OPERATIONAL RISK IN ReGIS - A SYSTEMICALLY IMPORTANT PAYMENT SYSTEM[1]

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[1] The authors are grateful to Bank of Finland for providing technical support and expertise in order to implement in Romania the BoF-PSS2 simulator, an instrument developed to better understand risks faced by payment and settlement systems.

Abstract

The study aims to quantify the impact of an operational incident on ReGIS payment system and to assess its ability to absorb a liquidity shock. Operational risk tends to increase in importance when payment systems expand their size and economy develops trigger lower economic and legal risks. The back-up systems and contingency plans ensure a low probability of occurrence for operational incidents with significant impact on the payment system smooth functioning, but the unpredictable nature of these incidents requires careful monitoring. The data available for this study cover September to December 2008 participant's transactions and liquidity resources. The results reveal a liquidity contraction in ReGIS since October 2008, but a high capacity of the payment system to absorb a medium intensity liquidity shock caused by an operational incident. Only one participant is of systemic importance, and being affected by a severe operational incident he could trigger a liquidity shock in ReGIS with significant negative impact, such as the impossibility to settle all payment orders, increasing interest rates on the money market or decreasing interbank landing.

Contents

Introduction

Smooth operation of payment systems is of particular importance for central banks. Current research is focusing on the development and modernization of payment systems, but also on identifying potential risks and inefficiencies caused by the architecture and/or operating manner of payment systems. The most recent analyses in the field have consisted in testing the performance of payment systems in terms of risk control and resistance to shocks.

In Romania, ReGIS, the national payment system, is critically important for financial stability, because it ensures the settlement of: central bank's monetary policy operations, payments related to interbank market operations, net positions of all payment and clearing systems, and funds transfers related to financial instrument (securities) transactions carried out among all securities settlement systems. ReGIS[2] is an RTGS system designed to ensure the processing and real-time gross[3] settlement, of large-value (over RON 50,000) or urgent payment instructions initiated by participants[4], as well as of instructions related to other ancillary systems[5].

Regarding operational risk control, the national payment system has been designed in accordance with international security standards, as envisaged measures to maintain a high level of operational resilience. Thus, the architecture of electronic payments system include a contingency processing center (secondary site), which allows resumption of data processing, by copying them automatically from the main operating center (primary site). Although operational risk (from a technical and technological point of view) is greatly diminished, human errors are still likely to occur. In order to prevent them, working procedures have been improved to clearly defining the activities and operations of system participants and system operator. Currently, there are operating procedures, contingency plans, the back-up procedures in case of disaster and plans to ensure the business continuity of ReGIS.

Smooth functioning of payment systems involves also the availability of resources such as buildings, experts, IT special equipment, electricity etc. All these resources are exposed to operational risks (idiosyncratic or not) that can cause business disruptions. For their own protection, participants use systems to archive data, use electrical generators and outsource certain activities. Due to the diversity and low probability of occurrence of extreme operational incidents, the costs of protective measures may exceed the benefits.

[2] Operational since April 2005
[3] Payments processing and settlement are performed instruction by instruction, in real time, as long as liquidity is available in participant accounts
[4] Participants in ReGIS payment system are credit institutions, State Treasury and National Bank of Romania
[5] Auxiliary systems are SENT, SaFIR, RoClear, PCH, MasterCard, Visa

The purpose of this analysis is to assess the impact of such extreme events on ReGIS, using a software application developed by the Bank of Finland, the simulator for payment and settlement systems (version BoF-PSS2). Simulation techniques allow us to build a real operating environment, which can be used for observing and testing scenarios with a view to assess the system capacity to absorb liquidity shocks. BoF-PSS2 simulator, one of the most appreciated analysis tool in the field of payment systems for liquidity and contagion risk, is currently used by central banks in over 60 countries. Soramaki and Leinonen (2003) provide a comprehensive presentation of the simulator.

Scenarios for operational incidents were aimed at analyzing the ability of the payment system to absorb liquidity shocks. Using for payments, besides the liquidity available in their accounts, also the received payments from other participants, the participants may face the risk that the constriction in liquidity flow (in payment system) could cause negative effects, such as the impossibility to settle all payment orders, increasing interest rates on the money market or decreasing interbank landing. Due to the lack of major incidents (so far) in ReGIS, the scenarios have not attached occurrence probabilities. Participant's behavior, as well as the general features, such as incentives to protect liquidity reserves, to reduce borrowing costs and to isolate participants with liquidity shortages has been assumed to be uniform.

Koponen and Soramaki (1998) first used the simulator to quantify the operational incidents impact on Finnish payment system and proposed indicators which identify liquidity tensions into the payment system. Bedford, Millard and Yang (2004) studied the systemic effects of an operational incident which affects one participant and then observed the other participants reaction. They used data from the CHAPS UK payment systems and concluded that only simultaneous disruption of three major banks could cause significant systemic losses. Glaser and Haene (2008) adapted scenarios assumptions to particularities of Swiss payment system, expanded time reaction of participants not directly affected by the incident and assess the daily moment when an operational incident would cause the maximum systemic loss. Lubloy and Tana (2007) identified systemic important participants in Hungary, quantitatively assessed the system ability to cope with a liquidity shock and computed the amount of additional liquidity needed to settle all the transactions when payment system faces a liquidity shock.

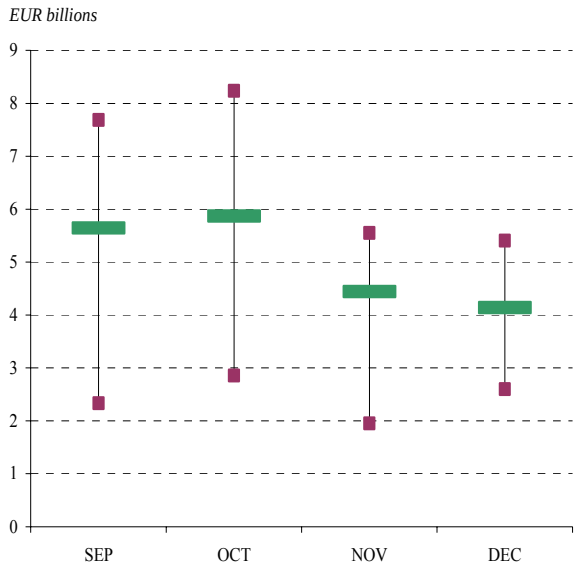
The data available for this study cover September to December 2008 participant's transactions and liquidity resources. Section 1 offers a general description of ReGIS payment system during September - December 2008, including its size, liquidity and concentration indicators, and issues related to participant's behavior. In Section 2 we analyze the 13th to 31st October 2008 period, when liquidity tightened in the banking system, and Sections 3 and 4 assess the payment system capacity to absorb medium-sized liquidity shocks (Section 3) and severe liquidity shocks (Section 4), all caused by operational incidents. Conclusions are available in Section 5.

1. ReGIS payment system during 1 September – 31 December 2008

International financial imbalances have triggered a global liquidity shortage and have spiked risk aversion through financial system. Increasing perceived counterparty risk in the financial system can deepen the liquidity shortage and develop market failures by building excess liquidity reserves and slump interbank lending. The domestic financial system benefited by 2008 from a liquidity surplus caused by inflows of non-resident investors, which allowed smooth payment system operation. A highly integrated European financial system and, especially a global one, add to their known benefits, new vulnerabilities, namely significant exposure to external liquidity shocks.

