Time pattern of payments in the Italian RTGS system: the effect of institutional and financial variables

by Luca Arciero and Claudio Impenna[1]

Abstract

In the recent years the widespread adoption of Real Time Gross Settlement System (RTGS) and the dramatic increase of large value financial flows have emphasised the relevance of liquidity management optimisation carried out by banks' treasury desks. Specifically, banks' decisions on the time pattern of outgoing payments have effects both at a macro level, influencing the sound functioning of RTGSs, and at a micro level, if negative externalities arise for banks in settlement systems. This paper examines the daily and intraday patterns of payments channelled in the Italian RTGS system (BI-REL), in order to explain the extent to which financial and institutional factors affect Italian banks' liquidity management. Results show that banks seem to operate in a risk aversion fashion; liquidity management is largely influenced by the deadlines of the single monetary policy framework and by short term interest rates movements in the euro area money market.

JEL Classification : E52; E58; G21.

1. Introduction

In the recent years European banks' treasurers have operated in a deeply changing institutional and market framework. Large value financial flows, both domestic and cross border, have increased paramountly, and the EMU has started. On one side, these developments have fostered public authorities' intervention, with the shift to real-time-gross-settlement (RTGS) from the previous deferred net settlement (DNS) systems; on the other side, banks treasury desks have been pushed to pursue liquidity management optimisation, by operating on the different segments of money and financial markets according to an integrated approach.

In a DNS system banks communicate each other due payments during the day, but settle only net balances at the end of the day (or at designated times of it). These balances can be determined on a bilateral basis (where each bank pays, or is paid by, another bank), or on a multilateral basis (in which case banks in overall debit pay the net due amount to a settlement manager, generally the central bank, which in turn pays banks in net credit). DNS systems generally require a low amount of liquidity to operate smoothly and efficiently, since only net balances have to be settled. On the other hand, participants to these systems are exposed to significant credit risks, since they implicitly grant each other during the day. systemic risks are high in this set up, since a failure to settle by a single bank could cause problems to other participants.

Such risks have seriously increased in the last decades, following financial markets developments and wholesale exchanges being boosted by widespread financial liberalisation and deregulation. RTGS

[1] Banca d'Italia, Payment System Department. The views expressed herein are those of authors and do not commit the Banca d'Italia. The authors wish to thank E. Barucci, R. Brizi, F. Palmisani and R. Valcamonici for their useful comments. Although the paper is a joint work, sections 3 and 4.1 were prepared by L. Arciero, sections 2 and 4.2 by C. Impenna.

systems for large value payments have therefore been introduced in the majority of industrialised and in a growing number of developing countries. These systems eliminate interbank credit risks by providing immediate settlement finality for single payments. Payments are settled on a one-by-one basis, which involves a simultaneous debit of the paying bank and credit of the receiving one. These reciprocal positions are immediately settled on the accounts each bank holds at the central bank. To operate smoothly, RTGS systems require an adequate amount of intraday liquidity, which is usually made available by central banks. In the EU intraday liquidity is provided by each NCB without interest charges, but against collateral. In the US system, Fedwire, the Federal Reserve Banks supply liquidity on an uncollateralised basis but impose an interest charge.

Hence, RTGS systems prevent systemic risks disruption at the expense of higher liquidity cost, either explicit (fees, like in Fedwire) or implicit (opportunity cost of holding cash and collateral, like in the EU). Liquidity comes therefore to represent the key variable for the smooth and efficient functioning of payment and settlement systems, under both a macro (systemic stability) and a micro (individual financial firm performance) perspective. The attention of central banks, as RTGS systems managers, and banks has therefore turned to pursuing and maintaining conditions of efficiency liquid funds management on a continuous intraday basis.

The degree of smoothness and efficiency of a RTGS system depends crucially on the time pattern of payments inlet. Such an element becomes more important in the European financial landscape, where markets and banks are increasingly integrating and where the settlement system, TARGET, is operationally founded upon the interlinking of the national RTGS systems[2]. In this set up, banks' decisions on the time pattern of outgoing payments are influenced essentially by two kinds of factors, operating both on a daily and an intraday basis:

- technical and 'institutional' deadlines, which in turn influence at large the operation of the pan-European money market (e.g. ECBS monetary policy technical management, required reserves regime, TARGET operational constraints) and of national segments of it (domestic RTGS systems regimes, national Treasury role in creating and absorbing money base);

- price and quantity of funds in the domestic segments of the European money and financial markets.

The goal of the paper is to examine the daily and intraday payments time pattern of Italian banks and its determinants. The analysis is based on high frequency data on flows channelled in the Italian RTGS system (BI-REL). These data are peculiar, since they allow to classify liquidity inflows and outflows in a way broadly according to the nature of the underlying negotiations carried on in the money market: domestic or cross border, over the counter or in official markets, on own account or on customers' behalf.

As mentioned before, data make it possible to consider both daily and intraday patterns. Daily analysis refers to the weekly and monthly horizon. The latter one encompasses not only the calendar month, but also the so called 'maintenance period', i.e. the reference period for the required reserve; in the EMU framework it spans form the 24th of month j up to the 23rd of month j+1. Intraday analysis considers the operating time of a normal day of the EMU money market, from 7 AM to 6.30 PM.

[2] The increasing relevance the intraday liquidity management has been recently stressed, among others, by ECB (2002), which underlines the role of the internal organization of banks for an effective liquidity management.

The paper is organised as follows. Section 2 presents a short literature review, where the most relevant contributions on the time profiles of operation in the RTGS system are assessed. Two broad guide-lines seem to emerge: the optimisation of the treasurers' activity, the close links with monetary policy conduct and money market microstructure. In section 3 available high frequency data are illustrated, and the basic time regularities of the BI-REL/TARGET system are introduced. Finally, empirical results are assessed in section 4, also in view of ongoing developments in the European payment system.

2. Review of the literature

A first set of contributions has been driven, in the 2nd half of the last decade, by the widespread adoption in the western countries of RTGS systems for large value operations. These papers follow generally a micro-founded approach, and assess costs and benefits of alternative settlement systems architecture in view of liquidity management optimisation and of possible negative externalities. In particular, this class of models share some key factors[3]:

- a trade off between immediacy and delay in the outgoing payments. By promptly submitting them, banks face an opportunity cost given by holding reserves on their accounts and/or collateral to obtain intraday liquidity[4], but satisfy customers' needs. On the other hand, by accepting a delay in making payments they minimise liquidity holding costs, at the expense of (explicitly) paying penalties to the customers and (implicitly) losing reputation;
- a significant risk aversion degree of banks, which is reflected by the timing (daily and intraday) of liquidity borrowing in the money market. Specifically, the treasurer faces in normal conditions a double kind of uncertainty: on prices – i.e. the expected pattern of market interest rates in the preferred time horizon - and on quantities – i.e. the available reserve stock at the end of the period, as determined by future inflows and outflows;
- as a consequence of the above points, the occurrence of negative externalities, given by co-ordination failure among banks in payment activity. The latter effect can in turn rise negative systemic disturbances, which span from an uneven liquidity distribution during the day to the system gridlock.

Trying to classify costs and benefits of different settlement systems (net and gross), Schoenmaker (1995) and Kobayakawa (1997) analyse the cost typologies, both private and public, for liquidity management at the single firm level: cost of the unclosed settlement of some obligations, of holding liquidity, of the delay in executing payments.

According to Kobayakawa these categories can be associated to the possible different 'funding sources' of outgoing payments: available reserves, central banks overdrafts, borrowing on the money market. His model predicts that for the single bank the settlement delay is the less advisable solution, the less expensive is the cost of borrowing from the central bank. Costs of the settlement delay outcome are also examined, in a neo-classic analytical set-up, by Kahn – Roberds (2001). In their model liquidity constraints, which are given in a RTGS system by collateralization and explicit fees charged on the overdraft, determine inefficient reserves allocation among banks and, therefore, time mismatching of incoming and outgoing payments.

[3] For an exhaustive survey see De Bandt – Hartmann (2000), par. 3.3.

