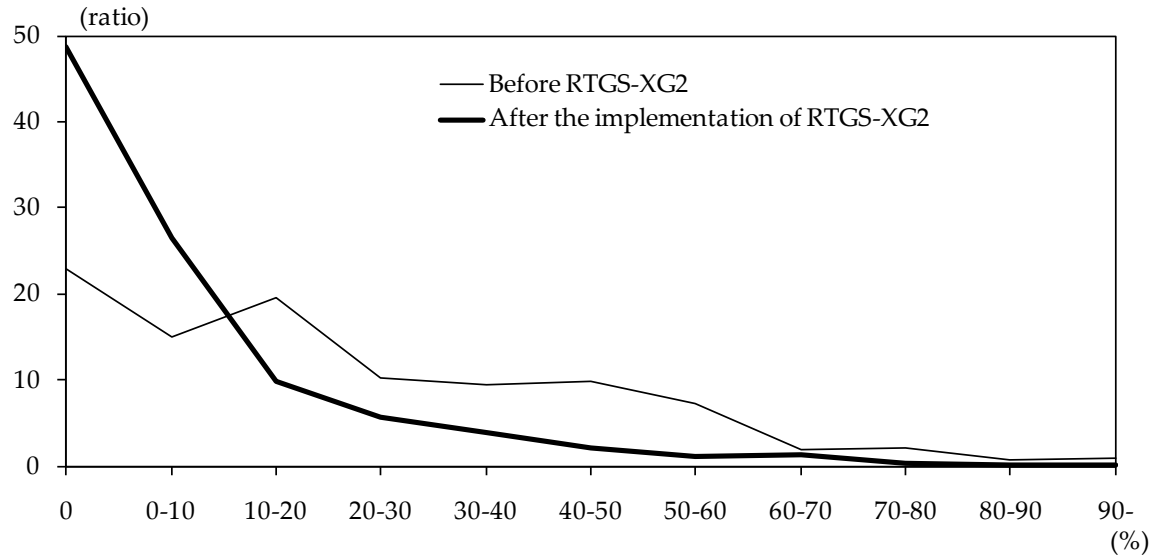
Exhibit 13 Closeness to Sender Net Debit Cap
(on the basis of aggregate values)



Note: The ratio of peak net outgoing payments to sender net debit cap.

Source: Japanese Banks' Payment Clearing Network (Zengin-Net)

Exhibit 14 Closeness to Sender Net Debit Cap at Month-End (on the basis of individual banks)



Notes: 1. The data before the implementation of RTGS-XG2 are those for the ends of November 2010 and January-March 2011 and those after the implementation of RTGS-XG2 are for the ends of November 2011 and January-February 2012.

2. The chart represents the distribution of ratios of peak net outgoing payments to sender net debit cap of each bank.

3. When the value of peak net outgoing payments is zero or lower for all day, the ratio is calculated to be zero percent.

Source: Japanese Banks' Payment Clearing Network (Zengin-Net)