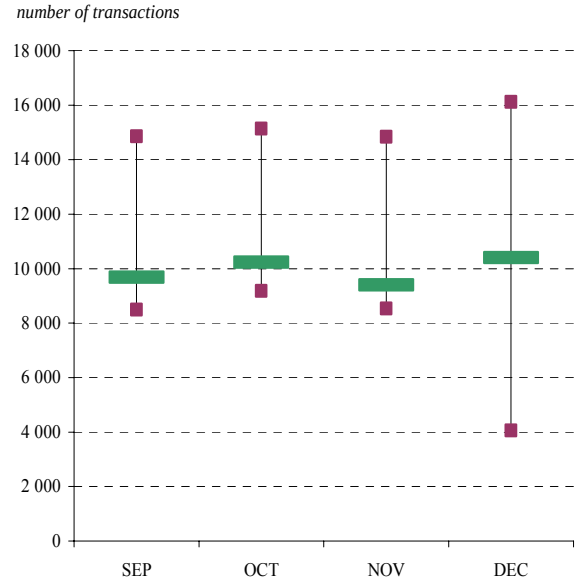
Payment values were high in October 2008, when significant tensions in the money market required an important intervention of the central bank, which absorbed liquidity from participants with excessive reserves and granted loans to participants with liquidity shortages. Transactions volatility, both in values and numbers, was higher in December 2009, which might be usual for the winter holiday season. (Chart 1 and 2).

Chart 1. Daily payment values settled in ReGIS in September – December 2008



Note: The chart contains maximum, minimum and median values for the indicator. This note is available also for charts no 2, 9-12, 14-16
Source: National Bank of Romania

Chart 2. Daily payments number settled in ReGIS in September – December 2008



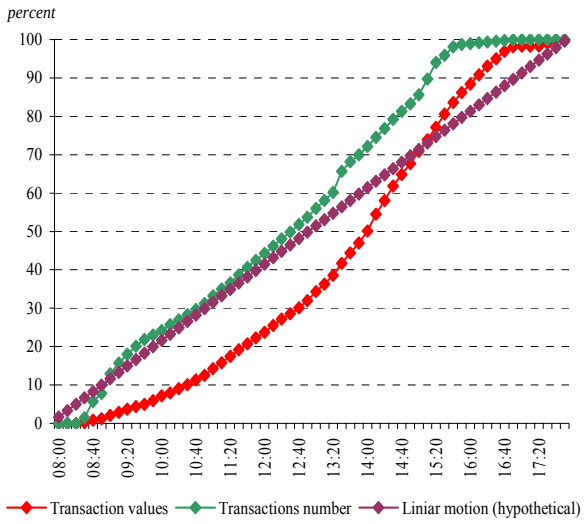
Source: National Bank of Romania

Observing transactions pattern during the day, behavioral model can be assess for participants preferences to initiate payments. The low value payments are settled at the beginning of the day, while higher value payments are settled at the end of the day (Chart 3). It is possible for participants to use this strategy in order to reduce liquidity risk and the cost of borrowing from the interbank market. Payments are settled in

the first part of the day using resources available at the beginning of the day, but for medium and large value payments, the participants take into account the received payments from other participants in order to minimize borrowing cost. They also need to find a balance between the liquidity management costs and the services quality provided to clients, because of the reputational risk implied by the delaying payments.

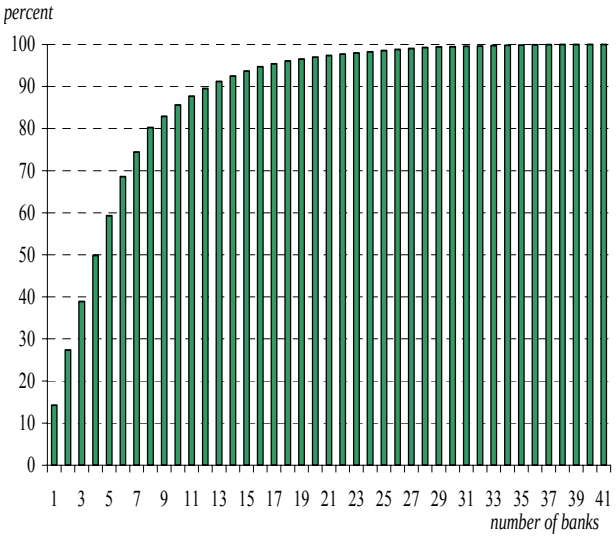
The first 4 participants in the payment system, by value of payments submitted, hold 50 percent of market share, and the first 12 participants accumulated about 90 percent of the total payments (Chart 4). The hierarchy in the payment system differs from that of the banking system because there are banks (subsidiaries of major international financial groups) with strong activity in the payments systems without holding significant assets.

Chart 3. Cumulate value and number payments during the day



Source: National Bank of Romania

Chart 4. Concentration into ReGIS payment system (excluding State Treasury and central bank)



Source: National Bank of Romania

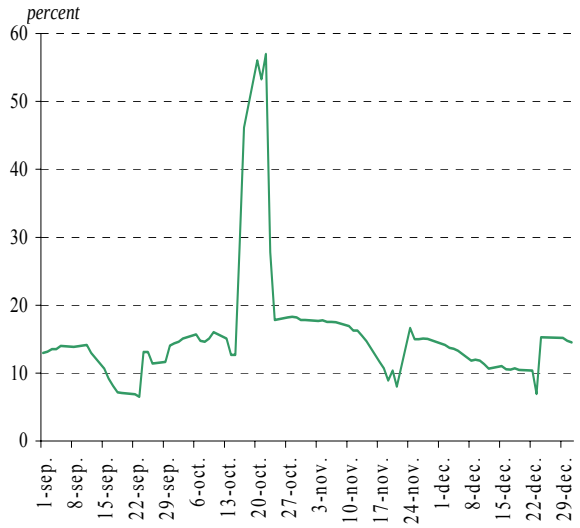
2. Does the credit risk perceived at participant's level increase when liquidity tightens during the interval 13 - 31 October 2008?

The analysis reveals a liquidity tightening in the payment system between 13th and 31st of October 2008. Interest rates increased with high velocity (Chart 5), and the operating schedule for ReGIS payment system was extended at the request of SaFIR[6] for settling transactions related to credit facilities granted to participants by the central bank (Table 1). Regarding open market operations, the central bank faced a

[6] SaFIR is the central depository and settlement system for government securities, owned and operated by National Bank of Romania. SaFIR provides custody services for government securities and certificates of deposit issued by National Bank of Romania, but also settle the transactions with these financial instruments. In addition, SaFIR manages collateral to settle money market operations, including operations with central bank.

period of transition from net debtor to net creditor of the banking system. The increasing government deficit and the slump of inflows from parent banks absorbed the excess liquidity.

Chart 5. ROBOR-ON interest rate in September – December 2008



Source: National Bank of Romania

Table 1. Extensions of ReGIS transitioning schedule

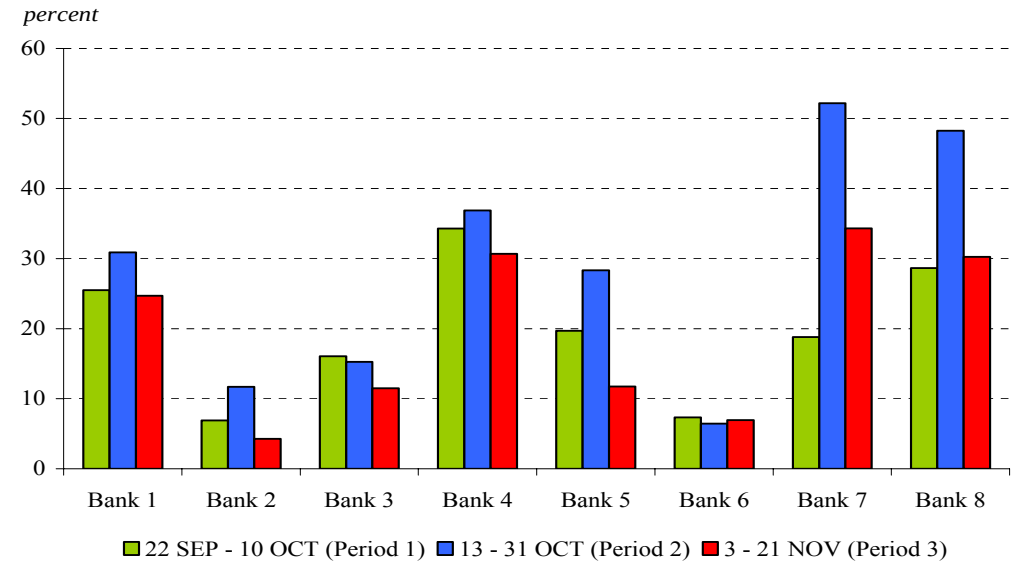
Date	Schedule extension
16 October 2008	5 min
17 October 2008	1h and 25 min
20 October 2008	20 min
23 October 2008	10 min
24 October 2008	5 min
31 October 2008	50 min

Source: National Bank of Romania

At international level, liquidity shortage and bank losses increased credit risk for the financial institutions and the side effect has consisted in a more severe liquidity contraction. The created spiral destabilized the global banking sector, with negative impact also on emerging markets, including the Romanian financial market.