[4] Or an explicit cost if fees are applied on *overdrafts*.

Angelini (2000) analyses the time distribution of the e-MID negotiations in a model where *risk aversion* is the key aspect in explaining treasurers' behaviour during the day. With respect to the quantitative target for the end of the day, which is represented by the desired level of stock reserves on reserve accounts, each bank faces a twofold kind of uncertainty. By choosing to adjust liquidity stock in the first half of the day the bank succeeds in limiting interest rate uncertainty, but increases the exposure to the risk that in the final part of the day outflows exceed significantly inflows, with the (undesired) consequent need to borrow at the margin on the money market. On the other hand, by delaying the quantitative adjustment at the last hours of the day the bank faces a major risk of adverse movements in interest rates.

The same author (Angelini, 1998) studies the time distribution of liquidity management with reference to the RTGS system operation. Assuming that *settlement delay* cost is less than the *overdraft* one, banks will be pushed to condition the inlet of outgoing payments to incoming flows. If the majority of intermediaries adopt this behaviour a negative externality arises, which could potentially cause a system *gridlock*. In order to avoid ex ante these risks provision of intraday liquidity at cheap conditions has to be granted.

Mc Andrews – Rajan (1999) perform a detailed analysis of the intraday pattern of payments in the US RTGS system, Fedwire. They verify that payments time pattern is overall regular during the day, and ascribe this smoothness to the balanced 'funding' of outflows. More specifically, outgoing payments can be in each single moment of the day be funded by the following sources: reserves stock on the account by the central bank, access to central bank credit lines (be it overdraft or intraday liquidity), incoming payments. The first two sources of liquidity are always costly, either explicitly (fees) or implicitly (opportunity cost of holding collateral or idle funds on the account); only the third source is free of any charge[5].

Moreover, the 'compensation effect' of incoming payments increases in those hours when overall payment activity reaches its peaks. Therefore, banks benefit from the mere existence of these peaks when payments concentrate. This introduces a co-ordination problem in payment activity, whose outcome can be a *delay* associated to a higher degree of synchronisation of inflows and outflows, and hence a greater compensation capacity of the system as a whole. This is precisely what the authors verify for Fedwire: banks tend to delay payments to the afternoon, the peak hours, in order to gain form the compensation effect of more concentrated activity and reduce the exploitation of more expensive liquidity sources. This in turn presents critical implications for banks participating to payment systems – such as CLS or the new CHIPS – distinguished by time critical operations to be settled early in the day. These banks will ceteris paribus have to significantly borrow overdraft funds by the central banks and/or rely on reserve accounts availability.

Time pattern of payments in Fedwire is studied by Furfine (1998; 2000) in a framework which extends the traditional analysis of optimising behaviour of banks' treasurers within the maintenance period. Moving from the hypothesis that reserve level uncertainty is an increasing function of settled payments, his model detects a link between payments pattern and the federal funds rate. In days when activity increases banks will tend to hold a higher storage of reserves, in order to minimise overdrafts. In turn, this will determine a positive relationship between payments and overnight interest rate, both in level and volatility.

After the start of EMU several studies have proposed an 'eclectic' interpretation of the pan-European money market developments, empirically verifying the relation among monetary policy management, money

[5] A formal model of costs faced by banks in order to benefit from central bank credit and a comparison of Japan, US and EU systems are in Furfine – Stehm (1997).

market microstructure and the European TARGET payment system functioning. This body of research takes explicitly into account common European technical and institutional features of the monetary policy operation and of TARGET, national peculiarities and the most relevant money and financial market magnitudes. All these variables, in fact, play a role in determining the daily and intraday anomalies of settlement system and, therefore, in conditioning banks' treasurers behaviour.

Biais et al. and Hartmann et al. (2000; 2001) make an extensive analysis of how the institutional architecture of EMU money market affects its microstructure and, more broadly, the effectiveness and smoothness of the liquidity re-allocation *whithin* the Eurozone. Institutional elements can logically be ascribed to four categories: the *decision making* process about short term interest rates (in the competence of the Governing Council); *implementation* of decisions by the proper use of instruments (especially the main refinancing operations); liquidity re-allocation carried on by the market; the role played by the payment system (TARGET) in the process. The authors show that each of these factors has an effect, which can be separately examined, on time concentration of money market exchanges, on interest rates level and volatility.

On the whole, all the contributions analysing – under a micro perspective – the optimising treasurers behaviour in an average required reserve regime or – under a macro point of view – the *modus operandi* of the EMU monetary policy have found the so called 'calendar' variables highly significant in determining short term rates or liquidity stock patterns within the Eurozone (see e.g. Angelini – Silipo, 2001; Bartolini-Bertola-Prati, 2001; Bindseil, 2000; Blenck, 2000; Mendizàbal - Quiros, 2000). Relevant technical deadlines are the closing day of the maintenance period ('*settlement day*'), days of announcement, execution and settlement of main refinancing operations of ECBS, final calendar month days.

3. Architecture of the Italian payment system and data

BI-REL[6] is the Italian RTGS systems for the settlement of large value payments managed by Banca d'Italia. As Italian component of TARGET (*Trans-Automated-Real-Time-Gross-Settlement-Express-Transfers*), BI-REL allows Italian banks to receive/send payments from/to banks located in the European Union. In order to facilitate the smooth functioning of the system, Banca d'Italia – as well as the other UE NCBs for their respective RTGS - provides free, entirely collateralised overdraft during the normal BI-REL operational day, that goes from 7 AM to 17.30.

The multilateral balances stemming both from the national retail clearing system (BI-COMP) and the cash leg of securities settlement system (Liquidazione dei titoli) are settled in BI-REL, respectively around 12 and 13 P.M. Moreover, in BI-REL are channelled the net balances arising from Euro1, the large value payment system managed by the Euro Banking Association (EBA).

This paper is entirely based on high frequency data collected by the Bank of Italy[7]. Time series of flows channelled through BI-REL are grouped in the domestic and the cross border component. These data are further broken down according to the different typologies. Thus, domestic payments are classified in the following way:

- official, screen based interbank market (e-MID) payments;

[6] For a detailed description of the Italian payment system architecture see Banca d'Italia (1999).

[7] The empirical value of high frequency data under both a theoretical and an empirical perspective is examined, among others, by Lequeux (1997).

- other interbank fund transfers;
- large value direct credit of customers;
- payments to and from the State Treasury.

Cross border flows include an interbank and a customer component. Financial variables used in the empirical investigation are e-MID negotiations, e-MID overnight and tomorrow-next interest rate, EONIA (European Overnight Index Average, calculated on data transmitted by a sample of large European bank) rate, the benchmark 10-years Bond rate, the stock index of Milan and other main European joint stocks.

Estimates include also daily and intraday technical and institutional deadlines, generally known to be relevant for the banks treasurers. The set of 'calendar' variables is reported in tab. 1. It comprises specific BI-REL system dates (settlement of ancillary systems and e-MID previous days contracts run out in the day), monetary policy management (ECB releases, auctions, required reserve), autonomous creation or absorption of money base, the most important of which being the State Treasury.

< Insert table 1 here >

To facilitate the interpretation of results, estimates have been run on the total settled payments (both number and value) and on 3 aggregations: e-MID flows, interbank domestic fund transfers, interbank cross border flows. Years 2000 and 2001 are considered.

4. Results and policy implications

A twofold investigation on BI-REL payments has been carried on. Firstly, in a more descriptive fashion, intraday time distributions of outgoing payments and their 'funding' sources have been examined. Then, regression estimates on both the daily and the intraday basis have shed light on some stylised facts which help explaining money market flows pattern. The effect of technical and institutional money market and payment system factors has been captured by inserting dummy variables $D_{i.}$

4.1. Intraday pattern of settled flows.

Fig. 1 reports average payments per minute (both in number and value) during the working time of the day. After a peak at the opening of BI-REL (7 AM), due to the automatic settlement of some payments put in place on previous days with delayed execution (essentially, large value domestic customer direct credits and interbank foreign currency exchanges), the figure shows a dramatic upswing at 9 AM, the highest value of the day. At this time there is in fact another automatic deadline of the system, as settlement of previous days e-MID negotiations takes place. It brings about a major liquidity distribution, which in turn helps to sustain BI-REL activity during the hours after. Hence, intraday flows pattern is substantially different from that of Fedwire, where settlements concentrate in the final hours of the day. Afterwards, other activity peaks may be seen when the ancillary systems settlement takes place: around 12 AM (multilateral net balances of the clearing system BI-COMP), at 1 PM (net balances of the securities settlement system) and after 4 PM (net balances of the European netting system Euro1, to which 8 primary Italian banks do participate).

