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***“Exploring the link between RTGS systems and money
market: a simulation approach”***

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*The opinions expressed are those of author
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Rationale

Borrowing from other banks through the MONEY MARKET is one of the possible funding sources in a RTGS system, the others being:

- **balances maintained on accounts with the central bank;**
- **daylight credit from the central bank;**
- **incoming payments.**

While the effects of shocks affecting the other liquidity sources have been deeply investigated from an empirical point of view, so far no quantification of the impact of money market shocks on RTGS system performance has been carried out

From a policy point of view, this issue should deserve more attention in the light of the current financial turmoil

Background

Money market funds are a peculiar funding source as they:

“... can only serve to redistribute funds already within the system, although that may nevertheless make an important contribution to reducing the reliance on banks' reserve balances and central bank credit extensions...” (BIS, RTGS Report, 1997)

I focus on the overnight maturity which is arguably the more relevant source for intraday payment purposes

Note: intraday money markets could also compete with daylight central bank credit as a liquidity source in a RTGS environment...

..but the o/n is the shortest quoted maturity in the Euro money market. Therefore if intraday prices for liquidity seem to emerge, this is due to systematic differences in the hourly prices of o/n deposits, as reported by Baglioni and Monticini (2008) on the basis of tick-by-tick data from the Italian interbank market e-MID

Why a simulation approach?

Since the start of the turmoil the money market has dried up and *“in mid-September 2008 [...] came to a virtual halt ...”* (Trichet, 2009)

However, TARGET2 (*T2 hereafter*) has been continuing to work smoothly because:

- the Eurosystem have injected additional liquidity in the system
- banks' desks have likely changed their liquidity management strategies

Therefore, it is not possible to evaluate the impact of a shrinkage in the money market on RTGS performance on the basis of actual data

Within a simulation exercise, it is possible to replicate a number of operational days in the life of RTGS systems with different money market conditions, keeping constant the central and commercial banks behaviour

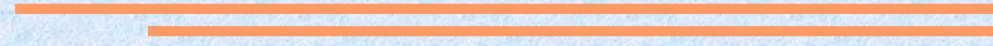
Revisiting existent literature

Aschraft, Durrel and McAndrews (2007)

The intra-day allocation and pricing of overnight loans of federal funds are (also) explained in term of settlement balances held by dealers in the US RTGS system (Fedwire).

Arciero et alii (2008)

A very stylised “agent based” model featuring the main elements of a real-life RTGS system, including a central bank acting as liquidity provider and a simplified money market. It emerges that money market may play a fundamental role in the evolution of the system after a critical event (*Further extensions of the model coming soon!!*).



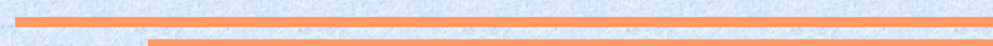
Identifying overnight deals from settlement data (1)

Furfine (1999)

By comparing one day's record of RTGS transactions with the next, o/n deposits may be associated to a pair of payments: one (ending with many zeros) originating transfer of funds between two institutions and a reverse transaction the following business day involving a “slightly larger amount of money”.

This “slightly larger amount of money” should correspond to a reasonable interest applied on the originating transaction

Additional filters are applied: i.e threshold of \$1 million and round lot increments of \$100,000



Identifying overnight deals from settlement data (2)

Demiralp, Preslopsy and Whitesell (2004)

More than one qualifying loan of the same size between two institutions are matched with an exactly equal number of qualifying repayments for the loans of the same size (“N for N transactions class”)

A number M of same-size qualifying loans between two banks is matched with a number N of qualifying repayments on the next day, (“M for N transactions class”).

Another possible class - already mentioned by Furfine - might include o/n deals with separate repayment of principal and interest

Identifying overnight deals from T2-BdI data (1)

Overnight unsecured deposits are exchanged either over-the-counter or on the regulated electronic market e-MID

Data on o/n deals executed via e-MID are routinely reported by the management company to the Banca d'Italia

e-MID offers a settlement facility which provides a fully-automated execution of o/n trades via T2. Contracts settled via this facility may be easily identified as the identities of both dealers and settlement agents are reported to the Banca d'Italia

e-MID participants not relying on the automated settlement facility execute their money market deals by directly submitting their payment to the settlement system. By analyzing these contracts, we may evaluate the accuracy of the identifying strategy

Identifying overnight deals from T2-BdI data (2)

A simple “1 for 1” Furfine-like strategy applied to T2-Banca d’Italia transaction data allows to identify 93 per cent of all e-MID trades not settled via the automated settlement facility

