

A study of competing designs for a liquidity-saving mechanism

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Large-value payment systems (LVPS)

- When banks want to make payments to each other they use a large-value payment system
- Payments typically must be made on a particular day, but not at a particular time
- This gives banks the option to choose the time at which the payment is sent

Why study LVPS?

- In standard theory of intertemporal trade, agents borrow and lend at market rate
- There are typically no organized markets for intraday credit in interbank settlement systems
- Banks have the choice between borrowing from CB at a fixed price or delaying payments

CBs care about flow of payments

- This has led to undesirable and unpredictable surges of payments toward the end of the day
- Improving the flow of payments during the day is an important policy concern for CBs
- CBs have been interested in queuing systems called liquidity saving mechanisms (LSMs)

What are LSMs?

- LSMs are queues to which payments can be submitted and where they remain pending until a pre-specified event occurs
- LSMs allow banks to make payments conditional on such events, typically the receipt of a payment
- LSMs can improve welfare

Increasing interest in LSMs

- Many CBs have recently been interested in LSMs
- TARGET 2, the ECB system, uses an LSM
- BoJ started using an LSM in October
- BoE plans to study the use of an LSM on CHAPS
- Fed is also considering the use of an LSM on Fedwire

Literature

- Angellini (1998, 2000), Bech and Garratt (2003), Kahn, McAndrews, and Roberds (2003), Mills and Nesmith (2006) analyze the coordination in RTGS
- Roberds (1999) considers the risk-taking incentives in netting, RTGS, and LSM environments
- Kahn and Roberds (2001) consider the benefits of coordination in CLS
- Willison (2004), Martin and McAndrews (2008) compare equilibria with RTGS and with LSM

Objective and preview of results

- Compare the equilibrium and welfare properties of different LSM designs
- LSM design can affect incentives to send different payments in *opposite* direction
- Either design can lead to higher welfare

The Environment

- Two periods: morning and afternoon
- Mass 1 of risk neutral core system participants
- Each participant sends (and receives) a payment to (and from) another participant
- Three factors influence banks decision to delay

Factor 1: Liquidity shocks

- Participants can receive a positive, a negative, or no liquidity shock
- The size of the liquidity shock is smaller than the size of payments between participants
- Idiosyncratic but no aggregate uncertainty

Factor 2: Time-Critical payments

- A fraction θ of payments are time-critical (TC)
- Cost of delay for time-critical payments: $\gamma \geq 0$
- Non-time-critical payments have no delay cost
- Participants know the time-criticality of payment they must make but not of the payment they receive

Factor 3: Cost of borrowing

- Participants start (and end) the day with zero reserves and cannot have negative reserves
- Reserves can be borrowed at the CB at cost R
- Excess reserves have a return of 0
- Payments made and received in the same period offset each other

Main trade-off

- Cost of borrowing alone provides an incentive to bunch payments
- Time-critical payments provide an incentive to make payments early
- Liquidity shocks and cost of borrowing provide an incentive to make payments late

A noisy signal

- Before observing their liquidity shock, banks receive a noisy signal that can take three values: s^+ , s^0 , s^-
- If a bank observes s^+ , the probability of
 - Positive liquidity shock is p in $[\sigma, 1]$
 - No liquidity shock is $(1 - p)(1 - 2\sigma) / (1 - \sigma)$
 - Negative liquidity shock is $(1 - p) \sigma / (1 - \sigma)$

A noisy signal (cont.)

- Similar expressions for s^0 and s^-
- The mass of bank with a given signal is equal to the mass of bank with corresponding shock
- Mass of bank with signal s^+ that do not receive positive shock is equal to mass of banks with signals s^0 and s^- that receive positive shock

Liquidity Saving Mechanism

- Payments can be put in a queue
- Payments in the queue can offset multilaterally
- The rules that dictate if a payment in the queue is released depend on the design of the queue

Two queue designs

- Balance reactive LSM (standard design):
Banks can set a balance threshold below which a payment is not released from the queue
- Receipt reactive LSM: Payment released from the queue if an offsetting payment is received, regardless of the bank's actual balance