< Insert figure 1 here >

In order to assess what kind of policy the banks treasurers in the domestic and cross border segment of the money market, BI-REL has been submitted to the empirical investigation suggested by McAndrews - Rajan (1999). As already mentioned, during the day outgoing payments may be funded in three ways. Two of them are costly for the bank (use of the reserve available stock and intraday borrowing form the central bank), the third one is free of charge and is therefore preferred (set-off from incoming payments)[8].

The empirical investigation has been carried on for 5-minutes intervals. Its results are reported in fig. 2. The incoming offsetting effect is obviously correlated to payment activity level as a whole, and is highest at 9 and 10 AM and 6 PM. The first two upswings take place in high traffic times, while the third is widely determined by treasurers' autonomous decisions: since at this time they have normally already achieved the *desired* stock reserve level for that day, they offset immediately incoming and outgoing payments, in order not to deviate from the quantitative goal. This task is facilitated by the fact that the overall number of payments is rather low, at this time of the day[9].

< Insert figure 2 here >

Intraday liquidity borrowing to cover settled outflows has a peak at 7 AM, due to few large value cross border transfers put in by domestic branches of foreign banks. Then, it keeps slightly above 20 per cent, with other increases at canonical times: 9 AM (automatic e-MID settlements) and 12 AM (settlement of the security settlement system). Finally, it diminishes sharply between 4 and 5 PM, when treasurers come to rely almost exclusively upon the reserve stock.

Descriptive analysis has been enriched by an empirical investigation of the main (financial and technical) determinants of the intraday liquidity management. To this aim a set of hourly dummy variables has been employed to check whether settled flows change significantly in specific times of the day. Since no dummy has been inserted for the interval starting at 1 PM, results tell us whether and to what extent payments in the remaining hours are significantly different from those settled at 1 PM. In addition, other dummies have been inserted in the regressions[10]. They are:

a) 11 AM of Tuesdays, when the ECB announces main refinancing operations results
b) 1 PM of Thursdays, when *Governing Council* decisions concerning interest rates are disclosed
c) morning and afternoon of Wednesdays, when ECB auctions are settled

[8] In this framework an outgoing payment is partially or totally 'financed': by intraday liquidity if its settlement has brought about a decrease in the available credit line on the account held by the central bank; by incoming payments if in a (conventional) 5 minutes interval the bank has received payments from other banks; if outflows are greater than inflows, the difference is to be considered as funded by liquidity stock held on the accounts by the central bank. A formal set up is presented in the Appendix.

[9] If the time interval is widened (e.g. from 5 to 10 minutes) the share of 'cleared' outgoing payments obviously increases.

[10] The 'morning' and 'afternoon' variables for the different technical deadlines refer respectively to the intervals from the start of the day and 11 AM, and from 3 and 6 PM. Dummy variables equal 1 in such intervals and 0 elsewhere. Equations have been estimated by including a dummy for each working day of the week, in order to control for single days' effect in the estimates of the intraday variables (fixed-effect model of the *Least squares dummy variables* kind, Greene 1993). To control for residuals heteroschedasticity problems, which are common in seasonal analysis of this kind, we have been calculated Wald χ^2 kind tests based on White residuals, in addition to the usual Student t-test,. In the equations dealing with intraday flows, R^2 and *p-values* of Student t and Wald χ^2 tests. For the sake of exposition, tables in the Appendix do not present Wald test values. Significance levels are reported with asterisks for each estimated parameter. R^2 values range from a minimum of .22 (in the intra-group interbank transfer equation) to a maximum of .94 (for the interbank flows channelled in the official, screen-based market). Given that the econometric exercise does not aim at forecasting, these values can be judged as satisfactory.

d) morning and afternoon of the closing day of maintenance period ('settlement day')
e) morning and afternoon of the last day for payments to and from the State Treasury ('Treasury day')

< Insert table 2 here >

Tab. 2 reports the set of exogenous variables included in the equations and their effects of BI-REL payments typologies. For each class of payments the following regression has been run:

$$Q_{kth} = a + S_i D i + e_{kth} \qquad (1)$$

where k = number (Q) of payments classes
t = 1,2, …, T number of days
h = 1,2, …, H number of hours
i = 1,2,…, I number of dummies (D_i)

Intraday profile of payments appears to be two hump-shaped, with the two upswings in the middle hours of the morning and towards the end of the day. Parameters for these operational phases are generally positive and significant for e-MID flows (tab. 3). Moreover, they increase remarkably after the Governing Council meetings (on Thursdays at 1 PM) and diminishes in the settlement days, notably in the afternoon. In such a day, in fact, interest rate volatility increases, which pushes treasurers to reduce exchanges[11].

Also, e-MID reacts more than the other money market segments to ECB auctions results and ECBS decisions; however, changes occurring on these occasions vanish in the immediate following hours, which signals a quick adjustment process (tab. 3).

< Insert table 3 here >

Other interbank transfers, be they within banking groups perimeter or not, show an intraday pattern broadly similar to the e-MID flows, while Treasury days are the only technical deadlines which has a significant influence during the day (tab. 4 and 5); in those days banks seem to anticipate at the morning the usual re-allocation of liquid resources within groups and with other counter-parties. ECB auctions do not affect significantly the intraday pattern of intra-group fund transfers, but does have an effect on a daily basis (see section 4.2).

< Insert tables 4 and 5 here >

[11] That money market interest rate volatility increases on *settlement day* is a general result of empirical investigations on both the US Federal funds market and the national segments of the European money market. The Eurozone market is analyzed by Quiros - Mendizabal (2001). They show that volatility increase on end of maintenance period days, though after the start of EMU such effect is less pronounced than in Germany before 1999. This result offer further evidence, *ceteris paribus*, of the stabilizing effect of a more liquid pan-European money market.

Since the cross border segment of the market is an open system the hourly pattern of TARGET activity has to be evaluated separately for inflows (tab. 6), outflows (tab. 7) and their net balance (tab. 8). Joint interpretation of the 3 tables confirms a 'two-hump shaped' pattern, with high activity levels in the morning and between 4 and 5 PM. Since inflows are greater, the balance is positive. They accelerate between 9 and 12 AM (tab. 6), as a consequence of both the ordinary activity and of settlement of e-MID negotiations carried on by foreign banks by remote access; a peak is reached at 4 PM, when balances of the European private netting system Euro1 are settled.

< Insert tables 6, 7 and 8 here >

On the other side, morning outflows appear to be postponed, form 11 AM to 1 PM (tab. 7), in response basically to funds transfers executed by local branches of foreign banks in favour of the respective head quarters abroad. Normally, funds sent cross border by branches derive from their cash positive balances in the securities settlement system.

On Treasury days cross border traffic overall declines, but showing a positive (and partially significant) net balance in the morning (tab. 8).

In short, BI-REL hourly flows pattern presents some regularities:

- it is largely conditioned by technical deadlines and operational conventions in the payment system. The automatic reimbursements at 9 AM of e-MID obligations and the low cost of intraday liquidity (collateral opportunity cost) provide for banks an incentive to inlet BI-REL payments mainly in the first hours of the day[12];

- on relevant technical deadlines payment traffic is normally anticipated to the morning. On settlement days, e.g, e-MID payments diminish significantly in the afternoon. On Treasury days other interbank fund transfers – and the liquidity re-distribution among banks – is greater in the morning. Cross border traffic evolves less clearly, but it declines on average and the morning balance is positive. Finally, ECB main refinancing auctions has an even and smooth intraday effect on banks treasuries, with the (obvious) exception of the cross border balance (Wednesday morning balance is slightly positive);

- on the whole, intraday payment pattern is consistent with the risk averse treasury hypothesis. Banks operate earlier during the day in order to minimise the risk of adverse interest rates variations. Towards the end of the day stocks cab be adjusted, in cases the expected final stock balance deviates from the desired level.