In order to test the increasing pressure on liquidity resources and perceived counterparty credit risk for payment system participants between 13 and 31 October 2008, we consider three observation periods: (1) 22 September – 10 October; (2) 13 - 31October and (3) 3 - 21 November. The periods 1 and 3 are not characterized by liquidity imbalances in the payment system. We measure intraday volatility of account balances for the first 8 participants (credit institutions) in the payment system (totalizing about 80% of total transactions) to observe if liquidity tensions occurred during period 2. In addition, we analyze bilateral transactions among the first 8 participants for all 3 periods considered in order to determine if the named transactions have or not increased during period 2, affecting the smaller participants. In a high uncertain environment, participants with a lower volume of transactions could be perceived as riskier, and their liquidity inflows would diminish.

Chart 6. Account balances volatility for the first 8 participants in ReGIS payment system in 22 September – 21 November 2008



Source: National Bank of Romania

The account balances volatility during the day is higher in period 2 compared to periods 1 and 3 for the most important participants in the payment system (Chart 6). The increased generalized volatility (6 out of 8 participants) leads to the conclusion that liquidity declined, but only temporary. Liquidity injections of central bank felt quickly in the payment system, reducing pressure on resources. Noteworthy is that since the mentioned period, the central bank becomes a net creditor of the banking system in terms of open market operations, after several years characterized by excess liquidity.

Table 2. Relative bilateral transactions for the first 8 participants in ReGIS payment system, sorted in the first column, in 22 September - 21 November 2008

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6	Bank 7	Bank 8
Bank 1	-							
Bank 2		-						
Bank 3			-					
Bank 4				-				
Bank 5					-			
Bank 6						-		
Bank 7							-	
Bank 8								-

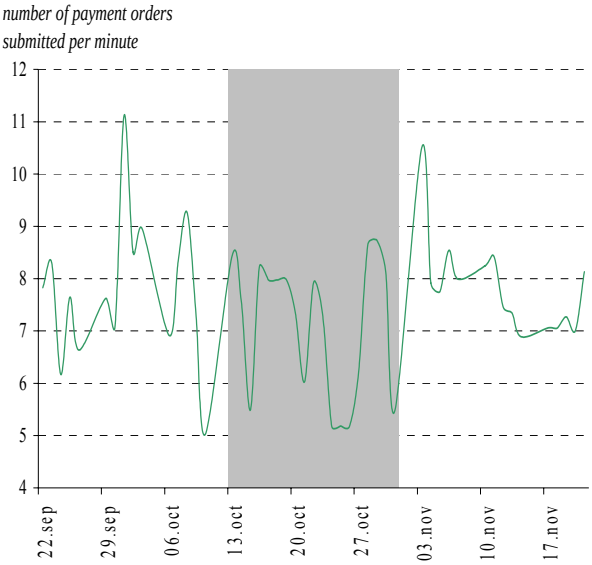
Note: With green color are marked the higher values of bilateral transactions in period 2 (13 – 31 October 2008), comparing to period 1 (22 September – 10 October 2008) and period 3 (3 – 21 November 2008) and with red color are marked the lower values of bilateral transactions in period 2, comparing to periods 1 and 3
Source: National Bank of Romania

Bilateral transactions between the first 8 participants in the payment system have not increased, to the detriment of smaller participants (Table 2). Marginalization of smaller participants, more vulnerable in periods with high uncertainty, could have revealed an increasing perceived counterparty risk in the payment system, caused by information asymmetry.

Observing the account balances volatility for the first 8 participants in payment system and their bilateral transactions, we consider that during 13 - 30 October 2008, characterized, moreover, by a high instability of global financial system, has been a liquidity shortage, but not an increase of perceived counterparty risk in ReGIS payment system.

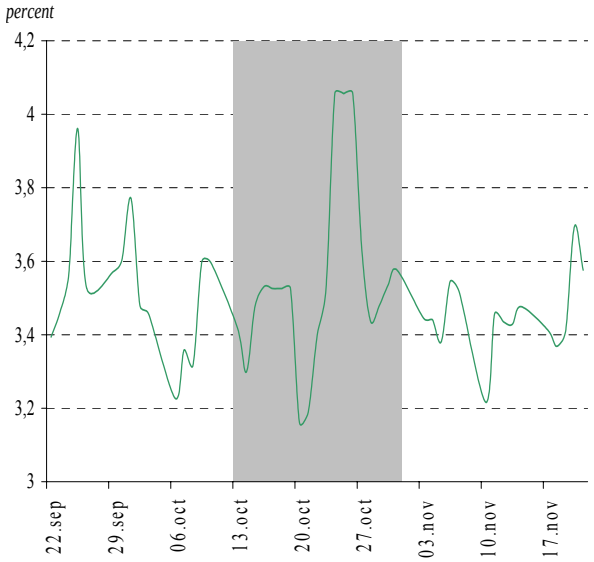
To strength our conclusions, we compute the payments frequency (number of payments per minute) and frequency volatility (Chart 7 and 8). Data do not indicate a significant change in participant's behavior for 13 - 31 October 2008. The results should be analyzed with caution because many factors can lead to random changes in payments frequency, with no connections to available liquidity.

Chart 7. Payment orders frequency in 22 September – 21 November 2008



Source: National Bank of Romania

Chart 8. The volatility of Payment orders frequency in 22 September – 21 November 2008



Source: National Bank of Romania

Further, we stress ReGIS payment system using two scenarios (medium and severe) for testing payment system ability to absorb liquidity shocks induced by operational incidents. Period 13 - 31 October 2008 is analyzed separately in these two scenarios as it provides important information about liquidity flows in the payment system during liquidity stress periods.

3. Scenario 1

Based on the available liquidity at the beginning of the day for each participant in the payment system (credit institutions and State Treasury) and payment orders entered the system, the simulator replicated the payment order settlements. Simulator applied FIFO method (first in first out) to settle payments and settles automatically at the end of the day all outstanding payments, so payment orders can not be postponed to the next day.

The scenario involves a liquidity shock of medium intensity and assumptions are as follows: a) Participants can settle their payments using only resources available in their account at the beginning of the day and the payments they receive from other participants;

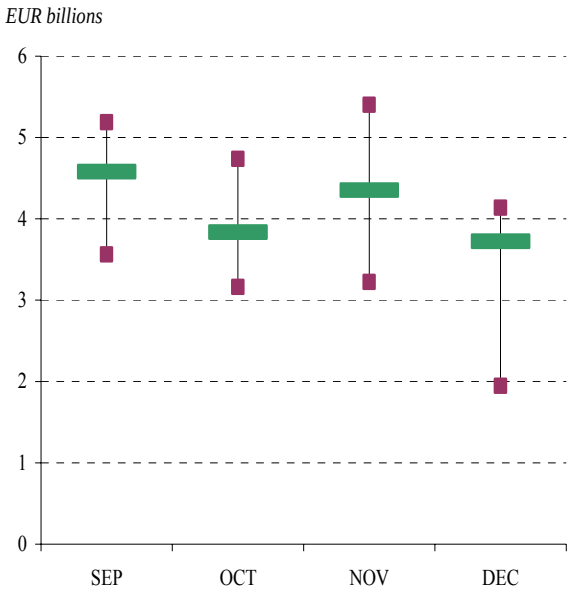
b) Large value payments can not be split; payments are settled only if participants have the entire amount in their accounts;

c) Central bank is not exposed to liquidity risk; it has the right to issue currency.

