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Payment Flows for Settlement of Foreign Exchange Trades: Japan's Experience since 2002

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This paper reviews changes in foreign exchange settlement for the yen since the introduction of CLS and how the changes have affected payment flows in the BOJ-NET. After the introduction of CLS in September 2002, a large value of yen payments migrated from the FXYCS to CLS, which, among other things, have resulted in larger amount of liquidity needed for settlement through the FXYCS. The design of CLS settlement process gave rise to time-critical payments in the BOJ-NET and heightened the interdependencies among RTGS systems for the relevant currencies. Analysis also indicates that the additional payment flows that have resulted from these changes could facilitate settlement in the BOJ-NET.

Introduction

Foreign exchange settlement process for the Japanese yen has undergone significant changes since September 2002, when CLS started live operation. CLS is a multicurrency payment-versus-payment (PVP) system that reduces principal risk associated with foreign exchange trades.[1] With the introduction of CLS, a significant portion of yen payments resulting from foreign exchange trades shifted over time to CLS; previously, most such trades had been settled by correspondent banking arrangements, which involved the use of the Foreign Exchange Yen Clearing System (FXYCS). A survey of selected number of Japanese banks indicated that, in April 2006, approximately 81% of their total foreign exchange settlement obligations in all currencies were with a CLS user, of which 86% (i.e., 70% of the total) were settled in CLS.[2] The remaining 30% of the total settlement obligations mostly consisted of trades with non-CLS users and trades currently ineligible for CLS such as same-day trades.[3]

Recent years have also seen changes in the way payments are settled in the FXYCS. Traditionally, the majority of the payments sent to the FXYCS were settled using its deferred net settlement (DNS) mode, which requires less amount of liquidity relative to the system's alternative settlement method, real-time gross settlement (RTGS). Partly due to the introduction of CLS, the share of payments settled in the RTGS mode increased significantly over the past several years. This generated additional payment flows in the BOJ-NET Funds Transfer System (BOJ-NET), an RTGS system owned and operated by the Bank of Japan.

After providing a brief description of the settlement process in the FXYCS and CLS, this paper reviews changes in the two systems since the introduction of CLS. It also examines how those changes have resulted in additional payment flows in the BOJ-NET and its effect on the entire system.

FXYCS and CLS

An overview of the FXYCS and CLS is presented in the box on the next page.[4] The FXYCS is owned and operated by the Tokyo Bankers Association (TBA) and processes yen payments resulting from foreign exchange trades, euroyen trades, and other cross-border transactions. It originally started out as a paper-based arrangement in 1980. An automated system, operated on behalf of the TBA by the Bank of Japan, was introduced in 1989. Direct participants in the system submit payment instructions and settle on behalf of indirect participants, overseas correspondent banks, and other customers. At the end of 2006, the FXYCS had 29 direct participants and 190 indirect participants.

Participants in the FXYCS primarily use the system's DNS mode. In the DNS mode, payment instructions are cleared by the system throughout the day, with final settlement of participants' multilateral net positions taking place over the BOJ-NET. The system also has an RTGS mode, in which payment instructions are directly forwarded to the BOJ-NET and settled in full value.

【BOX】Overview of FXYCS and CLS

		FXYCS	CLS
Year of implementation		October 1980	September 2002
Ownership		Tokyo Bankers Association	CLS Group Holdings
Number of participants[1]		29 direct participants 190 indirect participants	55 settlement members 2 user members 900 third parties
Currencies		Japanese yen	15 currencies (see endnote 6)
Type of settlement		DNS RTGS	Settlement on a gross PVP basis Pay-in and pay-out on a net basis
Operating hours[2]		DNS: Clearing 9:00–13:45 Settlement 14:30 RTGS: 9:00–19:00	Submission of instructions until 8:00 PVP settlement 15:00–17:00 Pay-in/pay-out 15:00–18:00
Risk Management	Exposure control	DNS: Net credit limit Sender net debit cap	Short Position Limit Aggregate Short Position Limit Positive Adjusted Account Balance
	Loss share	DNS: Survivors pay	Defaulter pays (using the defaulter's positive balance), survivors pay
	Liquidity provision	DNS: Yes	Yes

Notes: 1. Number of participants as of December 2006.
2. All times are in Japan Standard Time (J.S.T.). When Central European Time (C.E.T.) is in daylight saving time, the corresponding times for CLS settlement in Tokyo are one hour earlier than indicated.