These results have some interesting implications for the next evolution of the BI-REL system. If payments are settled mostly during the morning, smooth and efficient performance of the system is *ceteris paribus* facilitated and negative externalities arising from late payments are reduced[13]. BI-REL

[12] On the contrary, in the US Fedwire RTGS system intraday liquidity is charged an explicit fee which in turn, according to Mc Andrews e Rajan (1999), encourages banks to minimize borrowing and concentrate payment activity in the last hours of the day. This result is also conditioned by the timing of the ancillary systems settlement, such as CHIPS, which takes place at the final hours of the Fedwire day.

[13] ECB (2002) reports a similar evaluation for TARGET, where more than half of cross border payment value and three quarters of cross border payment number are settled within 1 PM.

is therefore 'endogenously' ready to the next start of the multicurrency CLS international payment system, whose balances will be channelled by banks in their respective national RTGS. Since CLS will have to treat time-critical payments in the first hours of the day, Italian banks participating to the new system will benefit from incoming payments from other banks which, as discussed above, is the 'cheap' source of liquidity. On the contrary, the start of CLS is rising some concerns about the US Fedwire system performance. The US banks, in fact, will have to face higher liquidity cost, just due to the time activity profile in Fedwire[14].

4.2. Daily pattern of settled flows

Likewise the analysis of intraday flows, the empirical investigation of daily flows has relied upon a set of dummies for institutional and technical elements. In this sub-section dummies refer to different days of the week, to the last working day of months, quarters and the year, to the settlement and Treasury day.

Moreover, in the daily analysis we can to enrich the set of exogenous variables with money and financial magnitudes: both level and volatility of the overnight interest rate, a proxy for expectations on future short term rates, the differential between the domestic overnight rate and the euro-zone EONIA rate. To improve the quality of the estimates lagged values have been inserted for dependent variables, the single BI-REL payments typologies.

For each class of payments the following equation has been estimated:

$$Q_{kth} = a + \sum_{i=1}^{I} D_i + \sum_{j=1}^{J} f_j + e_{kth} \qquad (2)$$

where k = number (Q) of payments classes
t = number of days
i = number of dummies (D_i), reported in tab. 3
j = number (three) of the interest rate variables, also reported in tab. 3.

Tab 9 (in short) and 10 – 13 (in detail) report estimates results; among explanatory variables, only dummies and significant financial variables have been recorded[15].

< Insert table 9 >

[14] McAndrews – Rajan (1999). To strengthen the BI-REL system and widen the services it makes available to banks, the Bank of Italy is introducing new operational facilities, which are consistent with the intraday endogenous payment pattern in the system. Overall, the new architecture of BI-REL aims at facilitating optimisation of liquidity on the intraday basis.

[15] Equations have been estimated in logarithms by OLS. R^2 provide satisfactory values, ranging from .45 (intragroup funds transfers) and .84 (interbank exchanges in the official market). To assess the validity of estimates several tests have been performed: Jarque-Berà test on residuals, ARCH, Godfrey, Chow, Ramsey's RESET test. Overall, diagnostics give good results. Relevant exceptions are the residuals high heteroschedasticity and non-normality in the interbank transfers equations. In the two equations the coefficient significance has been verified by Wald χ^2 test computed using White residuals.

Results are broadly consistent with the literature on the topic. Settlement and Treasury day deadlines significantly affect liquidity management. These dummies are significantly different from zero and with expected signs in all the equations. In settlement days e-MID negotiations and settlements are rather below the other working days (tab. 10-11). Traffic in the e-MID is vice-versa greater in Treasury days, as liquidity re-distribution is boosted by the need to face disbursements towards the State. On the contrary, ECB auctions seems to exert limited effects to the daily patterns in the e-MID: settled flows are minor on Tuesdays, when auctions are carried on, which is not expected. Moreover, treasurers' decisions are conditioned by interest rates: overnight e-MID exchanges decline as rate volatility increases[16] (tab. 11). Such results confirm that at the micro level liquidity management is normally risk-averse; negative correlation between money market traffic and interest rate volatility shows its peak at the close of the maintenance period[17].

< Insert tables 10 and 11 here >

Intra-group interbank fund transfers are not affected by monthly domestic deadlines[18]. As expected, these transfers increase on days (Wednesdays) where ECB main refinancing auctions are settled (tab. 12). Such a result depends on the practice to centralise liquidity functions by the head bank, which normally participates to auctions for the entire group's needs[19]. Daily liquidity variations originated by the State Treasury derive from several kinds of periodic payments, like interest coupon crediting, firms' fiscal disbursements etc. The positive correlation between these payments and the e-MID tom-next rate, used as *proxy* of the next-day rate expectations[20], could indicate that within banking groups liquidity is managed according to a precautionary attitude.

< Insert table 12 here >

As for movements in the cross border money market, net inflows via TARGET increase in the day just before the settlement day (tab. 13). Treasurers are likely keen to be compliant in somehow in advance with the reserve requirements, so avoiding to borrow from the money market on the last day, when rates volatility is systematically higher. Reserve requirement regime could also explain higher net cross border inflows on Fridays, since reserve stocks in these days enter in the average reserve computed also for Saturdays and Sundays. Inflows increase also in those days when liquidity shortages tend to arise and banks borrow more intraday funds form the central bank.

< Insert table 13 here >

[16] There exist several methods to obtain a measure of daily volatility of interest rates (or stock prices) from intraday data. A standard method calculates the sum of squared intraday rates, as suggested by Andersen – Bollerslev (1998). In this paper the Fourier method is employed. Fourier parameters estimation is carried on by integration, which can be employed for every time span of data. Integrated volatility is given by the sum of squared Fourier coefficients, instead of rates. Such a method returns precise estimates of the daily volatility, which can in turn be treated as an observed variable. This offers relevant econometric advantage in comparison with alternative techniques (like GARCH models) which treat it as a latent variable.

[17] The relative magnitude of coefficients in settlement days seems to confirm the risk-aversion based explanation. The coefficient for the new trades (tab. 4) is indeed greater in absolute values, since the settled operations of the day (tab. 3) are obviously conditioned by the contracts of previous days.

[18] Dummies for Treasury days in intragroup funds transfers and cross border flows equations are not significant, since the liquidity changes caused by overall Treasury transactions with banks happens to be highly significant.

[19] The centralized treasury management activities performed within banking group by head banks has been widely documented by both Alonzo-Arciero-Ferrara (2001) and Impenna-Marcelli (2001).

[20] See Angelini – Silipo, 2001.

The increase (decrease) in the cross border net balance when the State Treasury absorbs (injects) liquidity from (to) banks depends on the crucial task of re-distributing short term liquidity within the Eurozone, performed by TARGET. Finally, Italian banks carry on a continuous arbitrage activity on the (small) interest differentials between the EONIA and the domestic overnight rate[21].

With different magnitudes and directions, end-of-month and/or end-of-quarter effects come out to be significant in all the estimates. Intra-group transfers increase on these dates reflects probably window-dressing adjustments for Supervision compliance purposes, while net positive cross border balances reduce since international business and commercial transactions are customarily settled at the end of calendar months.

Finally, the effects of other price variables on daily payments in BI-REL have been investigated. The set of such variables includes some daily differentials: on one side, the differential between the Italian long term Treasury bills (BTP, *Buoni del Tesoro Poliennali*) interest rate and the benchmark rate on the 10-years Bund; on the other side, the differential between the Milan stock exchange index (MIBTEL) and indexes of the main European stock markets. None of these variables has come out to be significant.

