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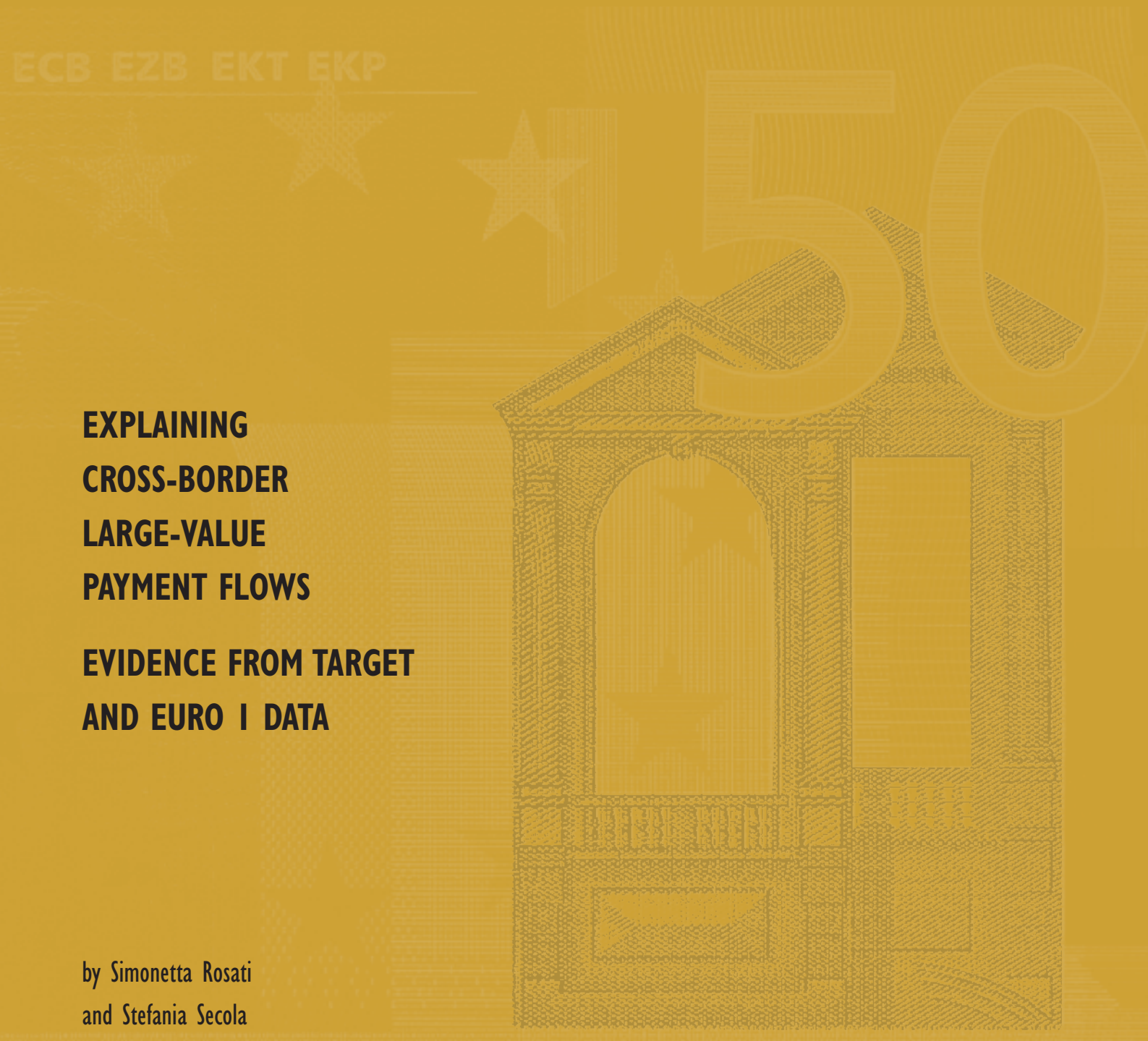


# EXPLAINING CROSS-BORDER LARGE-VALUE PAYMENT FLOWS

## EVIDENCE FROM TARGET AND EURO 1 DATA

by Simonetta Rosati
and Stefania Secola

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by Simonetta Rosati [2]
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In 2005 all ECB publications will feature a motif taken from the €50 banknote.

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# CONTENTS


Abstract 4

Non-technical summary 5

Introduction 7

1 The euro large value cross-border payment systems: TARGET and EURO 1 8

2 The geography of TARGET cross-border interbank payments 10

2.1 TARGET cross-border payments are geographically concentrated 15

2.2 Tiered market and payment systems operational risk 15

3 A gravity model for TARGET cross-border interbank payments 16

4 The determinants of TARGET cross-border payment flows: a time series analysis 19

4.1 The data 19

4.2 Background 20

4.3 The empirical model (daily frequency) 22

4.4 Re-estimating the model at monthly frequency 30

5 The determinants of payments settled in EURO 1 32

6 Conclusions 34

References 36

Annex 38

European Central Bank working paper series 40

## Abstract

We analyse the distribution of the TARGET cross-border interbank payment flows, from both a cross-section and time series point of view, using average daily data for the period 1999-2002. We find out that first, "location matters", in the sense that bilateral payment flows seem to reflect an organisation of interbank trading between countries whereby the size of the banking sectors, geographical proximity and cultural similarities play a significant role. This result is confirmed also by a model developed drawing on the gravity models literature. Second, we find that the payment traffic in TARGET is strongly affected by market technical deadlines. In addition, such traffic is positively related mainly to the liquidity conditions and to the turnover of the euro area money market, (particularly the unsecured overnight segment). Our model also provides a good explanation of the determinants of the interbank payments settled in the EURO 1 system.