Both the FXYCS and CLS place limits on the level of exposure that each participant can pose to the system. In the FXYCS DNS mode, each participant is required to set a bilateral net credit limit against every other participant. Based on the total amount of net credit limit granted by other participants, each participant's sender net debit cap is calculated. The sender net debit cap represents the maximum multilateral net short position that a participant is permitted to incur in the system.

In CLS, various risk management tests are applied each time a settlement or pay-out takes place. When a member has a negative balance in one currency, CLS requires that the member have positive balances in other currencies to cover the short balance. In other words, a member's Adjusted Account Balance (overall balance across all currencies after converted to U.S. dollars) needs to be equal to or greater than zero. A member's balances at CLS Bank must also stay within currency-specific Short Position Limits (maximum negative balance in each currency) and member-specific Aggregate Short Position Limit (maximum negative balance in all currencies after converted to U.S. dollars). When calculating a member's account balance, CLS applies haircuts to protect against exchange rate movements.

CLS is a multicurrency settlement system set up by a consortium of global banks active in the foreign exchange market. It was one of the industry responses to the G10 central bank strategy to reduce foreign exchange settlement risk.[5] Among the fifteen currencies currently eligible for settlement in CLS, the Japanese yen accounts for 9% in value.[6] In December 2006, CLS had 55 settlement members, 2 user members, and over 900 third party customers, which include banks, corporates and investment funds. Settlement members settle on behalf of user members and third parties.

Each CLS settlement member has a single multicurrency account at CLS Bank. Settlement of the two legs of a foreign exchange trade takes place over CLS Bank's books on a PVP basis by simultaneously debiting the members' accounts by the amount of the currency being sold and crediting the accounts by the amount of the currency being bought. In making these transfers, CLS Bank extends intraday overdrafts to settlement members.

While settlement over CLS Bank's books takes place on a gross basis, funding and de-funding of members' accounts take place on a net basis. Pay-ins and pay-outs to and from CLS Bank are made using RTGS systems for the eligible currencies, with the BOJ-NET used for the yen. In some cases, settlement members use "nostro" agents to make these payments on their behalf. For the yen, 12 members make their own payments to and from CLS Bank; the remaining

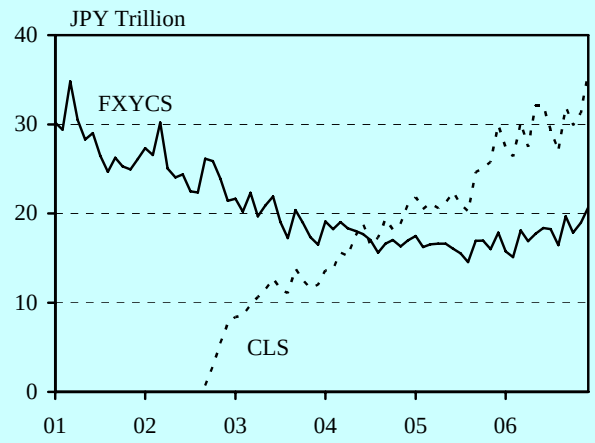
43 members outsource these operations to one of the 3 yen nostro agents.

Both the FXYCS and CLS have risk management measures including limits on the level of exposure that each participant can pose to the system (see Box). Such requirements can influence the way payments are processed in the system.

Turnover and netting ratio in FXYCS and CLS

Chart 1 shows the daily turnover in the FXYCS and CLS. Since the introduction of CLS in September 2002, yen payments resulting from foreign exchange trades continued to migrate from the FXYCS to CLS. As a result, the daily value of yen payments processed in CLS exceeded that of the FXYCS in mid-2004.[7] The value settled in CLS continued to grow and exceeded 30 trillion yen in 2006, reflecting increased trading activity in the foreign exchange market. Meanwhile, the daily value processed in the FXYCS continued to decline from 2001 to 2005 until it picked up in 2006. The rise in 2006 reflected an increase in the value of payments made by foreign banks that raise funds in the euroyen market.