5. Conclusions

The main findings of the paper can be summarised as follows:

- the intraday pattern of money market flows settled in BI-REL follows a 'two hump shaped' profile, with peaks in the middle hours of the morning and at the end of the day. Such a pattern is basically determined by the technical and institutional regularities of the RTGS system. But the morning upsurge – largely due to the automatic settlement of previous days' interbank market exchanges – is significantly more pronounced than the afternoon peak, which is a differential feature in comparison with other European RTGS systems;
- on the daily basis, both the most relevant monthly technical deadlines – some of which are common to the EMU – and some interest rate variables are significant. The first set of variables includes the end-of-maintenance-period day ('*settlement day*') and, more significantly, the day in which monthly fiscal disbursements to the State Treasury take place ('*Treasury day*').
- overall, according to the analysis banks treasurers seem to operate in a risk-aversion fashion. On the intraday pattern, it can be detected from the fact that when monthly technical deadlines occur, banks anticipate early in the morning payments they do normally execute later in the day. On the daily pattern, risk-aversion attitude is confirmed both by the increase in activity as technical deadlines approach and by its elasticity to interest rates variation: payment flows are negatively correlated to short term interest rates volatility;
- given to its 'endogenous' functioning, the Italian system BI-REL is ready to smoothly absorb the next innovations: the launch of the international multicurrency settlement system CLS, where urgent payments will have to be settled early in the morning, and the scheduled developments of the Italian securities settlement system, which will adopt a 'delivery versus payment' (DVP) model with real-time settlement of cash balances.

[21] P. Vergara (2000) gives evidence of such arbitrage activity for a primary European banking group (Rabobank).

References

Alonzo, S., L., Arciero, L., Ferrara, L. (2001), "L'operatività delle banche in BI-REL dall'avvio dell'UEM", *Bancaria*, 10, pp. 71-79

Andersen, T., Bollerslev, T. (1998), "Answering the Skeptics: Yes, Standard Volatility Models do Provide Accurate Forecasts", *International Economic Review*, vol. 39, pp. 885-905.

Angelini, P. (1998), "An analysis of competitive externalities in gross settlement systems", *Journal of Banking and Finance*, vol .22, pp. 1-18.

Angelini, P. (2000), "Are banks risk-averse? A note on the intraday timing of operations in the interbank market", *Journal of Money, Credit, and Banking*, vol. 32(1), pp. 54-73.

Angelini, P., Silipo, L.(2001), *The demand for settlement balances in the euro area*, Banca d'Italia, mimeo.

Banca d'Italia (1999), *White Paper on Payment System Oversight. Objectives, Methods, Areas of Interest*, November.

Bartolini, A., Bertola, L., Prati, G. (2002), "The overnight interbank market; evidence from the G-7 and the Euro zone", forthcoming in *Journal of Money, Credit and Banking*

Bindseil, U., Seitz, F. (2001), *The supply and the demand for eurosystem deposits: the first 18 months*, ECB working paper n. 44

Blenck, D. (2000), "Main features of the monetary policy frameworks of the Bank of Japan, the Federal Reserve System and the Eurosystem", paper given at the ECB conference *"The Operational Framework of the Eurosystem and Financial Markets"*, Frankfurt, 5-6 may.

Darnell, A. C. (1994), *A Dictionary of Econometrics*, Aldershot Elgar, New York

De Bandt, O., Hartmann, P. (2000), *Systemic risk: A survey*, ECB working paper n. 35.

E.C.B. (2002), *2001 Annual Report*, April 2002.

Furfine, C., Stehm, J. (1997*), Analyzing alternative intraday credit policies in Real-Time Gross Settlement Systems*, Federal Reserve Bank of New York, working paper

Greene, W.H. (1993), *Econometric Analysis*, 2nd, Prentice Hall.

Hartmann, P., Manna, M., Manzanares, A. (2001), *The microstructure of the euro money market*, ECB working paper n. 80.

Impenna, C., Marcelli, S. (2001), "La specializzazione delle banche e l'attività dei gruppi bancari nel sistema dei pagamenti", *Bancaria*, n. 10, pp.60-70

Kahn, C.M., Roberds, W. (2001), "Real-time gross settlement and the cost of immediacy", *Journal of Monetary Economics*, vol. 47, 299-319.

Kobayakawa, S. (1997), *The comparative analysis of settlement systems*, Centre for Economic Policy Research Discussion Paper, no. 1667.

Mc Andrews, J., Rajan, S. (1999), *The timing and sources of funding of Fedwire Funds Transfers*, Federal Reserve Bank of New York working paper.

Lequeux, P. (1997), "On the impact of high frequency data in the financial markets", *Derivatives Use, Trading & Regulation*, vol. 2, n. 2.

Quiros, G.B., Mendizabal, H. R. (2001), *The daily market for funds in Europe: has something changed with the EMU*, ECB working paper n. 67.

Schoenmaker, D. (1995), *A comparison of alternative interbank settlement systems*, London School of Economics Financial Market Group Discussion Paper, n. 204.

Vergara, P. (2000), "The performance of the Operational Framework of the Eurosystem since the introduction of the Euro: a market appraisal", paper given at the ECB conference *"The Operational Framework of the Eurosystem and Financial Markets"*, Frankfurt, 5-6 may.

Appendix

Definition of variables: liquidity sources

P_{ijt} = payment sent by bank i to bank j within 5-minute interval t
M_{it} = credit available for bank i at the end of interval t
A_{it} = payments settled by bank i in the interval t funded by intraday liquidity
R_{it} = payments settled by bank i in the interval t funded by cash balances
C_{it} = payments settled by bank i in the interval t offset by incoming payments

$$A_{it} = max\left\{0, \frac{M_{it-1} - M_{it}}{\sum_{j}^{N} P_{ijt}}\right\} \times 100$$

$$C_{it} = \frac{\min\left\{\sum_{j}^{N} P_{ijt} - max\left(0, M_{it-1} - M_{it}\right), \sum_{j}^{N} P_{jit}\right\}}{\sum_{j}^{N} P_{ijt}} \times 100$$

$$R_{it} = \frac{\sum_{j}^{N} P_{ijt} - A_{it} - C_{it}}{\sum_{j}^{N} P_{ijt}} \times 100$$

Tab. 1

Technical and institutional factors affecting BI-REL

Event	**Date**
Announcement of ECB auctions results	Tuesday at 11.15 AM
Settlement of ECB auctions	Normally, Wednesdays morning
Announcement of ECB Governing Council decisions	Thursdays at 1.45 PM
Automatic settlement of e-MID expired contracts	Daily at 9 AM
Settlement of BI-COMP system net balances	Daily approximately at 12 AM
Settlement of the securities settlement system net balances	Daily approximately at 1 PM
Settlement of the European Euro1 system net balances	Daily after 4 PM
End of maintenance day (‘settlement day’)	Each month on the 23rd or, if it is a holiday, the preceding working day
Payments to the State Treasury (‘Treasury day’)	Each month on the 23rd or, if it is a holiday, the subsequent working day

Tab. 2

Effects of technical and institutional factors on intraday pattern in BI-REL

Event	**Date**	**Effect on settled flows**				
		e-MID	**Other interbank trnasfers**	**Intra-group interbank transfers**	**Target Interbank outflows**	**Target interbank inflows**
Announcement of ECB auctions results	Tuesday at 11.15 AM	+	none	none	none	none
Settlement of ECB auctions	Normally, Wednesdays morning	-	none	none	-	+
Announcement of ECB Governing Council decisions	Thursdays at 1.45 PM	+	none	none	+	none
End of maintenance day (settlement day)	Morning of the working day preceding the 23rd, when the 23rd is a holiday	none	none	none	none	none
End of maintenance day (settlement day)	Afternoon of the last working day preceding the 23rd, when the 23rd is a holiday	-	none	none	none	none
End of maintenance day (settlement day) and payments to the State Treasury (Treasury day)	Morning of the 23rd when it is a working day	none	none	+	-	+
End of maintenance day (settlement day) and payments to the State Treasury (Treasury day)	Afternoon of the 23rd when it is a working day	-	none	none	-	none
Payments to the State Treasury (Treasury day)	Morning of the first working day after the 23rd, when it is a holiday	none	+	+	-	none
Payments to the State Treasury (Treasury day)	Afternoon of the first working day after the 23rd, when it is a holiday	none	none	none	none	none