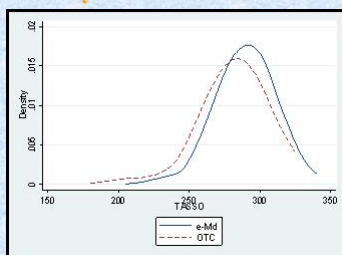
No massive evidence of contract settled on neither “N for N” nor “M for N” basis. Instead a not negligible share of the 7 per cent missing contracts can be associated with rolled-over contracts where the principal is not always repaid

Missing contracts may also stem when two dealers rely on the same settlement bank

“Split principal and interest repayment” identification strategies easily lead to over-identification (e.g. MTS repo rolled-over)

Identifying overnight deals from T2-BdI data (3)

Density estimation



•The distribution of e-MID reported rates substantially overlaps the distribution of OTC deals rates identified from T2 data

•Overnight loans identified by T2 data track well the corresponding volume of EONIA contracts as reported by the panel of Italian banks

Replicating TARGET2 – Banca d’Italia

The current version of BoF-PSS2 is not able to perfectly reproduce the TARGET2 design, due to lack of the proprietary T2 optimisation algorithms

Among the possible T2 clones built for this exercise, the best performing is the one including a combination of FAFO mechanism for resubmission of queued payments, a continuously running bilateral off-setting algorithm and a multilateral off-setting algorithm running at pre-defined intervals

Participants with RTGS accounts at other NCBs and ancillary systems, as well as participants joining a “cross-border” pool of accounts, are assigned unlimited intraday credit due to lack of data on their liquid balances

Simulation scenarios

Two related set of simulation scenarios

Structural reduction

Uniform reduction of all overnight deposits for a percentage ranging from 10 to 90 per cent

Sudden shock

Uniform reduction of originating transaction of overnight deposits for a percentage ranging from 10 to 90 per cent, leaving unchanged the repayments

Complementary scenarios

Two additional alternative simulation scenarios

Opening balances reduction

Uniform reduction of all opening cash balances held by participants at the Banca d'Italia

Daylight credit lines

Uniform reduction of all daylight credit lines granted to the participants by the Banca d'Italia

RTGS performances indicators

Unsettled payment

- Value of unsettled payments
- Value of unsettled payments as % of total submitted interbank payments
- Number of unsettled payments

Queued payment

- Maximum amount of payments held in queue
- Average queue length
- Number of queued payments

Intraday liquidity need

- Lower bound of liquidity
- Relative credit usage

Simulation details

The time a transaction enters the system is postponed to the actual settlement time. Thus, the *Queued Payment Indicators* measure the additional time payments would have remained in the queue, due to different money market conditions

In the *Structural Reduction Scenarios*, unsettled payments are carried over to the next operational day and initial balances equals previous day end-of-day balances (from the 2nd day onward)

The *Structural Reduction* and the *Sudden Shock Scenarios* are not immediately comparable. In the former we must consider the simulation period as a single sample, in the latter each operational day has to be interpreted as a repeated measure of a same size shocks.

Being some participants endowed with unlimited balances, second round effects due to lack of liquidity at their disposal are not considered

Simulation details: actual data

Simulations refers to 21 workings days falling in the compulsory reserve maintenance period 12/11/2008 to 10/12/2008.

The daily average turnover amounted to 170 EUR billions (48,000 transactions per day) of which around 16 related to o/n deals (550 transactions per day)

On daily average the 92 participants were endowed with 22 EUR billions of aggregate opening balances

Calendar day effects in the e-MID have been less significant during the turmoil

During the reference period the overnight deposits held by participants at Banca d'Italia stood at the sizeable level of 4.3 EUR billions

**ALL IN ALL, GIVEN THE EXCEPTIONAL LIQUIDITY MEASURES
TAKEN BY THE EUROSISTEM, RATHER LIMITED IMPACTS OF
MONEY MARKET SHRINKAGES ARE EXPECTED**

Results: Unsettled payment indicators (a)

Percentage reduction in the money market	Structural reduction scenarios			Sudden shock scenarios		
	Value of unsettled payments (EUR millions)	Value of unsettled payments (% of total submitted interbank payments)	Number of unsettled payments (units)	Value of unsettled payments (EUR millions)	Value of unsettled payments (% of total submitted interbank payments)	Number of unsettled payments (units)
Baseline	0	0	0	0	0.00	0
10	5	0.00	0	36	0.04	1
20	29	0.03	2	151	0.15	3
30	124	0.13	4	340	0.34	6
40	234	0.25	8	576	0.59	10
50	357	0.38	13	785	0.81	33
60	527	0.57	15	1161	1.21	21
70	666	0.74	22	1436	1.51	34
80	814	0.91	26	1783	1.89	46
90	965	1.10	32	2069	2.22	85