Queued payments can offset

Figure 1: Queued payments in a cycle

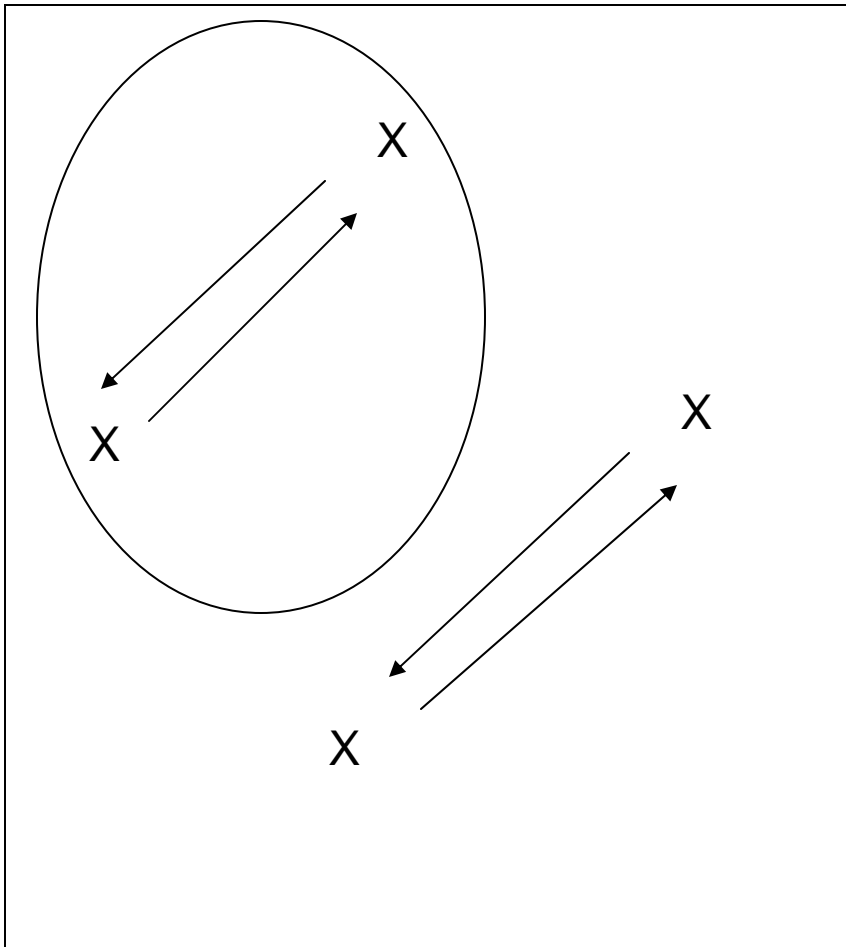
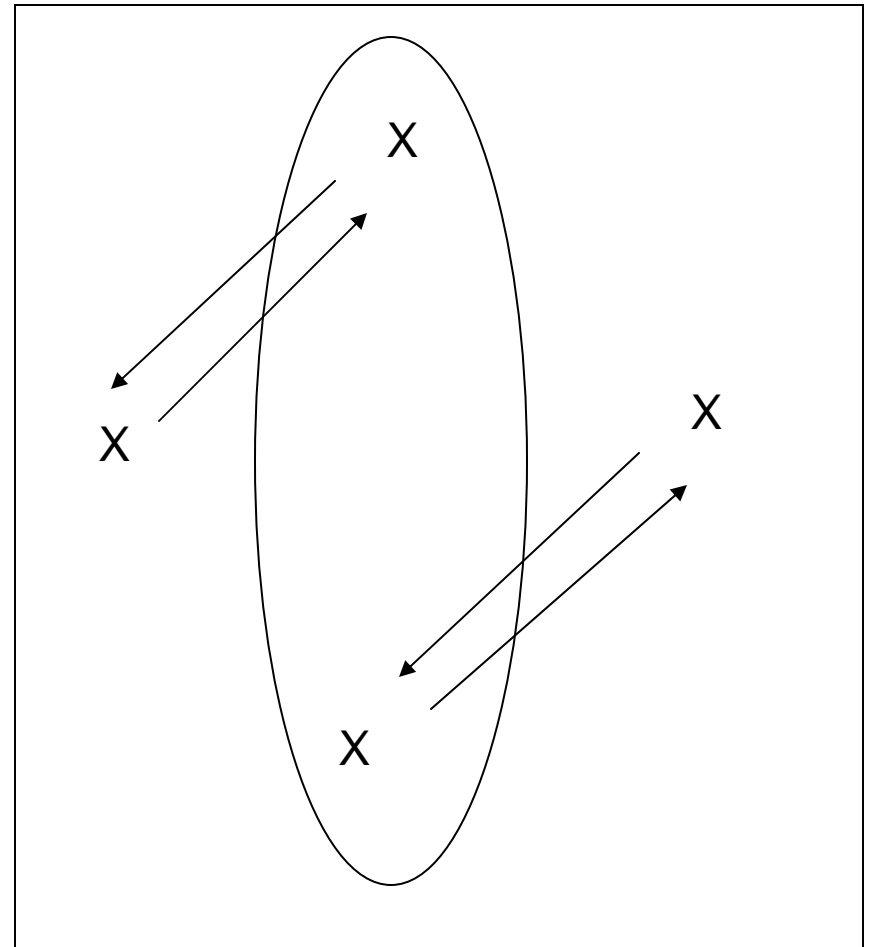