Tab. 3

e-MID settled flows - Hourly data

Variables		Coeff.	Std. err.	P-value
Constant		-2030,4	374,2	0,0001**
Hour dummies	8	49,0	79,3	0,5369
	9	17187,0	79,3	0,0001**
	10	1840,0	86,6	0,0001**
	11	801,5	86,6	0,0001**
	12	556,0	96,9	0,0001**
	14	542,4	85,9	0,0001**
	15	1028,0	85,9	0,0001**
	16	938,5	83,5	0,0001**
	17	241,1	83,6	0,004**
Hour dummies for Tuesday	10	-201,3	167,6	0,2298
	11	340,6	167,6	0,0422
	12	91,1	173,3	0,5991
Dummies for Tuesday	Morning	-150,6	105,2	0,1524*
	Afternoon	-48,2	136,9	0,7248
Hour dummies for Wednesday	12	38,8	174,9	0,8246
	13	290,9	156,7	0,0635**
	14	87,6	168,9	0,6041
	15	25,7	168,9	0,8791
Settlement day	Morning	-8,5	368,3	0,9816
	Afternoon	-356,2	475,8	0,4541**
Settlement day e Treasury day	Morning	149,1	238,7	0,5322
	Afternoon	-227,6	309,1	0,4614**
Treasury day	Morning	207,3	411,0	0,6141
	Afternoon	51,7	531,0	0,9224

R^2 = .94. One or two asterisk denote significance at the 5 or 1 percent respectively for the Wald χ^2 test computed using White robust heteroskedasticity formula.

Tab. 4

Interbank fund transfers -Hourly data

Variables		Coeff.	Std. err.	P-value
Constant		-244,2	175,5	0,1643
Hour dummies	7	-340,6	46,3	0,0001**
	8	44,2	46,3	0,3395
	9	575,3	46,3	0,0001**
	10	394,2	49,4	0,0001**
	11	109,7	48,1	0,0226
	12	181,4	50,4	0,0003**
	14	202,7	46,2	0,0001**
	15	282,2	46,6	0,0001**
	16	299,8	46,8	0,0001**
	17	704,7	46,8	0,0001**
Hour dummies for Tuesday	10	-13,9	78,3	0,8589
	11	-9,2	78,0	0,9061
	12	-4,9	81,0	0,9517
Dummies for Tuesday	Morning	40,5	50,6	0,4234
	Afternoon	14,8	59,3	0,8033
Hour dummies for Wednesday	12	-67,2	81,8	0,4115
	13	10,9	79,0	0,8905
	14	9,8	79,0	0,9007
	15	-81,8	78,6	0,298
Settlement day	Morning	256,8	174,0	0,14
	Afternoon	331,9	215,6	0,1237
Settlement day e Treasury day	Morning	153,8	113,5	0,1753
	Afternoon	-37,6	137,4	0,7842
Treasury day	Morning	439,8	197,0	0,0256**
	Afternoon	192,7	231,2	0,4047

R^2= .31. One or two asterisk denote significance at the 5 or 1 percent respectively for the Wald χ^2 test computed using White robust heteroskedasticity formula.

Tab. 5

Intragroup fund transfers -Hourly data

Variables		Coeff.	Std. err.	P-value
Constant		274,7	96,5	0,0045**
Hour dummies	7	-108,7	25,5	0,0001**
	8	98,2	25,5	0,0001**
	9	103,8	25,5	0,0001**
	10	11,9	27,2	0,6602
	11	14,4	26,4	0,5867
	12	0,9	27,7	0,9729
	14	107,8	25,4	0,0001**
	15	174,7	25,6	0,0001**
	16	194,2	25,7	0,0001**
	17	-5,1	25,8	0,8433
Hour dummies for Tuesday	10	-22,0	43,1	0,61
	11	-36,4	42,9	0,3964
	12	-15,3	44,5	0,7314
Dummies for Tuesday	Morning	-18,2	27,8	0,514
	Afternoon	-56,5	32,6	0,0835*
Hour dummies for Wednesday	12	8,2	45,0	0,8556
	13	17,7	43,4	0,6833
	14	7,9	43,4	0,8558
	15	23,6	43,2	0,5852
Settlement day	Morning	62,8	95,6	0,5113
	Afternoon	76,3	118,5	0,5199
Settlement day e Treasury day	Morning	121,7	62,4	0,0512**
	Afternoon	-45,3	75,5	0,5482
Treasury day	Morning	118,6	108,3	0,2734**
	Afternoon	80,1	127,1	0,5289

R^2= .22. One or two asterisk denote significance at the 10 or 5 percent respectively for the Wald χ^2 test computed using White robust heteroskedasticity formula.

Tab. 6

TARGET interbank inflows -Hourly data

Variables		Coeff.	Std. err.	P-value
Constant		1525,5	412,4	0,0002**
Hour dummies	7	-698,7	108,8	0,0001**
	8	-938,5	108,8	0,0001**
	9	975,5	108,8	0,0001**
	10	2185,9	116,1	0,0001**
	11	3427,1	113,0	0,0001**
	12	978,0	118,5	0,0001**
	14	-139,0	108,6	0,2007
	15	858,0	109,5	0,0001**
	16	2827,3	109,9	0,0001**
	17	565,9	110,0	0,0001**
Hour dummies for Tuesday	10	-184,4	184,0	0,3163
	11	-104,5	183,3	0,5687
	12	-483,8	190,3	0,011**
Dummies for Tuesday	Morning	177,1	118,9	0,1364
	Afternoon	55,5	139,4	0,6907
Hour dummies for Wednesday	12	-263,5	192,1	0,1704
	13	2,2	185,5	0,9907
	14	50,8	185,5	0,7842
	15	44,4	184,6	0,8098
Settlement day	Morning	-142,5	408,7	0,7274
	Afternoon	116,7	506,5	0,8178
Settlement day e Treasury day	Morning	357,0	266,6	0,1806
	Afternoon	19,5	322,7	0,9518
Treasury day	Morning	-1144,5	462,8	0,0134*
	Afternoon	-1655,0	543,1	0,0023**

R^2= .57. One or two asterisk denote significance at the 10 or 5 percent respectively for the Wald χ^2 test computed using White robust heteroskedasticity formula.

Tab. 7

TARGET interbank outflows -Hourly data

Variables		Coeff.	Std. err.	P-value
Constant		3712,5	503,2	0,0001**
Hour dummies	7	-3553,9	132,8	0,0001**
	8	-3366,4	132,8	0,0001**
	9	-1384,2	132,8	0,0001**
	10	-20,7	141,6	0,8836
	11	965,8	137,8	0,0001**
	12	-203,0	144,5	0,1602
	14	-691,5	132,5	0,0001**
	15	-498,5	133,6	0,0002**
	16	279,0	134,1	0,0375*
	17	-3781,3	134,3	0,0001**
Hour dummies for Tuesday	10	151,1	224,5	0,501
	11	105,4	223,6	0,6373
	12	-134,1	232,1	0,5636
Dummies for Tuesday	Morning	-408,0	145,0	0,0049**
	Afternoon	225,8	170,1	0,1844
Hour dummies for Wednesday	12	-199,7	234,4	0,3943
	13	445,5	226,3	0,0491**
	14	77,0	226,3	0,7339
	15	89,9	225,2	0,6899
Settlement day	Morning	-456,9	498,6	0,3595
	Afternoon	-146,4	617,9	0,8127
Settlement day e Treasury day	Morning	-1077,7	325,2	0,0009**
	Afternoon	-791,1	393,7	0,0446**
Treasury day	Morning	-1567,5	564,5	0,0055**
	Afternoon	-1158,4	662,6	0,0805*

R^2= .56. One or two asterisk denote significance at the 10 or 5 percent respectively for the Wald χ^2 test computed using White robust heteroskedasticity formula.