The scenario goal is to determine whether participants in the payments ReGIS had sufficient liquidity, and otherwise to identify to what extent they used additional resources and what was the impact of liquidity deficit on the functioning of payment system.

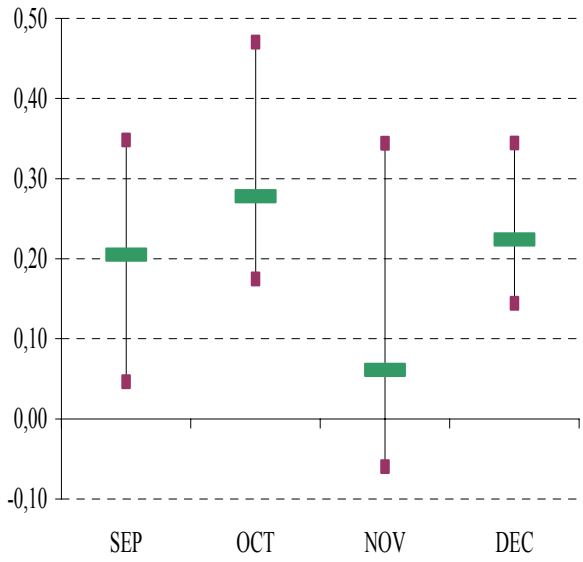
Liquidity used means the amount of financial resources effectively used by participants to settle the submitted payments. This amount is lower than the total value of transactions because liquidity recycling allows for more transaction settlements with the same amount of cash. Recycling ability of financial resources is an indicator for the efficiency of the payment system from the perspective of reducing both borrowing cost and the opportunity cost of holding cash, but a high degree of resources recycling may trigger vulnerabilities if liquidity suddenly slumps. Participants have rational incentive to reduce costs, which can be also in advantage for clients by decreasing transaction costs, but cautious balancing of risks and benefits is required in order to prevent taking excessive liquidity risk.

Chart 9. Daily liquidity used in September – December 2008



Source: National Bank of Romania

Chart 10. Liquidity usage indicator in September – December 2008

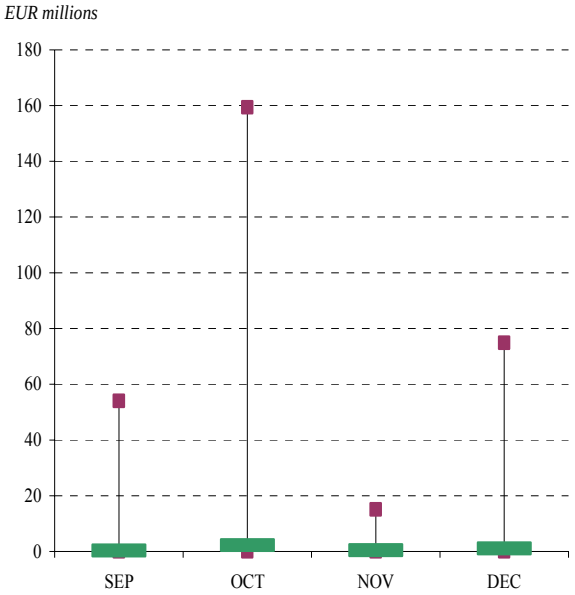


Note: Liquidity usage indicator is computed by dividing liquidity used at bigining of the day account balance
Source: National Bank of Romania

In ReGIS payment system, the degree of resources recycling was low during the analyzed period, due to excess liquidity and the high level of the reserve accounted by the central bank, but since October 2008 participants must deal with a less liquidity environment. The total amount of liquidity used in payment settlements and the liquidity usage indicator has been volatile during the period September - December 2008 (Chart 9 and 10) as a result of international financial turmoil, frequent liquidity injections provided by central bank and increasing budget deficit. We consider that liquidity usage indicator will stabilize in medium term, but at a higher level compared with the one before October 2008. We believe that this development of the indicator will have positive effects on the domestic payments because it will impose a more rigorous management of financial resources.

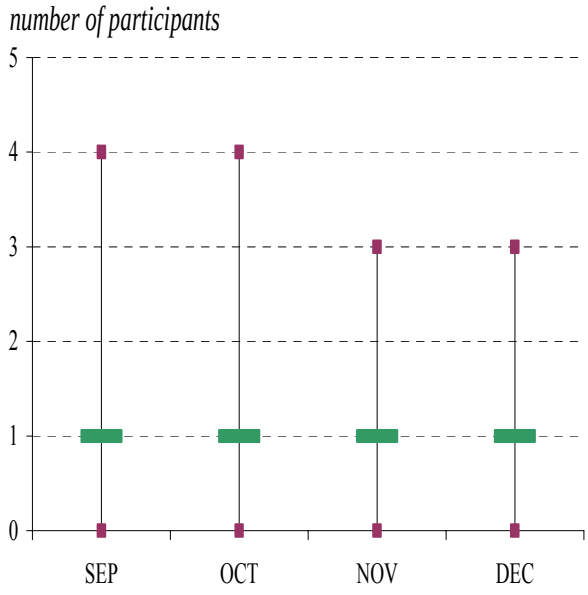
To quantify the impact of scenario assumptions, we use indicators like total queues size (maximum daily values and 10 minutes frequency values throughout the day), the number of participants with temporary liquidity shortages and minimum balances of the participant accounts.

Chart 11. Maximum daily queues in September – December 2008



Source: National Bank of Romania

Chart 12. Maximum daily participants with queued payment orders in September – December 2008



Source: National Bank of Romania

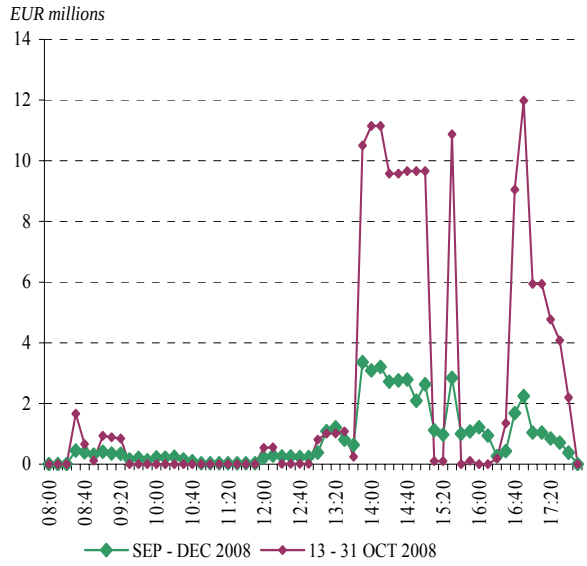
Liquidity tightening from October 2008 and significant injections of central bank in the period October-November 2008 are captured by scenario results. Queues increased significant in October and December 2008 (Chart 11), but only few participants had been directly affected (Chart 12).

Queues increases in the second part of the day, when most of the large value payment orders are submitted, triggering higher pressure on financial resources. Payment system is not affected by an operational incident if it takes place in the first half of the day, but tensions can arise if it occurs in the second part of the day. The impact was more pronounced during 13 - 31 October 2008, when the payment system had been already faced liquidity tightening. By the end of the day, the payment system fully

absorbed tension induced by scenario assumptions (the queues size reaches zero), so it shows strong resistance to the liquidity shock (Chart 13).