**Keywords:** payment systems, TARGET, EURO 1, location, euro area interbank market.

**JEL classification:** E58, G20, G21

## Non-technical summary

The euro area financial markets are served by two main large value payment systems, TARGET and EURO 1. TARGET is owned and operated by the central banks of the Eurosystem, and from the beginning of its operations at the start of 1999, it emerged as the major euro payment system, settling on a yearly basis payments for more than 10 times the total GDP of the EU (12) countries. EURO 1 is owned by the European Banking Association, a private banking association providing settlement services to its participants on a net basis.

We start from the basic idea that payment flows mirror the trading activities carried on the serviced markets, and therefore payments data in general (and cross-border payments flows in particular) may provide useful indications about the organization and functioning of the underlying, financial markets. We explore two dimensions of analysis.

First, we look at the geography of cross-border payments flows, focusing on the distribution (and concentration) of payments flows originated in the various countries connected to TARGET (which include, unique in its genre, also three countries that have not adopted the euro as national currency: the United Kingdom, Sweden and Denmark). This analysis is aimed at gaining insight about the role played by the various European financial centers in redistributing liquidity in euro. For instance, the existence of significant and stable patterns for sending and receiving funds from one country to another could reflect a dependence of one country/banking system on another for its liquidity provision. If the extent to which the various banking communities engage in cross-border activity is taken as a sign of integration of the financial markets served by TARGET, it can be concluded that liquidity in euro circulates within three different circuits:

- A first level where major flows circulate among the major countries (a "core integrated market" composed by Germany, France and the United Kingdom);
- A second level, linking the middle and small countries to the major countries (with the major countries distributing liquidity to the middle and smaller countries);
- A third, "local level" where liquidity is transferred by the countries with (often) neighboring "preferred" partners (e.g. a "Scandinavian circuit", and an "Iberian circuit").

We formalize these observations by means of an econometric exercise which draws on the gravity models literature. These models, which have been extensively used to study the relations between (real economies) trading partners, have also been applied to the analysis of financial markets, with good results. We find confirmation about the role of size, physical proximity and cultural similarities (mainly sharing a common language) in determining the preferred partners. This results strikes a bit with the assumption that "location should not matter" in a highly integrated market like that of the euro area, which is, moreover, served by a cash transfer infrastructure enabling each bank to send payments to any other bank connected to the system and thus exploit any possible arbitrage opportunity irrespective of where it arises. However, one explanation could be that the banks organize

their business relations based on considerations that go beyond the plain and simple availability of the settlement infrastructure. Therefore, even if in principle they could trade with anyone irrespective of location, they do tend to have "preferred partners" located in the biggest financial centers, or in neighboring countries.

Our second line of investigation was trying to understand the determinants of payments over time. In principle, the need to settle large value payments may originate on various segments of the euro financial markets (interbank money market transactions, but also settling the euro leg of forex transactions, and the cash leg of securities transactions conducted in the bond and stock markets). Moreover, payments activities can be affected by the overall liquidity conditions in the market and by some technical conditions (like banking holidays in the major financial centers and the unavailability of some TARGET components due to technical incidents in the payment systems). We find that TARGET cross-border payments are explained mainly by the trading activities conducted in the money market (especially in the unsecured overnight segment). They are also affected significantly by the liquidity conditions of the market (including the calendar of the monetary policy operations carried out by the Eurosystem), and by some banking holidays. Additionally, we find that the system has proved to be very sound, and did not suffer significantly because of the few technical incidents in some of its major components.

Finally, observing a strong correlation between TARGET turnover and the values settled by EURO 1, we test our model also on EURO 1 values, finding interesting similarities between the payment traffic in the two systems.

## Introduction

TARGET, the Trans-European Automated Real-time Gross settlement Express Transfer system, is the euro interbank fund transfer system set up by the Eurosystem with the objective of facilitating the implementation of the single monetary policy and providing a sound and efficient mechanism for settling same-day payments throughout the EU, thus contributing to the integration and stability of the euro area money market (Giannini and Monticelli, 1997, and Hartmann, Manna and Manzanares, 2001). In addition to the settlement of money market operations, large-value interbank payments might represent the counterpart of different types of financial transactions (i.e. the purchase of securities or foreign currencies). They may also be related to transfers of liquidity between banks belonging to international groups. TARGET is used to settle payments between participants located in the same country (domestic) or in two different countries of the EU (cross-border). In this paper we concentrate our analysis on the cross-border flows of TARGET, in the belief that they could provide useful information in understanding the organisation and functioning of the euro area interbank market.