Tab. 8

TARGET interbank net balances -Hourly data

Variables		Coeff.	Std. err.	P-value
Constant		-2187,1	568,1	0,0001**
Hour dummies	7	2855,2	149,9	0,0001**
	8	2427,9	149,9	0,0001**
	9	2359,7	149,9	0,0001**
	10	2206,7	159,9	0,0001**
	11	2461,3	155,6	0,0001**
	12	1181,0	163,2	0,0001**
	14	552,5	149,6	0,0002**
	15	1356,5	150,8	0,0001**
	16	2548,4	151,3	0,0001**
	17	4347,1	151,6	0,0001**
Hour dummies for Tuesday	10	-335,5	253,4	0,1857
	11	-209,9	252,4	0,4058
	12	-349,8	262,1	0,1821*
Dummies for Tuesday	Morning	585,2	163,8	0,0004**
	Afternoon	-170,3	192,0	0,3752
Hour dummies for Wednesday	12	-63,8	264,6	0,8095
	13	-443,3	255,5	0,0829*
	14	-26,1	255,5	0,9185
	15	-45,4	254,3	0,8582
Settlement day	Morning	314,4	563,0	0,5765
	Afternoon	263,1	697,6	0,7061
Settlement day e Treasury day	Morning	1434,8	367,3	0,0001**
	Afternoon	810,6	444,5	0,0683
Treasury day	Morning	423,0	637,4	0,5069
	Afternoon	-496,6	748,1	0,5068

R^2= .56. One or two asterisk denote significance at the 10 or 5 percent respectively for the Wald χ^2 test computed using White robust heteroskedasticity formula.

Tab. 9

Effects of technical and institutional factors on daily pattern in BI-REL

Variables	e-MID	Other interbank transfers	Target Interbank outflows	Target interbank inflows
Financial variables				
E-mid overnight rate volatility	none	-	none	none
E- mid tom next rate	none	none	+	none
E-MID-EONIA spread	none	none	none	-
Liquidity creation and absorption				
Treasury	none	none	+	+
Securities settlement syst.	none	none	(*)	+
Day of the week effect				
Monday	none	none	none	none
Tuesday	-	none	-	-
Thursday	none	none	none	none
Friday	none	-	none	none
Settlement of ECB auctions	none	none	+	none
Intramonth effects				
End of the month	+	+	+	-
End of the quarterly	none	none	+	none
End of the year	none	none	-	-
Settlement day				
T –1	none	none	none	+
T	-	-	none	none
Settlement day and Treasury day				
T –1	none	none	-	none
T	none	none	none	+
T+1	none	+	none	none
Treasury day				
T	+	+	none	none
T +1	-	none	none	none

Tab. 10

e-MID settled flows - Daily data

Variables	Coeff.	T value	P- value	Wald χ^2	P-value
Constant	2,164	3,539	0,000	6,880	0,009
e-MID $_{(t-1)}$	0,952	21,993	0,000	224,885	0,000
e-MID $_{(t-2)}$	-0,153	-3,365	0,001	10,268	0,001
e-MID $_{(t-5)}$	0,121	4,390	0,000	23,091	0,000
Interbank fund transfers	0,024	2,481	0,013	2,835	0,092
Interbank fund transfers $_{(t-1)}$	-0,033	-3,616	0,000	5,075	0,003
Dummies for:					
Monday	0,005	0,491	0,624	0,246	0,620
Tuesday	-0,067	-6,420	0,000	41,521	0,000
Thursday	-0,002	-0,216	0,829	0,051	0,821
Friday	-0,007	-0,643	0,520	0,451	0,502
End-of-the-month	0,049	3,006	0,003	9,165	0,003
End-of-the-quarterly	0,004	0,124	0,901	0,031	0,861
End-of-the-year	0,008	0,112	0,911	0,207	0,649
Settlement day $_{(t-1)}$	-0,014	-0,511	0,610	0,221	0,638
Settlement day	-0,062	-2,157	0,032	15,347	0,000
Settlement day and Treasury day $_{(t-1)}$	-0,007	-0,426	0,671	0,315	0,575
Settlement day and Treasury day	-0,002	-0,136	0,892	0,037	0,848
Settlement day and Treasury day $_{(t+1)}$	-0,014	-0,787	0,432	0,736	0,391
Treasury day	0,111	3,579	0,000	36,721	0,000
Treasury day $_{(t+1)}$	-0,023	-0,884	0,377	0,651	0,018
Bank holidays $_{(t-1)}$	0,090	1,275	0,203	17,628	0,000
Bank holidays	-0,173	-4,605	0,000	5,617	0,018
Bank holidays $_{(t+1)}$	0,141	3,683	0,000	7,185	0,007

Diagnostic tests	**Value**	**P-value**
R^2	0,837	-
Jarque-Bera	187,569	0,000
ARCH(12)	48,283	0,000
Godfrey LM(12)	12,965	0,372
Chow: stability test (50)	0,769	0,771
Chow: stability test (100)	1,176	0,262
Chow: stability test (150)	1,528	0,057
Chow: stability test (200)	0,910	0,586
Chow: stability test (250)	1,184	0,254
Chow: stability test (300)	1,355	0,127
Predictive Chow (350)	1,013	0,458
RESET (2)	1,449	0,229
RESET (3)	0,751	0,473
RESET (4)	0,977	0,403

Tab. 11

e-MID overnight exchanges – Daily data

Variables	Coeff.	T value	P-value
Constant	4,809	8,931	0,000
E-mid overnight exchanges $_{(t-1)}$	0,486	8,470	0,000
Emid overnight rate volatility	-0,255	-4,297	0,000
Dummies for:			
Monday	0,020	0,786	0,433
Tuesday	0,015	0,591	0,555
Thursday	0,025	1,000	0,319
Friday	0,051	1,997	0,047
End-of-the-month	-0,030	-0,734	0,464
End-of-the-quarterly	-0,010	-0,115	0,909
End-of-the-year	0,114	0,793	0,429
Settlement day $_{(t-1)}$	-0,079	-1,071	0,285
Settlement day	-0,171	-2,288	0,023
Settlement day and Treasury day $_{(t-1)}$	-0,023	-0,532	0,595
Settlement day and Treasury day	0,010	0,188	0,851
Settlement day and Treasury day $_{(t+1)}$	0,112	2,450	0,015
Treasury day	0,284	3,115	0,002
Treasury day $_{(t+1)}$	-0,119	-1,321	0,188
Bank holidays $_{(t-1)}$	-0,160	-1,204	0,230
Bank holidays	-0,386	-5,120	0,000
Bank holidays $_{(t+1)}$	0,207	2,624	0,009

Diagnostic tests	**Value**	**P-value**
R^2	0,470	-
Jarque-Bera	1,299	0,522
ARCH(12)	10,043	0,612
Godfrey LM(12)	10,738	0,552
Chow: stability test (50)	0,809	0,702
Chow: stability test (100)	0,603	0,909
Chow: stability test (150)	0,807	0,703
Predictive Chow (164)	1,295	0,084
RESET (2)	0,002	0,969
RESET (3)	0,014	0,986
RESET (4)	0,471	0,703