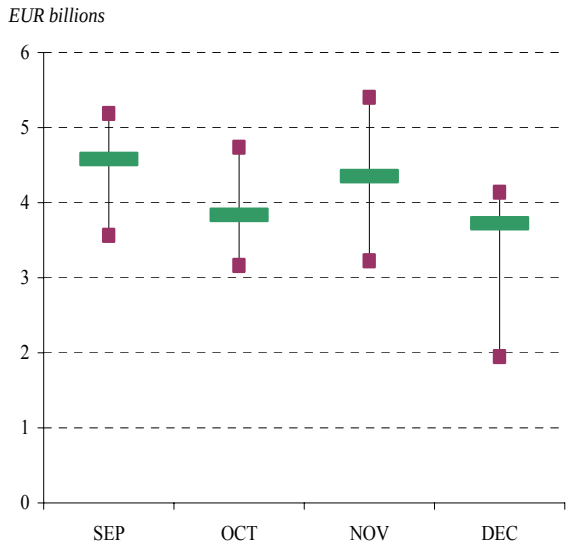
Evolution of minimum balance of the participant accounts throughout the day reflects a liquidity shortage in October 2008 and a seasonal effect in December 2008, due to winter holidays (Chart 14).

Chart 13. Shock transmission during he day (data available every 10 minutes)



Source: National Bank of Romania

Chart 14. Minimum daily account balance in September – December 2008



Source: National Bank of Romania

4. Scenario 2

This scenario implies a severe liquidity shock, with the following assumptions:

a) An operational incident disrupts the IT system of the most important participant in payment system ReGIS (by total payments submitted, excluding the central bank and the State Treasury), being unable to submit payments any more into the system;

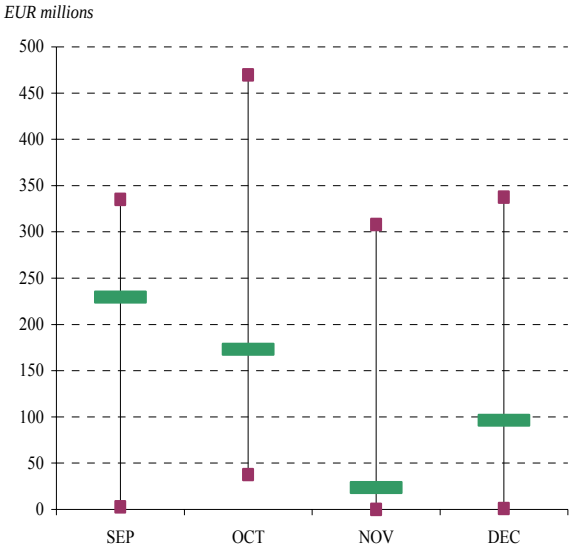
b) The other participants don't observe the operational incident and continue to make payments to the participant affected by incident, but they can't receive payments from that participant;

c) Central bank is not exposed to liquidity risk; it has the right to issue currency.

The scenario aims to quantify the impact of halting the liquidity injection by the principal participant on queues and unsettled payments. The payments submitted by State Treasury and central bank were excluded from the sample.

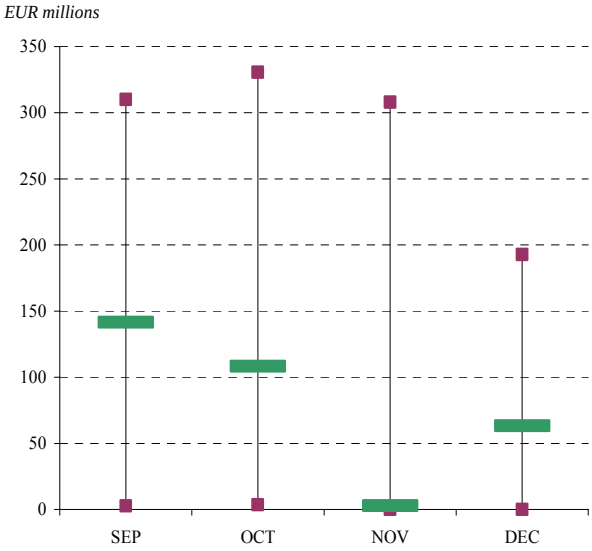
The results indicate both an increased impact as a result of a severe liquidity shock and a lower resistance of the payment system in September 2008, which is not detected by the medium intensity liquidity shock (Scenario 1).

Chart 15. Maximum daily queues in September – December 2008



Source: National Bank of Romania

Chart 16. Daily unsettled payments in September – December 2008



Note: Unsettled payments are queued payments at the end of the day
Source: National Bank of Romania

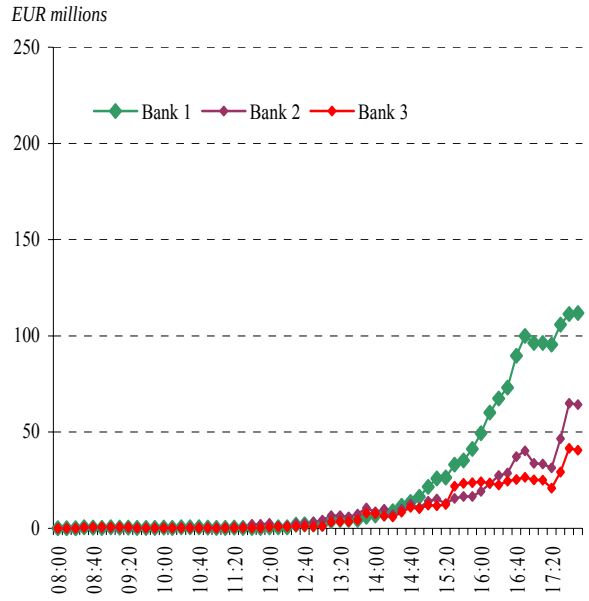
The larger queues in September 2008 (Chart 15) may capture some tension in the payment system, which will accelerate and become visible in October 2008. Lehman Brothers bankruptcy in September 2008 sent a shock wave through the global financial system, and the high integrated domestic financial system into the European one rapidly faced liquidity imbalances.

The system was unable to completely absorb the liquidity shock, so at the end of the day were still unsettled payments. A similar pattern was observed for queues, with the maximum value in September 2008 (Chart 16).

To assess which participants are systemically important, we extended the scenario for the first 3 participants (credit institutions) by payments submitted and we analyzed both the shock propagation through the payment systems during the day and the shock impact (absolute and relative) on queues and unsettled payments.

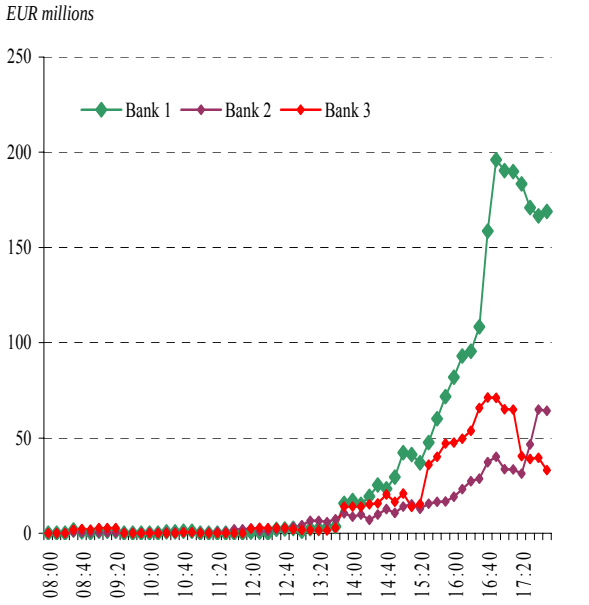
Shock propagation pattern is similar with first scenario. In the first half of the day, the impact is almost nonexistent, but then strongly increases in intensity. Payment system is not affected by an operational incident if it takes place in the first half of the day and trading platform is quickly restored, but tensions can arise if operational incident occurs in the second part of the day.