Figure 2: Queued payment in paths



Timeline

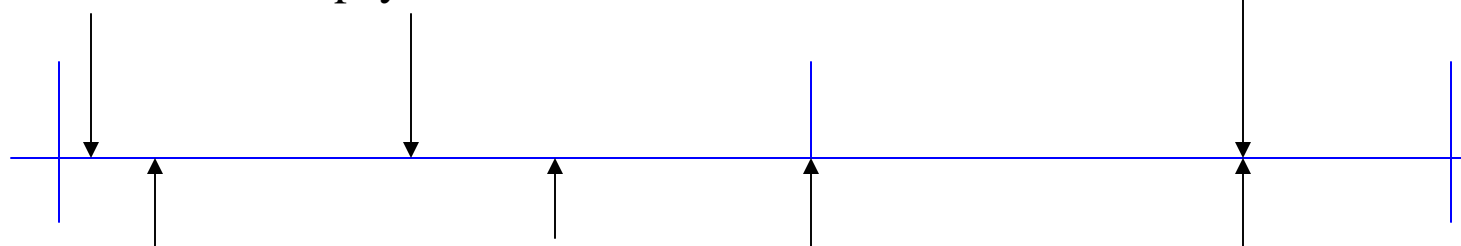
Morning period

Afternoon period

Nature chooses
banks that receive a
liquidity shock and
that must send time-
sensitive payments

Banks decide to send,
queue, or delay
payments

Remaining core payments made



Liquidity shock is observed

Afternoon shock occurs

Noisy signal is received
Banks observe time-
criticality of payment

Borrowing cost incurred if balance is
negative, delay cost incurred if time-
sensitive payment not made

Bank behavior

- Given their signal, banks compare the cost of delaying, queuing, and paying early
- They have rational expectations about the probability of receiving a payment early
- They choose the action with lowest expected cost

BRLSM and RRLSM

- We consider Nash equilibria
- A BRLSM is equivalent to a RRLSM with a perfect signal
- BRLSM equilibria correspond the RRLSM equilibria with $p = 1$

Welfare Comparison

- We compare the welfare associated with RRLSM, BRLSM, RTGS
- Proposition: Welfare increases with the share of payments received early.
- No system dominates the other

Incentive effect of queue design

- Payments that are not costly to delay settle at least as early, or earlier, with a BRLSM
 - Tends to make welfare higher with BRLSM
- Payments that are costly to delay settle at least as early, or earlier, with a RRLSM
 - Tends to make welfare higher with RRLSM

Effect on non-time-critical payments

- Proposition: If delay cost is high, NTCPs are delayed with RRLSM, queued with BRLSM
- Intuition:
 - With a RRLSM, a negative liquidity shock has positive probability, so it is safer to delay NTCPs
 - With a BRLSM, the threshold can be set such that payment is not released when shock is negative

Effect on time-critical payments

- Proposition: Share of TCP released early is at least as high with RRLSM as with BRLSM
- Intuition:
 - More uncertainty with RRLSM: more incentives to pay early or queue with s^- , fewer with s^+
 - In equilibrium, more queuing implies lower incentives to delay as few banks pay early

Simulation results could be misleading

- Our results show that queue design can affect banks' incentives in unexpected way
- Simulations cannot capture the changes in incentives and may give misleading results
- We recommend calibration

Calibration of welfare costs

- In a separate paper we compare the welfare costs of BRLSM and RTGS using Fedwire data
- Depending on parameter, the benefit of an LSM ranges from \$1 million and \$3.5 million per day
- Cost of delay can be up to 7 times the cost of borrowing

Conclusion

- LSM design matters
- Incentives to send early, delay, or queue are sensitive to the queue design
- Different types of payments can be affected in opposite ways