Tab. 12

Intragroup fund transfers – Daily data

Variables	Coeff.	T value	P- value	Wald χ^2	P-value
Constant	5,550	1,305	0,192	1,553	0,213
Intragroup fund transfers $_{(t-1)}$	0,175	4,073	0,000	13,952	0,00
e-MID tom-next rate	0,498	3,530	0,000	12,784	0,000
e-MID settled flows	0,495	2,812	0,005	6,901	0,009
Liquidity creation absorption	0,185	2,546	0,011	10,291	0,001
Dummies for:					
Settlement of ESBC auctions	0,156	2,232	0,002	5,957	0,015
Monday	0,130	1,588	0,211	3,462	0,063
Tuesday	0,010	0,120	0,113	0,017	0,896
Thursday	0,050	0,715	0,475	0,634	0,426
Friday	0,137	1,611	0,108	3,038	0,081
Banking consolidation	-0,173	-2,983	0,003	13,114	0,000
End-of-the-month	0,284	3,092	0,002	13,316	0,000
End-of-the-quarterly	0,304	1,631	0,104	7,679	0,006
End-of-the-year	-0,535	-1,251	0,212	13,316	0,000
Settlement day $_{(t-1)}$	0,166	1,083	0,280	0,951	0,329
Settlement day	-0,198	-1,193	0,234	1,338	0,247
Settlement day and Treasury day $_{(t-1)}$	-0,194	-1,944	0,052	6,271	0,012
Settlement day and Treasury day	-0,059	-0,384	0,701	0,187	0,666
Settlement day and Treasury day $_{(t+1)}$	0,090	0,922	0,357	0,690	0,406
Treasury day	-0,212	-1,066	0,287	2,210	0,137
Treasury day $_{(t+1)}$	-0,142	-0,938	0,345	1,001	0,317
Bank holidays $_{(t-1)}$	0,017	0,082	0,935	0,020	0,887
Bank holidays	-1,127	-7,738	0,000	0,144	0,000
Bank holidays $_{(t+1)}$	0,576	3,802	0,000	11,147	0,001

Diagnostic tests	**Value**	**P-value**
R^2	0,452	-
Jarque-Bera	11,125	0,003
ARCH(12)	25,209	0,051
Godfrey LM (12)	21,049	0,050
Chow: stability test (50)	1,196	0,210
Chow: stability test (100)	1,210	0,196
Chow: stability test (150)	1,244	0,164
Chow: stability test (200)	1,104	0,318
Chow: stability test (250)	1,083	0,346
Chow: stability test (300)	1,092	0,334
Predictive Chow (350)	0,582	0,999
RESET (2)	1,539	0,215
RESET (3)	1,053	0,350

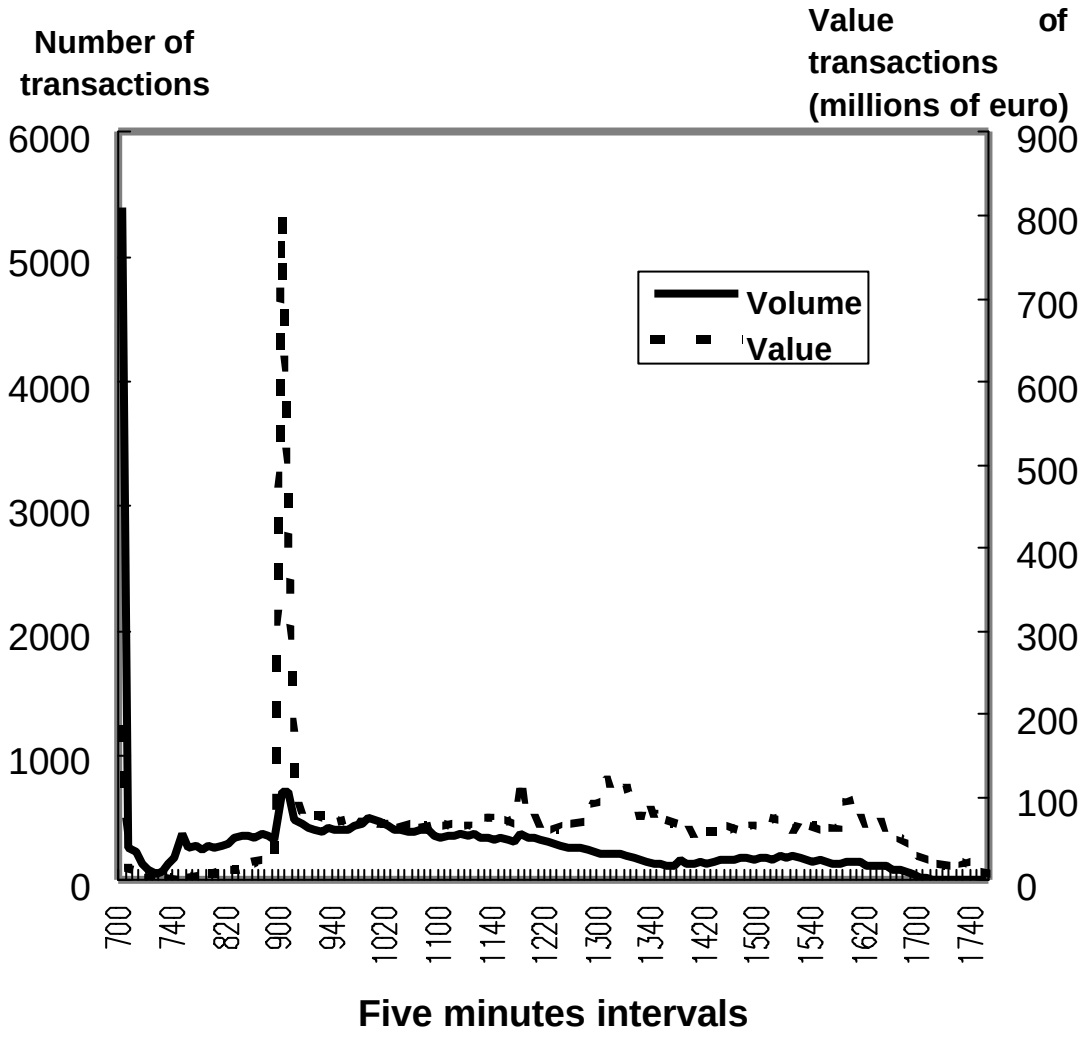
Tab. 13

Target interbank net balances - Daily data

Variables	Coeff.	T value	P- value
Constant	-0,289	-4,014	0,000
Target interbank net balances $_{(t-1)}$	-0,089	-2,232	0,026
Target interbank net balances $_{(t-6)}$	-0,127	-3,776	0,000
EONIA -e-MID differential	-1,903	-3,133	0,002
Securities Settlement System liquidity creation/absorption	0,104	3,356	0,001
Treasury liquidity creation/absorption	0,027	5,461	0,000
Target customer net balances plus Euro1 net balances	-0,026	-4,707	0,000
Intraday liquidity maximum usage	0,078	3,936	0,000
Dummies for:			
Italian Treasury Bond Auctions	0,053	5,034	0,000
Monday	-0,017	-1,512	0,131
Tuesday	0,017	1,463	0,144
Thursday	0,000	0,008	0,994
Friday	0,020	1,688	0,092
End-of-the-month	-0,102	-4,879	0,000
End-of-the-quarterly	-0,057	-1,560	0,120
End-of-the-year	-0,241	-2,935	0,004
Settlement day $_{(t-1)}$	0,063	2,033	0,043
Settlement day	0,032	0,966	0,335
Settlement day and Treasury day $_{(t-1)}$	0,005	0,247	0,805
Settlement day and Treasury day	0,064	1,723	0,086
Settlement day and Treasury day $_{(t+1)}$	-0,022	-0,936	0,350
Treasury day	0,050	1,169	0,243
Treasury day $_{(t+1)}$	-0,015	-0,476	0,634
Bank holidays $_{(t-1)}$	0,083	1,856	0,064
Bank holidays	0,007	0,176	0,860

Diagnostic tests	**Value**	**P-value**
R^2	0,546	-
Jarque-Bera	1,110	0,574
ARCH(12)	8,688	0,729
Godfrey LM (12)	16,438	0,172
Chow: stability test (50)	0,465	0,988
Chow: stability test (100)	1,140	0,293
Chow: stability test (150)	1,648	0,027
Chow: stability test (200)	1,367	0,114
Chow: stability test (250)	1,277	0,170
Chow: stability test (300)	0,879	0,635
Predictive Chow (350)	1,219	0,206
RESET (2)	3,466	0,063
RESET (3)	3,822	0,023
RESET (4)	2,669	0,047

Average daily payments settled via BI-REL (sample 2000 - 2001)



Shares of outgoing payments by liquidity sources (sample 2000-2001)