Chart 17. Shock transmission through payment system during the day when operational incidents disrupt possibility to submit payments for one of the first 3 participants (average values every 10 minutes for *September – December 2008*)



Source: National Bank of Romania

Chart 18. Shock transmission through payment system during the day when operational incidents disrupt possibility to submit payments for one of the first 3 participants (average values every 10 minutes for *13 – 31 October 2008*)

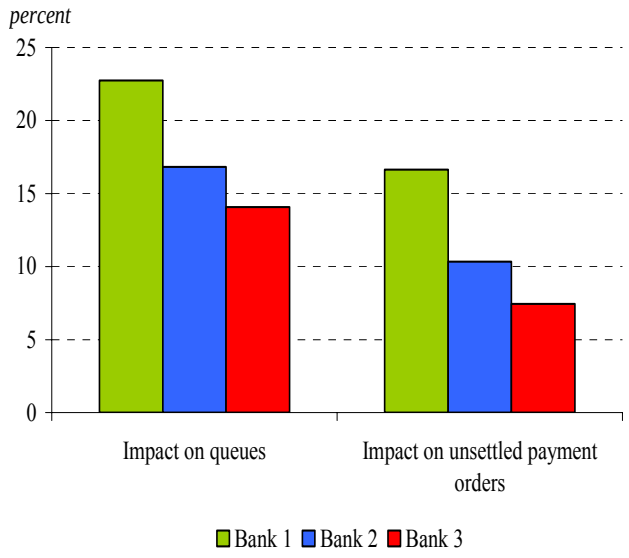


Source: National Bank of Romania

The system can not fully absorb the liquidity shock when operational incident affects directly one of the first 3 participants, but the magnitude of impact depends on the participant share in the payment system. Like first scenario, the impact increased in the period 13 - 31 October 2008 due to tensions already existed in the system and the size of impact is directly proportional to the participant share in the payment system (Chart 17 and 18).

Results reveal only the first participant as systemically important, which can induce substantial imbalances in the payment system. Other participants have a lower impact, which is also less sensitive to the overall liquidity not injected into the payment system. Queues triggered by an operational incident which cause failure of participants 2 and 3 is approximately equal for the periods September - December 2008 and 13 - 31 October 2008.

Chart 19. The relative impact of transaction not submitted by the first 3 participants on queues and unsettled payment orders in September – December 2008



Source: National Bank of Romania

Relative size of the impact is also directly proportional to the participant share in the payment system. A severe tightening of liquidity injections into the system leads to large values for queues and unsettled payments, but as the shock became less severe, relative impact decreases significant (Chart 19). Nier, Yang, Yorulmazer and Alentorn (2008) analyzed concentration risk in the banking system and concluded that the higher the concentration is, the more exposed the system is to contagion risk when a major participant fails. Their conclusion doesn't depend on the shock size.

5. Conclusions

Global financial crisis caused imbalances in the RTGS payment system ReGIS, but with low intensity. Liquidity decreased during 13 - 31 October 2008, after Lehman Brothers bankruptcy sent a shock wave through the global financial system, including emerging markets, but it was stabilized by central bank injections. Starting that period, central bank has become net creditor of banking system from the market operations perspective.

An operational incident, even a severe one, which occurs in the first half of the day and is quickly neutralized, does not affect liquidity in the payment system because participants submitted only small value payments in that period of the day. But tensions can arise in the payment system if the operational incident occurs in the second part of the day. Queues would increase and some payment orders could remain unsettled by the end of the day, depending on shock intensity. Even if the shock is completely absorbed, participants are exposed to higher borrowing costs from money market and the interest rates may also increase.

Improvement in participant abilities to manage liquidity is limited by uncertainty concerning the behavior of other participants. The system tends to an equilibrium point, where participants inject into the payment system just liquidity necessary both to meet customer needs and not send liquidity imbalance signals to other participants. The incentive to make liquidity reserves and to delay payments until receiving funds

from other participants is justified by information asymmetry and cutting costs, so remain few options to change their behavior.

The central bank, as lender of last resort, provide liquidity to banking system when it's needed and can even extend the list with eligible assets accepted as collateral if liquidity is tightening aggressively. So, the probability that submitted payments remain unsettled at the end of the day is almost zero. Notwithstanding, the current global financial crisis shows that liquidity recycling and it's efficient allocations through the system meter more than just liquidity volume. Liquidity injections provided by central bank allow payment settlements, but imbalances could arise in the payment system, like increasing interest rates and tightening money market, with negative impact on the real economy.

The study assesses liquidity shock propagation through payment system from the perspective of an operational incident and not an economic or financial crisis. Analyses of liquidity indicators and liquidity allocation mechanism in the payment system test system ability to absorb the liquidity shock, which is directly related to the payment system state when operational incident occurs.

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ReGIS payment system main features [7]

ReGIS is the national RTGS (Real Time Gross Settlement) system of payments in domestic currency provided by the NBR. It ensures the real-time (on a continuous basis) processing and the final and irreversible settlement of large-value (above 50,000 RON) and urgent payments in Romanian Leu, whether they are inter-participant payments, payment instructions submitted by clearing systems (houses) or securities settlement systems.

1. Participants

The following categories of institutions are eligible for participating in ReGIS:

a) credit institutions from the European Economic Area, including when they operate via a branch set up in the European Economic Area;

b) credit institutions from outside the European Economic Area, provided that they operate via a branch set up in the European Economic Area;

c) the National Bank of Romania;

d) the State Treasury;

e) organisations based in countries set up in the European Economic Area providing clearing or settlement services, that are supervised by a competent authority.

2. Settlement account

Each participant has a single settlement account within ReGIS system. The exception is the organization of the European Economic Area providing clearing or settlement (supervised by a competent authority). They have a settlement account within ReGIS system only when acting as central counterparty. Otherwise, to facilitate the settlement of payment instructions sent by these institutions in the ReGIS system are used technical accounts (tranzit accounts).

During the ReGIS operating day, the settlement account stands for the current account of the participant open with the NBR. All funds transfers related to the instructions initiated by the participants are carried out through the settlement accounts. To be able to control the flow of transactions (receipts and payments), each participant is required to monitor its own settlement account during the day. At the same time, in order to ensure the settlement and compliance with the obligation to manage its liquidity during the day, each participant may hold reserves in its settlement account.

Any payment instruction introduced in ReGIS can be immediately settled, if there are sufficient funds in the debtor participant settlement account. With a shortage of funds, the payment instruction is placed in a waiting queue. Liquidity management involves a better knowledge over the payment instructions status (settled, pending, and canceled), the settlement on a net basis

[7] ReGIS System Rules (31.10.2007)

instructions, the settlement on gross basis instructions and any transfers between participants accounts, as well as over the payment transactions initiated by the central bank (which may credit or debit the participants accounts). Depending on the given profile, each participant can access a part or all the functions of ReGIS (displaying information on the settlement account; waiting queue management, including the change or the cancel in payment transactions order to manage liquidity effectively; managing the own reserve funds, receiving daily reports, other information about ReGIS and participants) through the stations and virtual private network (TFDNet).

In order to ensure the processing and smooth settlement of payment transactions within ReGIS, according to current regulation, the NBR can set for certain participants a minimum credit balance of the settlement account during the operating day.

3. Types of transactions

The types of payment transactions processed and settled via ReGIS[8] are as follows:

a) credit transfer for large- value or urgent payments initiated by participants[9], excepting the institutions which are not central counterparty in its own name and on its own account or on account of their clients;
b) settlement of net positions calculated within ancillary systems[10] processing payments in RON (SENT, SaFIR and other clearing and settlement securities system);
c) payments for the settlement of funds related to operations with securities (gross settlement payment from SaFIR and other clearing and settlement securities system; cash-leg of DvP payments from SaFIR);
d) transfers between participants accounts;
e) crediting and debiting transactions on participants settlement accounts;
f) payments related to central bank operations in connection with other participants;
g) payments related to cash operation in relation to NBR;
h) payments related to State Treasury operation in relation to other participants;
i) direct debiting of fees related to the participation in the three components of the electronic payment system (ReGIS, SaFIR and SENT).