Chart 1: Average daily value of yen payments processed by FXYCS and CLS

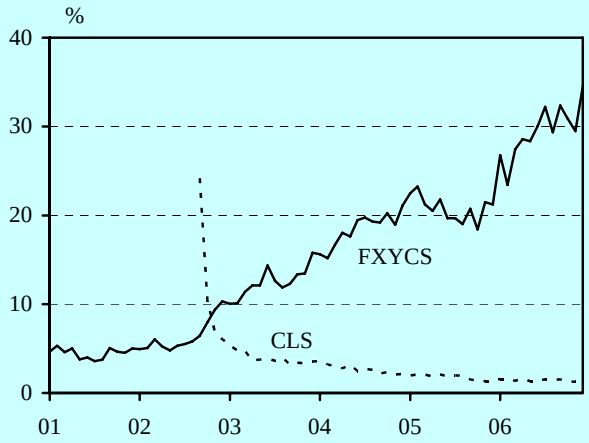


Sources: TBA; CLS.

Chart 2 shows the netting ratio in the two systems. Netting ratio is calculated as the ratio of the value of funds required to settle the total value of transactions to the total value of transactions themselves. Lower netting ratio represents higher level of efficiency in liquidity usage. CLS' netting ratio for the yen fell sharply immediately after the start of operation and declined steadily as the value of transactions increased. As of December 2006, the system required on average a little over 1% of the 30 trillion yen settled, or 400 billion yen.

Inside/Outside (I/O) swaps has partly contributed to CLS' low netting ratio. I/O swaps allow settlement members to trade down their net positions in CLS while leaving their overall foreign exchange position unchanged. An I/O Swap comprises two equal and opposite foreign exchange transactions that are agreed as an intraday swap.[8] One leg of an I/O swap is settled inside CLS, while the other leg is settled outside CLS, with the yen "out" leg typically settled in the FXYCS. During 2006, the value of I/O swaps conducted for the yen averaged 1 trillion yen daily. Even without I/O swaps, however, the netting ratio in CLS would have stayed relatively low with an average of 5%.

Chart 2: Netting ratio in FXYCS and CLS



Note: Netting ratio in the FXYCS is the sum of the total value of net short positions in the DNS mode and the value of payments processed in the RTGS mode, divided by the value processed in the DNS and RTGS modes. Netting ratio in CLS is the value of yen pay-ins divided by the value of yen payments processed.

Sources: TBA; CLS.

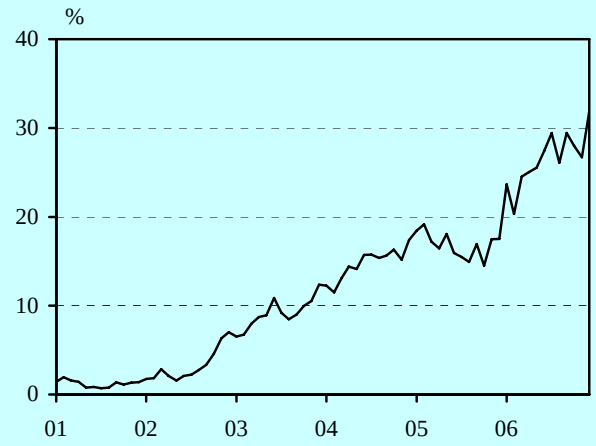
In contrast to CLS, netting ratio in the FXYCS increased from 5% in 2001 to over 30% in December 2006. Factors responsible for the increase include migration of payments to CLS, which reduced the amount of offsetting payments in the FXYCS. In addition, a series of mergers between major Japanese banks, which tend to have net short positions, resulted in a small number of banks having very large short positions.

Despite the increase in net short positions of some participants, their sender net debit caps in the DNS mode could not be increased proportionately. After each merger, the sender net debit cap for the new bank was generally maintained at the level for a single bank. Furthermore, the level of sender net debit caps for all participants was lowered three times from March 2003 to April 2004 in order to enhance failure management in the DNS mode.

Accordingly, some participants, typically major Japanese banks, routed some portion of their payments to the RTGS mode in order not to hit their

exposure limits in the DNS mode.[9] With such practice, the share of RTGS payments in the FXYCS increased from less than 2% in 2001 to nearly 30% in 2006 (Chart 3). This raised the total amount of funds needed for settlement in the FXYCS and increased the system's netting ratio.[10]

Chart 3: Average daily share of RTGS payments in FXYCS



Source: TBA.