(average daily values)

Results: Unsettled payment indicators (b)

Percentage reduction	Opening cash balances			Daylight credit lines		
	Value of unsettled payments (EUR millions)	Value of unsettled payments (% of total submitted interbank payments)	Number of unsettled payments (units)	Value of unsettled payments (EUR millions)	Value of unsettled payments (% of total submitted interbank payments)	Number of unsettled payments (units)
Baseline	0	0	0	0	0.00	0
10	388	0.38	1	14	0.00	0.04
20	574	0.57	2	14	0.00	0.04
30	661	0.65	4	14	0.00	0.04
40	930	0.92	6	14	0.00	0.04
50	1,211	1.19	7	14	0.00	0.04
60	1,537	1.51	15	14	0.00	0.04
70	1,867	1.84	27	14	0.00	0.04
80	2,225	2.19	41	14	0.00	0.04
90	2,746	2.71	71	14	0.00	0.04

(average daily values)

Results: Queued payment indicators (a)

Percentage reduction in the money market	Structural reduction scenarios			Sudden shock scenarios		
	Maximum amount of payments in queue (EUR millions)	Average queue length (minutes)	Number of queued payments (units)	Maximum amount of payments in queue (EUR millions)	Average settlement time (minutes)	Number of queued payments (units)
Baseline	0	0	10	10	0	10
10	201	11	45	589	12	127
20	309	32	109	1,764	11	291
30	1,121	39	180	3,838	15	361
40	2,238	48	240	6,401	16	472
50	3,055	46	310	8,521	25	622
60	4,034	43	391	12,579	21	702
70	5,179	41	493	15,444	27	767
80	6,126	39	616	19,738	29	853
90	7,292	46	794	22,940	37	919

(average daily values)

Results: Queued payment indicators (b)

Percentage reduction	Opening cash balances			Daylight credit lines		
	Maximum amount of payments in queue (EUR millions)	Average queue length (minutes)	Number of queued payments (units)	Maximum amount of payments in queue (EUR millions)	Average settlement time (minutes)	Number of queued payments (units)
Baseline	0	0	10	10	0	10
10	9.502	26	21	4,205	10	77
20	10.204	21	74	4,589	8	201
30	11.004	16	160	4,843	8	312
40	15.431	15	262	5,471	9	413
50	18.624	13	420	6,487	10	567
60	21.706	19	730	7,945	9	709
70	24.912	24	1,053	9,035	8	930
80	28.335	27	1,370	9,912	8	1,319
90	34.929	28	1,909	10,694	7	1,984

(average daily values)

Results: intraday liquidity needs indicators

Percentage reduction in the money market	Structural reduction scenarios		Sudden shock scenarios	
	Lower liquidity bound (EUR Millions)	Daylight credit usage (% of total credit)	Lower liquidity bound (EUR Millions)	Daylight credit usage (% of total credit)
Baseline	4,417	13.0	4,417	13.1
10	4,437	13.1	4,525	13.6
20	4,494	13.1	4,680	13.9
30	4,611	13.2	4,852	14.1
40	4,749	13.4	5,150	14.5
50	4,849	13.6	5,165	14.7
60	4,977	13.9	5,368	15.0
70	5,108	14.2	5,574	15.4
80	5,196	14.5	5,789	15.7
90	5,306	14.9	6,008	16.0

(average daily values)

Results

- The Unsettled Payment Indicators show that our (hypothetical) RTGS system would have operated smoothly even for sizeable reductions of overnight deals
- The Queued Payment Indicators highlight significant increase in queued payments and in average queue time for relatively mild scenarios.
- Intraday Liquidity Need Indicators exhibit a (quasi)-linear growing trend as the money market conditions worsen
- All the indicators show that Sudden Shocks would hamper the system functioning more than a Structural Reduction. This presumably comes from the fact that a number of o/n money market deals is rolled-over.
- Sudden shocks to the money market would turn out into lower, but similar in magnitude, effects than those triggered by an analogue reduction of opening cash balances

Conclusion and next steps

- Further money market shrinkages, even of significant size, would have caused a relatively mild effect on RTGS performances.
 - To a certain extent, this result is expected, as the money market should have played a less pivotal role in the period under examination
 - Provided the necessary caveats, these results would indicate that the Eurosystem policy measures were effective to face the most severe phase of the crises
 - Next steps should be devoted to
 1. remove the hypothesis of uniform reduction and build the empirical distribution of a x-per cent shrinkage in the money market through “Montecarlo-like” techniques
 2. extend the period with a view to analysing correlations between the role of the money market and the amount of liquidity injected by central banks
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