ReGIS can receive payment instructions (which settlement takes place on the net or gross basis) from the following clearing and settlement securities systems:

♣ the automated clearing house for low value payments (SENT);
♣ the central depository and settlement system for government securities (SaFIR);
♣ the clearing and settlement securities system for corporate securities traded on Bucharest Stock Exchange (RoClear);
♣ other clearing and settlement securities system for derivatives (Eltrans, System for Clearing-Settlement and Central Counterpart);
♣ the system for clearing payments made via cheques, bills of exchange and promissory notes (PCH);
♣ the clearing systems for domestic currency card transactions (VISA, MasterCard)

[8] In domestic currency, Romanian Leu
[9] Payment message using SWIFT (SWIFT FIN Y-Copy)
[10] Payments mentioned at b), c), d) and e) are initiated by participants using TFDNet

In ReGIS can be processed other operations related to the holding of: (1) the reserves to guarantee the settlement of net positions calculated by clearing systems and (2) the cash reserve and the general reserve by the participants for a better management of liquidity. Currently, according to the national banking legislation, the ReGIS function of processing the debit or credit limits imposed by the NBR on the settlement accounts of the participants can not be used.

4. Transaction processing

4.1. General terms

- The ReGIS system operating schedule is 08:00 - 18:00;
- To optimize flow, participants have to meet the program / time limit for instructions submission;
- Payment instructions are processed and settled in the ReGIS only if the settlement date of payments is the same with the current day of operating system;
- The maximum amount of a corresponding payment instruction processed by ReGIS is limited by the SWIFT messages fields configuration standards used (15 characters including the decimal separator), if overrun, the participant will devide the amount in more payment instructions;
- Each payment instruction initiated by the participants should include the code of the transaction type.

4.2. Operating schedule

Operating days and operating hours

ReGIS operates Monday to Friday, between 8:00 a.m. and 6:00 p.m. (local time), with a cut-off time for customer payments established for 4:00 p.m. and a cut-off time for interbank payments established for 5:00 p.m, according to the ReGIS operating schedule.

The system does not operate on legal or religious holidays, namely on 1 and 2 January, Easter Monday, 1 May, Ascension Monday, Assumption of Holly Virgin Day, 1 December, 25 and 26 December.

ReGIS operating schedule

Event	*Time*	*Activity description*
Opening of the system	08:00	The system is initialised.
Opening of the processing day	08:30	The system is opened and all types of instructions are allowed (payment messages SWIFT[11] MT102, MT103; gross basis settlement instructions; net basisi settlement instructions)
Initial cut-off	16:00	Cut-off for customer payments; interbak payments are still allowed
Final cut-off	17:00	Cut-off for interbank payments; until 17:45 the credit institutions may still ask for the NBR credit facilities in order to settle the transactions in the waiting cue.
General cut-off	17:45	All the tranzaction from the waiting queue are cut-off; no more tranzaction using credit facilities are permitted; only the credit and debit transaction on the participants accounts initiated by NBR are still allowed.
Closing of the processing day	18:00	The final position are calculated and the daily closing reports are printed (the list of processed transactions during the day, including NBR(Model FI 101); the debiting and crediting amounts of every settlement account for the current operating day, excepting the transactions connected to NBR (Model FI 100); the debiting and crediting amounts for each settlement account during the current operating day, excepting the transactions with NBR (Model FI 100))
Closing of the system	18:30	System management operation

4.3 Processing stages

In ReGIS, payment instructions submitted by participants are settled on a gross basis (instruction by instruction), just after they are received by the system, up to the limit of available funds in the settlement accounts. The payment instructions accepted in the system are chronologically processed, according to the principle of FIFO (first in, first out).

The steps taken in processing a payment instruction in ReGIS are:

a) Start - the payment instruction is sent by the participant to ReGIS;
b) Validation - ReGIS verify by a series of operational procedures the instruction;
c) Technical acceptance – the time when, after validation, the system considers the instruction accepted by the system;

[11] SWIFT Instructions: MT102 –- *Multiple Customer Credit Transfer* ; MT103 - *Single Customer Credit Transfer;*MT202 - *General Financial Institution Transfer.*

d) Checking the funds availability in the settlement accounts and entering the payment instruction in the waiting queue, if there are insufficient funds;
e) Acceptance of payment instruction to settlement by the ReGIS, if there are sufficient funds available in the settlement account / accounts;
f) Direct (immediate) settlement. Accepting payment instruction to settlement is immediately followed by the final settlement. The settlement is unconditional and irrevocable, the payer account is debited and the beneficiary account is credited.

4.4 Waiting queue mechanism

If the available funds from the participant settlement account are not sufficient to settle the payment instructions, ReGIS will move the payment instruction to the waiting queue. Whenever the participant settlement account with instructions in the waiting queue will be credit, ReGIS will restart the instruction processing under the following algorithm:

- Instructions are processed in chronological order (using FIFO), if the instructions in queue are assigned the same priority;

- Instractions with a higher priority are always processed before the instructions with lower priority, the latter will be settled only if there are no instructions with a higher priority in the queue;
- Instructions in the queue will be settled according to the by-pass FIFO principle (ie FAFO - First available, first settled) only if the instructions have the same priority and there are no instructions with higher priority in the queue.

Participants are required to monitor the initiated instructions that are in queue and take the necessary measures to settle these instructions before closing ReGIS operating day. They can change the processing priorities of payment instructions and / or to cancel the instructions in the waiting queue.

If the payment instructions settlement for two or more participants from the queue is blocked due to lack of funds in the participant settlement accounts ("gridlock"), ReGIS system provides an automatic trigger of an unlock mechanism pursuing the concurrent settlement (by simulating a bilateral or multilateral clearing) of as many instructions of respective participants.

4.5 Settlement of payment instructions initiated by the clearing and settlement secutities systems

Multilateral net positions in payment instruction sent by the SENT (automated clearing house) following each settlement sessions are finally settled as a single transaction (first, all participant accounts in the net debtor position are debited, and then all participant accounts in the net creditor position are credited).

To settle the funds related to securities transactions, SaFIR (securities settlement system) initiates, according to its own rules, the payment instructions to settle on a net basis and the payment instructions to settle on a gross basis. Net multilateral positions in payment instruction sent by SaFIR is final settled as a single transaction. After calculating the net positions of participants involved, SaFIR requires ReGIS to set the reserves as funds for participants in the net debtor position. At the time limit set by SaFIR system rules, within the reserves which have been set up to that point in the ReGIS, SaFIR will send the payment instruction to REGIS in order to be settled. The payment instructions settlement on gross basis initiated by the SaFIR is achieved by debiting the settlement account of the debtor participant, followed by crediting the settlement account of the creditor participant.

4.6 Settlement of payment instructions initiated by other securities clearing and settlement systems

Multilateral net positions resulting from the clearing made by the other securities clearing and settlement systems may be guaranted by collaterals (in the form of blocked funds in reserves hold in settlement accounts in ReGIS and the form of blocked eligible securities in the participants account in SaFIR) held by participants within both systems. Once the payment instructions to settle the net position is sent to ReGIS, the available funds in the participants settlement accounts in the net debtor position are automatically blocked in those accounts within the net debtor position limits, to ensure the settlement of net positions at the acceptance time for the payment instructions settlement. Multilateral net positions in the payment instruction is final settled as a single transaction.

Payment instructions initiated by other securities settlement systems for their participants related to the settlement on gross basis transactions operated within such systems, shall be settled through the participants settlement accounts opened with ReGIS.

4.7 Settlement acceptance time and final settlement of payment instructions

The settlement acceptance time of payment instruction (time for entering into the system) is the moment when the payment instruction is technical accepted by the system in order to be settled, according to Law no. 253/2004 on settlement finality in payment systems and securities settlement systems; from this moment the payment instructions accepted, which are in waiting queue and / or have already been settled, are protected even when the insolvency proceedings on a participant is opening.

A payment instruction can not be revoked by a participant in the system or the system administrator after its acceptance by the system for settlement.

A payment instruction is final settled (irrevocable) for the paying participant when debiting its settlement account and for the beneficiary participant when crediting its settlement account.

Between the time of acceptance to settlement and final settlement there is no perceivable difference in the ReGIS system.

4.8 Provision of intraday liquidity

Under the provisions of art. Article 22. (3) and Article 19. (1) of Law no. 312/2004 on the Statute of the National Bank of Romania and in accordance with its rules, the NBR can provide intraday liquidity to eligible participants through intraday repo transactions colateralised with eligible financial instruments .