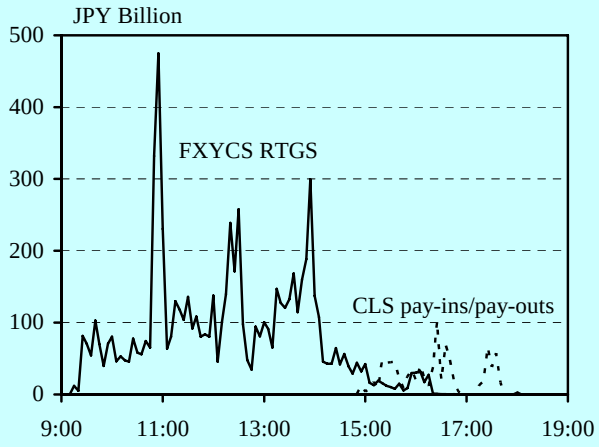
Effects on payment flows in BOJ-NET

Recent developments in the FXYCS and CLS have influenced payment flows in the BOJ-NET, which is used by the two systems for settlement and funding purposes. The table on the following page shows the daily timetable for the FXYCS, CLS, and the BOJ-NET. The FXYCS DNS mode settles participants' net positions over the BOJ-NET at 14:30. Payments sent to the FXYCS RTGS mode are immediately settled as RTGS payments in the BOJ-NET each time an instruction is sent from 9:00 to 17:00 (19:00 for participants that have access to the extended operating hours). Pay-ins and pay-outs to and from CLS take place in the BOJ-NET (via the FXYCS RTGS mode) from 15:00 to 18:00.[11] Because of the differences in settlement timings for the FXYCS DNS mode, RTGS mode, and CLS, participants in these systems could have temporary large short or long fund positions during the day.

Chart 4 takes a closer look at foreign exchange -related payment flows in the BOJ-NET by illustrating the average intraday pattern of payments resulting from the FXYCS RTGS mode and CLS. It shows that the average value of FXYCS RTGS payments spikes just before 11:00, 12:30, and 14:00. These are related to member guidelines for submitting payment instructions to the FXYCS. The guidelines require that participants check their throughput in the DNS mode around 11:00 and where necessary, route payments to the RTGS mode by around 11:30.[12] After 12:30, a bank sending an RTGS payment over 20 billion yen is required to contact the receiving bank in order to facilitate the forecasting of DNS net position by the receiving bank. After 14:00, the sending bank is required to obtain consent from the receiving bank for all RTGS payments. In order to avoid such additional procedures, participants try to send RTGS payments shortly before those deadlines.

The chart also shows that pay-ins and pay-outs to and from CLS are concentrated around 15:30, 16:30, and 17:30. Most settlement members and their nostro agents tend to pay thirty minutes prior to each pay-in deadline.

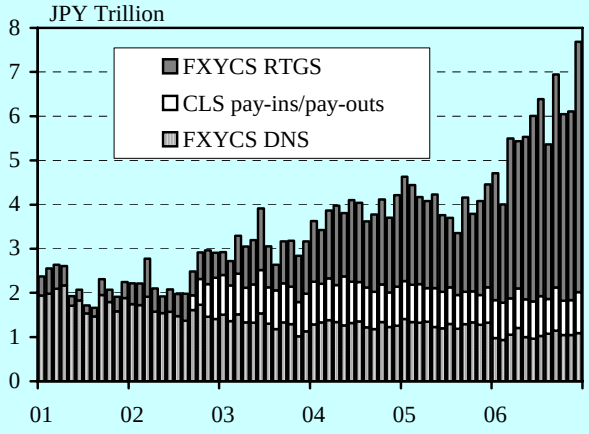
Chart 4: Intraday pattern of BOJ-NET payments resulting from FXYCS RTGS mode and CLS



Note: Average value of payments made during each 5-minute interval of the day in December 2006.

Source: Bank of Japan.

Chart 5: Average daily value of BOJ-NET payments related to foreign exchange trades



Source: Bank of Japan.