The eligible financial instruments used as colateral for intraday liquidity are the eligible assets defined by the NBR regulations.

Deadline for repayment of the intraday liquidity provided by the central bank to participants in ReGIS is the general cut-off time of the ReGIS operating schedule.

4.9 Financial colateral

In order to ensure the settlement of own net debiting positions calculated in the securities clearing and settlement systems, each participant holds financial colaterals at NBR as funds, in settlement account opened within ReGIS system and / or as eligible securities for the SaFIR. If the debtor participant settlement account has not sufficient available funds for net positions settlement, the financial colateral is used to first supplementing the funds; if the funds are insufficient they can be supplemented by using the colaterals on the eligible financial instruments hold by the participant in its opened account at SaFIR.

Annex 2

A short presentation of the BOF-PSS2[12] simulator

Bank of Finland has a long tradition in research and economic modeling, and the modern payments and settlement system is one of the main areas concerned. The simulator for the payment and settlement systems used in research has proven to be a valuable tool for studying the liquidity requirements and system risks during the introduction of euro. Based on the results and market positive feedbacks, Bank of Finland has decided to improve the simulator, especially for international use. At present, this simulator (BoF-PSS2) has over 60 users worldwide, mainly central banks. In recent years, interest in this instrument has increased both in academia and private organizations in the financial infrastructure. Until now, central banks have carried out a very large number of studies; since 2003, most of these studies were presented at the annual seminar organized by the Bank of Finland. The main objective of the seminars is to stimulate research in the area of payment and settlement, using simulation, and to share the research results and experiments with the community members in order to capture new ideas and feedbacks for simulator development. Recently, BoF PSS2 simulator was equipped with analysis facilities for payment networks[13].

Presentation of technical characteristics of simulator BoF-PSS2

Originally built as a tool for studying the probable effects of the introduction of European Monetary Unit (Euro) in the Finnish payments system, Bank of Finland simulator was embraced by the central banks of other countries, being used for studies and analysis in payment systems area. The main focus of the analyses is on continuity arrangements, operational and liquidity risks, stability, liquidity requirements, liquidity economising, gridlock resolution, transaction queuing arrangements, network features and network topologies. Due to the popularity enjoyed in 2003, Bank of Finland has tried to improve the simulator, giving those interested in payment systems research a new version of it (BoF-PSS2).

BoF-PSS2 can be independently used by designers and administrators of payment and settlements systems, analysts of central banks and financial institutions, as well as research institutes or universities. Software can be downloaded on a personal computer (PC Classic) for local processing, the necessary documentation is included. Bank of Finland organizes periodic seminars to promote the simulator and provide limited technical assistance.

BoF-PSS2 simulator is a tool for a diversity of analysis. The basic principle is that the flows of payments are processed in a given model of an existing structure of payment and settlement systems. Thus, the simulator is modelling the settlement processes for a payment system. Simulation results match the rules defined for the payments in question. The process results can be analyzed using an analysis tool included or can be exported into other programs such as Excel. Field of interest includes intersistem credit risk, liquidity risk, speed of settlement, the mechanism of payments settlement in waiting queue (gridlock resolution) and settlement efficiency.

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[12] Source: Bank of Finland

[13] Bank of Finland and *National Infrastructure Simulation and Analysis Center, Sandia National Laboratories Los Alamos National Laboratory* din USA

The simulation begins by creating payments flows (transactions) to be processed and define the characteristics of payment / settlement systems and the system rules (eg systems, participants, and the settlement rules). Next, the simulation is performed. Results are then compared with results of other simulations or observations of real life. The use of the simulator is an iterative process of learning, and the first simulations become the basis for sequentially improving and refining the later simulations. Consequently, the simulator is not a model of determination, econometric, for optimization, but rather an heuristic tool for analyzing systems which are too complex for determination model. Simulator can process in one simulation several million transactions of several thousand accounts in several interconnected systems. In other words, optimization analysis is performed mainly by statistical or empirical method. Simulation is repeated for different values of decisional parameters, and the obtained values / the results are compared for different combinations. For example, a central bank may want to determine the minimum liquidity requirement of banks to ensure that 99.5% of the settlement is carried out continuously throughout the day so that transactions do not stand in waiting queues more than 10 minutes. To find the answer, the bank will model different levels of liquidity to see the level corresponding to its objective. The model is a way of testing the alternative situations. Main difference between the simulator and the real payment system is that the operation time is induced and not real. Transaction processing is done transaction by transaction. Simulator operates in general, faster than real life, but the speed of processing depends on the volume, complexity of processing and capacity available for processing. Where RTGS test, simulator processes approximately 2 million transactions in an hour. In any case, the results are similar to processing in real time.

Simulations can be made for different days or for a succession of days. In this case, the closing balance or unsettled transactions can be transferred to the next day or period of settlement. Simulator uses the standard calendar and assume that all days (including the weekend) are banking days.

Simulator is limited to processing payments and transactions, and the types of colaterals are not included. Processing collateral for repo may be included through repo DvP transactions (Delivery versus Payment), especially if the simulation contains security settlement.

Simulator identify 3 general types of systems: RTGS (real-time gross settlement), CNS (continuous net settlment) and DNS (deferred net settlement).

The central banks interest in BoF PSS2 simulator

The interest in the simulator highly increased in recent years due to the central banks responsabilities in the payment systems oversight, which involves more complete and detailed analysis in the payment systems field. Globalization and international cooperation, technological progress, the interdependence of payment systems and new relationships established between them are the factors influencing the interest in studying the crisis and systemic risk. The necesity of some relevant results in studies/analysis in the crisis management area, has imposed the development of instruments and types of stress test scenarios. Currently, it seems that we are in a new era of true globalization of payment and settlement systems operated completely by interfaces and network connection. Payment systems have become huge network, which has led to new research themes such as network analysis.

If in the early 1990s, simulations were used to determine how payments system and participants are influenced, in general, of new settlement agreement, and to discover the hidden credit and liquidity risks, especially in the cross-border systems, now the focus is on understanding the architecture of payment systems network and the impact on individual or group of participants' behavior. Customers and banks are tempted to react to external stimuli and to change their payment behavior during crisis. Oriented simulation models of the participants is a way of surprising the types / models of behavior in payments infrastructure. Research is needed to determine the response of participants to the system in different situations, constantly changing. Studies are permanently developed from scope and complexity perspective. Counterparty risk and the payment systems interdependencies are subjects of permanent interest to central banks as well as the usage of the stress-test scenarios, as an instrument for overseers. For years the efficiency of algorithms for real-time settlements were refined and have become standard features for RTGS systems. Network analysis are part of a new area of interest, which tries to describe the network of payment systems and the weak and strong dependencies in the system. The aim is to describe behavioral patterns of payments networks.

"The payment and settlement systems simulation" Seminar

Focused on managing the payment and settlement systems simulator, as an instrument used in the payment systems analysis, the annual simulator seminar organized by the Bank of Finland is aimed at meeting worldwide professionals from central banks and research institutes in the financial sector, involved in activities related to the payment systems analysis. Participants have the opportunity to share their experiences based on the simulator, provided by the Bank of Finland, presenting their studies results, in order to develop research in this area and, jointly, to benefit from a real exchange of information, experiences and criticisms. Annualy, the participants are introduced to the innovations in the field, the simulator for potential users (through practical exercises), and presentations provided by simulators' users from other central banks (eg Bank of Austria, the Swiss National Bank, National Bank of Hungary, the Bank of England, Bank of Canada, Bank of Italy, Bank of France, the Netherlands Bank, Bank of Denmark, etc.) which experienced this instrument for several years.

Most of these studies were carried out in collaboration with specialists from Bank of Finland, group coordinated by Mr. Harry Leinonen. As Advisor to the Board of the Bank of Finland, Mr Leinonen is in charge of payment and settlement policy issues in the central bank. At the same time, Mr. Leinonen is the Finnish representative on the payment and settlement system committee (PSSC) within the Eurosystem and has over the years participated in several other domestic and international authorities'working groups.