The daily value of foreign exchange-related payments in the BOJ-NET has almost tripled in the past six years, as shown in Chart 5. The introduction of CLS in September 2002 has generated pay-ins and pay-outs that, on average, total 800 billion yen. The

Table: Operational timeline for BOJ-NET, FXYCS, and CLS[1]

Time	BOJ-NET	FXYCS	CLS
8:00			Cut-off time for non-same -day trades Initial Pay-In Schedule
9:00	FXYCS: Start of RTGS mode ⇐	Start of clearing in DNS mode Start of RTGS mode	Announcement of I/O swaps
10:00			
11:00		Throughput check in DNS mode	
12:00			
13:00 13:45		Cut-off time for DNS mode	
14:00 14:30	FXYCS: Settlement of DNS net positions ⇐	Settlement of DNS net positions	Cut-off time for same-day trades Revised Pay-In Schedule
15:00	CLS: Start of pay-in/pay-out ⇐		Start of CLS settlement Start of pay-in/pay-out
16:00	CLS: First pay-in deadline		
17:00	CLS: Second pay-in deadline		End of CLS settlement
18:00	CLS: Third pay-in deadline, completion of pay-out		End of pay-in/pay-out
19:00	FXYCS: End of RTGS mode	End of RTGS mode	

Note: All times are in J.S.T. When C.E.T. is in daylight saving time, the corresponding times for CLS settlement in Tokyo are one hour earlier than indicated.

daily value of FXYCS RTGS payments has increased significantly after 2003 and reached 5.7 trillion yen in December 2006.

Apart from these payment flows that are directly associated with CLS and the FXYCS, payments to and from direct and indirect participants of the two systems also generate payment flows in the BOJ-NET, although it is difficult to distinguish them from other payments due to data availability. Typically, indirect participants in the FXYCS make initial funding to direct participants early in the operating day. Shortly after 14:30, the DNS mode settlement time, direct participants make pay-outs to indirect participants with net long positions. Similarly, payments between CLS settlement members and third parties and those between settlement members and their yen nostro agents take place over the BOJ-NET.

Based on available data, we examine below how the recent developments in foreign exchange-related payments have affected settlement in the BOJ-NET. This is done in two aspects. First, we look at how pay-ins and pay-outs to and from CLS have created a "liquidity sink" in the BOJ-NET. Second, using impulse response analysis, we examine how the increase in FXYCS RTGS payments could have affected settlement of existing payment flows in the BOJ-NET.

(1) Liquidity sink in the BOJ-NET

Minimizing the size and duration of a liquidity sink is an important factor in maintaining smooth settlement of payments in an RTGS system. A liquidity sink can develop when some portion of the overall available liquidity is trapped in an account of a participant. This could temporarily cause liquidity shortages elsewhere in the system, which in turn may lead to delays in settlement of payments among other participants unless the remaining liquidity is recycled more efficiently or additional liquidity is added from an external source (e.g., intraday credit extension from the central bank).

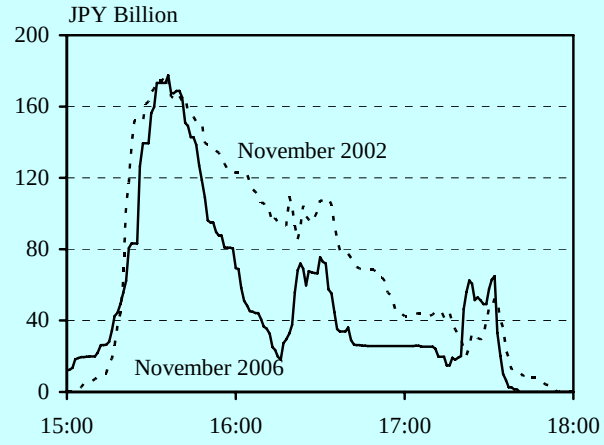
CLS Bank holds accounts with central banks of the fifteen eligible currencies, including the Bank of Japan. During the day, certain amount of liquidity is locked up in these accounts because of the design of CLS' settlement process that creates a time-lag between pay-ins and pay-outs. Pay-ins are made in installments according to a pay-in schedule issued by CLS. Pay-outs are made as settlement over CLS Bank's books progresses and as various risk management requirements are met (see Box). Of particular importance is the requirement that, to the extent a member has negative balances in one or more currencies in its account with CLS Bank, it must have positive balances of equivalent or larger value in other

currencies.

Because settlement and pay-out in one currency is conditional upon pay-in in other currencies, the size of a liquidity sink in CLS Bank's account is affected by the rate of pay-in in all fifteen eligible currencies. For example, if a participant fails to meet its pay-in requirement for the yen for operational or other reasons, pay-outs could be delayed not only in the yen but in all the other currencies, potentially increasing the amount of liquidity trapped in the relevant RTGS systems. Conversely, if a pay-in delay occurs in a currency other than the yen, pay-out for the yen may be delayed even if all the yen pay-ins are completed. As such, the design of CLS' settlement process creates significant interdependencies among the relevant RTGS systems. Meeting time-critical pay-in requirements in all currencies is therefore a key factor in minimizing liquidity sinks in the RTGS systems of the fifteen eligible currencies.

Chart 6 shows the average minute-by-minute pattern of CLS Bank's account balance with the Bank of Japan. We see that the balance rapidly builds up shortly after the start of pay-in at 15:00. After reaching a peak at 15:30, the balance starts to fall as the value of pay-outs per minute exceeds that of pay-ins per minute. Two smaller spikes occur around 16:30 and 17:30, when settlement members' pay-ins are concentrated. After 17:30, the balance declines and approaches zero at the Asia-Pacific pay-out completion time at 18:00.

Chart 6: Intraday pattern of CLS Bank's balance with the Bank of Japan



Source: Bank of Japan.

The chart also compares the average amount of liquidity locked-up in CLS Bank's account in November 2002 and 2006. In both cases, the balance initially builds up at a similar pace. After reaching the peak, however, the rate of decline is almost twice as high in 2006 than in 2002. This implies improved liquidity management by settlement members in complying with their pay-in schedules. An upgrading of the CLS core system also seems to have contributed to reducing the liquidity sink in the BOJ-NET by improving the rates of settlement and pay-out.

(2) Coordinating different types of payment flows

As seen above, the value of BOJ-NET payments resulting from foreign exchange trades has increased in the past several years and has reached almost half of that of BOJ-NET interbank transfers (e.g., call loans) made by banks that participate directly in both the BOJ-NET and the FXYCS. Such an increase in certain types of payments could affect the settlement timing of existing payment flows because participants can use the incoming payments to fund their outgoing payments.

In order to analyze the dynamic interdependencies among different types of payment flows in the BOJ-NET, impulse response functions are estimated based on a vector autoregression (VAR) model. Impulse response functions are used to examine how a shock to one variable is transmitted to other variables over time. The model contains three variables: (a) BOJ-NET interbank transfers from FXYCS direct participants to banks that are not direct participants in the FXYCS; (b) BOJ-NET interbank transfers between two FXYCS direct participants; and (c) BOJ-NET payments resulting from the FXYCS RTGS mode.[13,14]

Chart 7 presents the accumulated impulse responses of a one-percentage point increase to each of the three variables. The top graph shows that an increase in (a) has only a short-term impact on (a) itself, with an immediate and negative response after the shock. Variable (b) responds slightly only after 30 minutes.

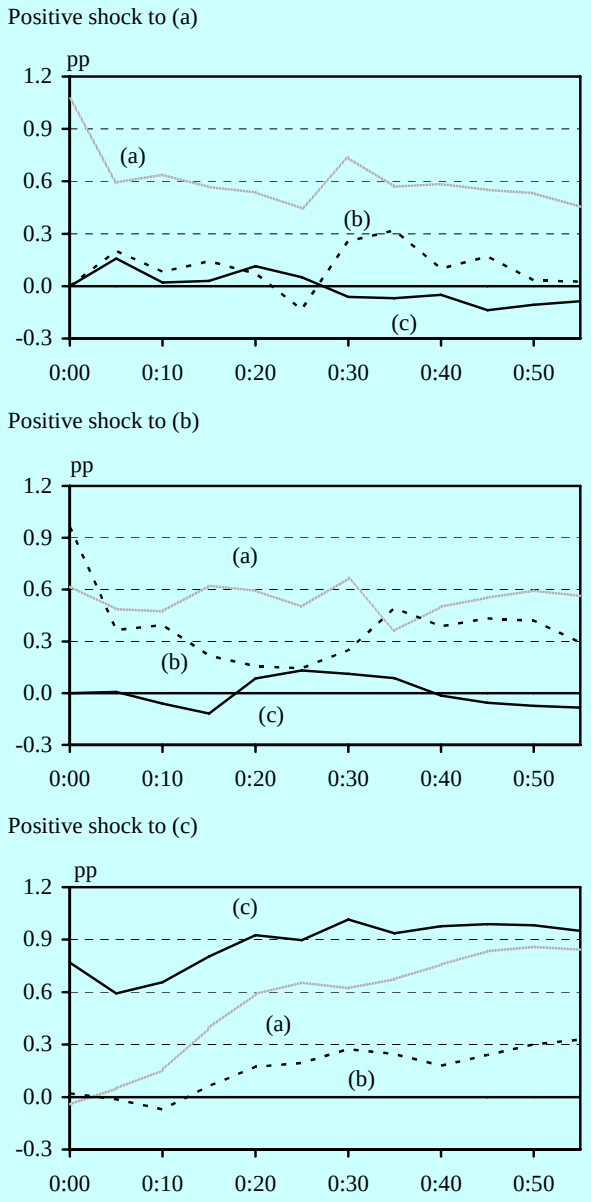
In the middle graph, a positive shock is given to (b). After the shock, the value falls initially but then rises after 30 minutes. This implies that funds circulate among FXYCS direct participants once every thirty minutes. Turning to other variables, we see that the shock to (b) has an immediate and positive impact on (a), indicating the possibility that (a) is processed with higher priority than (b).

In both cases, responses by (c) are not statistically significant. One reason for this may be that banks usually manage FXYCS payments (i.e., (c)) separately from BOJ-NET payments (i.e., (a) and (b)). For example, payment flows associated with the BOJ-NET are typically managed by treasury departments, while those associated with the FXYCS are managed by foreign exchange departments. Another reason may be that BOJ-NET interbank transfers are usually processed with higher priority than FXYCS payments. BOJ-NET interbank transfers largely comprise payments for call loans, which,

according to market practices, need to be settled within one hour after trade execution. Most FXYCS payments are less time critical.

In the bottom graph, we see that a positive shock to (c) has a positive effect on all three variables, with a moderate rise in (c) immediately after the shock and an increase in (a) and (b) after 20 minutes. The results imply that an increase in FXYCS RTGS payments facilitates not only payments among direct participants in the FXYCS (i.e., (b) and (c)) but also payments to banks that are not direct participants in the FXYCS (i.e., (a)), which in turn accelerates the circulation of liquidity within the entire system. Payment flows in (a) include payments between direct and indirect participants in the FXYCS and CLS.

Chart 7: Accumulated impulse responses of three types of payment flows



Source: Authors' calculations.

The impulse responses suggest that settlement in the BOJ-NET could become more efficient if banks integrated management of BOJ-NET and FXYCS payment flows. In particular, if banks coordinated incoming BOJ-NET interbank transfers with outgoing FXYCS RTGS payments, combined with the observed effect of increased FXYCS RTGS payments inducing BOJ-NET interbank transfers, the funds can be recycled more quickly within the system. This would likely reduce liquidity costs for participants as well as speed up settlement in the system.

Conclusion

This paper reviewed recent changes in Japanese yen payment flows for settlement of foreign exchange trades. During the first several years following the launch of CLS, a large portion of yen payments migrated from the FXYCS to CLS. In the FXYCS, the reduction in volume, along with other developments, led to an increase in the use of the RTGS mode and higher netting ratio. CLS also gave rise to time-critical payments in the BOJ-NET.

The paper also considered how the above changes have affected payment flows in the BOJ-NET and what measures could be taken to maintain smooth flow of payments in the system.[15] The design of CLS' settlement process creates a liquidity sink in the BOJ -NET and other relevant RTGS systems with some portion of the liquidity temporarily trapped in CLS Bank's account with the relevant central banks. The size of such balance in each currency is affected by the rate of pay-in in all fifteen eligible currencies, creating significant interdependencies among the relevant RTGS systems. Meeting time-critical pay-in requirements in all currencies is therefore a key factor in minimizing liquidity sinks in the relevant RTGS systems.

Impulse response analysis indicated that the recent increase in FXYCS RTGS payments, which has adversely affected the system's efficiency in liquidity usage, could facilitate settlement in the BOJ-NET. Such effects could be further enhanced if banks integrated internal management of BOJ-NET and FXYCS payment flows. Coordination of these payment flows will become more relevant with the planned implementation of the neXt-Generation RTGS (RTGS-XG) project in 2008, under which all payments currently processed in the FXYCS will be incorporated in the new BOJ-NET.[16]

[1] Foreign exchange settlement risk is the risk that one party to a foreign exchange trade pays the currency it sold but does not receive the currency it bought. It is often referred to as Herstatt risk after the failure of Bankhaus Herstatt, a small German bank, in 1974. PVP ensures that a final transfer of one currency occurs if and only if a final transfer of the other

currency takes place.

[2] The Committee on Payment and Settlement System of the Bank of International Settlements carried out a survey of foreign exchange settlement risk during the second quarter of 2006. For the global survey results, see Bank for International Settlements (2007), *Progress in reducing foreign exchange settlement risk – consultative report*.

[3] The Code of Conduct of the Tokyo Foreign Exchange Market Committee states that a bank should acknowledge the best practice that a CLS-eligible transaction conducted between two CLS users will be settled via CLS unless stated otherwise.

[4] For a more detailed description of the FXYCS and the BOJ-NET, see the section on Japan in Bank for International Settlements (2003), *Payment and Settlement Systems in Selected Countries.*

[5] See Bank for International Settlements (1996), *Settlement risk in foreign exchange transactions.*

[6] CLS started operation with seven first-wave currencies, which were the Australian dollar, Canadian dollar, euro, Japanese yen, Swiss franc, U.K. pound sterling, and U.S. dollar. In September 2003, Danish krone, Norwegian krone, Singapore dollar, and Swedish krona were added, followed by Hong Kong dollar, New Zealand dollar, South African rand, and South Korean won in December 2004.

[7] The figures for the two systems are not directly comparable due to the difference in the way payments between indirect participants are settled.

[8] Each day, CLS provides settlement members with details of suggested swap transactions that would reduce the members' net short or long positions. For the yen and other Asia-Pacific currencies, in which CLS settlement takes place late in the RTGS system's operating day, I/O swaps are conducted to mainly reduce net long positions. Note that the out legs of I/O swaps will be exposed to foreign exchange settlement risk.

[9] Because of sender net debit caps, the netting ratio in the FXYCS DNS mode remained relatively stable around 3–5%.

[10] Assuming that a participant has a square position in the yen, I/O swaps can be an effective tool for managing imbalances between "inside" and "outside" CLS positions and improving the netting ratio in the FXYCS. For example, if a participant enters into a swap transaction and settles the "in" leg in CLS and the "out" leg in the FXYCS, it could reduce both a net long position in CLS and a net short position in the FXYCS.

[11] Pay-ins and pay-outs take place over a three-hour period (15:00–18:00) for Asia-Pacific currencies and over a five-hour period (15:00–20:00) for others.

[12] Throughput guidelines in the FXYCS DNS mode require participants to send 65% of the daily volume and 55% of the daily value by 11:00.

[13] (a) and (b) mainly comprise borrowings and repayments of call loans. Pay-ins and pay-outs to and from CLS Bank are included in (c).

[14] The variables used in the model is the first-order difference in the logs of average value of payments made during each five-minute interval of the day for December 2006 (96 samples). The results did not change substantially when we used the same set of samples without the first and/or last one hour of the operating day. A lag length of seven (35 minutes) was selected using the Akaike Information Criterion (AIC). The impulse responses are based on the Choleski ordering (a), (b), (c).

[15] For a discussion of smooth flow of payments in the BOJ-NET, see Imakubo, Kei and Hidetsugu Chida (2006), "BOJ-NET Funds Transfers after the End of the Quantitative Monetary Easing Policy," Bank of Japan Review Series 2006-E-5.

[16] For an overview of the RTGS-XG project, see Bank of Japan (2006), "Japan's next-generation RTGS."

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