The analysis in this paper focuses on two main dimensions of the functioning of the TARGET system. First, we look at how payment flows are distributed geographically, to identify possible structural bilateral payment flows linking the various countries connected to TARGET, which may have implications from the perspective of payment systems functioning as well as of organisation of the euro area interbank market. Second, we carry out a time-series analysis of the payment traffic to identify their economic determinants and other technical conditions affecting cross-border payments (i.e. business holidays, end of the reserve maintenance period, disturbances in the functioning of TARGET, and so on).

Our main results are that first, *location matters*, in the sense that bilateral interbank payment flows seem to reflect an organisation of interbank trading between countries whereby the size of the banking sectors, geographical proximity and cultural similarities play a significant role. This result is confirmed also by means of a model developed drawing on the gravity models literature. Second, we find that the cross-border payment traffic in TARGET is strongly affected by *market technical conditions (e g. end of the month, business holidays)*. In addition, such traffic is positively related mainly to the *turnover of the euro area money market*. The paper is organised as follows. Section 1 provides a short description of the institutional aspects of the euro area large value payment systems, TARGET and EURO 1. Section 2 focuses on the geography of TARGET cross-border payment flows. Section 3 describes our gravity model and its results and implications. Section 4 elaborates on the determinants of total TARGET cross-border flows, and Section 5 describes the results of applying our time series model to EURO 1 data. Section 6 concludes.

# 1 The euro large value cross-border payment systems: TARGET and EURO 1

Interbank funds transfer systems enable the actual transfer of funds among their participants with different degrees of finality. Real-time gross settlement (RTGS) systems ensure finality to take place for each single transaction in real time, while in netting systems funds are transferred with finality only at a certain point in time - typically in the afternoon or at the end of the business day. Cross-border large value payments in euro are mainly settled in two systems, TARGET, which is owned by the Eurosystem, and EURO 1, the netting[1] system owned by the European Banking Association, a Paris-based private banking organisation.

As noted by Giannini and Monticelli (1997), TARGET provides the interbank market with the infrastructure needed to distribute funds in euro in real time. Such re-distribution of liquidity takes place typically through the interbank market. TARGET performs its function by connecting around 3,500 credit institutions (more than 40,000 between branches and subsidiaries are reachable all in all) in the European Union.[2] TARGET is a real-time gross settlement system, and processes only credit transfers denominated in euro. Unconditional payment orders are automatically processed one at a time on a continuous basis, provided that there are sufficient funds or overdraft facilities available on the sending institution's account with its national central bank (NCB). TARGET provides for the immediate and final settlement of all payments. In its current form, TARGET is a decentralised payment system consisting of 15 national RTGS systems and the ECB payment mechanism (EPM), which are connected to each other through the interlinking mechanism. This consists of inter-NCB accounts for recording mutual claims and liabilities between NCBs stemming from payment transfers and a telecommunications network for the real-time transmission of data (ECB, 2001a).

Around 70 clearing banks participate in the EURO 1 system. Payments channelled to such net system through its participants are cleared in the afternoon and the resulting net obligations and claims are settled at around 4.30 pm through TARGET transfers (the ECB acts as settlement agent for EURO 1, through its connection to TARGET via the EPM). A system of exposure limits among the clearing banks (together with other risk management measures) ensure appropriate management of the intraday credit risk exposures among participants that are implicit in the use of netting schemes.

As noted by Hartmann et al. (2001), while both TARGET and EURO 1 provide settlement facilities for large value payments in euro, they are not necessarily in direct competition, as market participants tend to use TARGET (i.e. RTGS systems) for larger transactions, and the net system EURO 1 for smaller cross-border transactions. In terms of value handled, in 2001 TARGET settled almost 129,000

[1] Legally speaking, Euro1 is not a netting system as it is based on the Single Obligation Structure concept; economically speaking it can be qualified as a netting system.

[2] Also the EU countries not adopting the single currency are granted access to TARGET under a special agreement covering, inter alia, limitations to the use of intra-day credit in TARGET, and the impossibility for the participants in those systems to have access to overnight credit and/or standing facilities in euro. In 1999, these countries were four: Denmark, Greece, Sweden and the United Kingdom. As from 1 January 2001, Greece joined the euro area.

billion EUR in cross border transactions, while EURO 1 cleared transactions totalling more than 52,000 EUR billion, thus representing 40% of TARGET cross border flows. As shown in Chart 1 for a three-month sample period of 2001, the time pattern of TARGET cross-border and EURO 1 payment flows is very similar and exhibits a high correlation (0.76). Indeed, this result is very compelling considering that EURO1 end-of-day net settlements are excluded from our TARGET cross-border data. Therefore, after developing a model for the time series analysis of TARGET flows, we repeat the analysis on EURO1 data, finding that the possible determinants of the payments settled in the two systems are largely the same.

**Chart 1 - Daily value of TARGET cross-border payments and gross value of payments cleared by EURO1 (amounts before netting),**

01 January 2001 - 30 March 2001

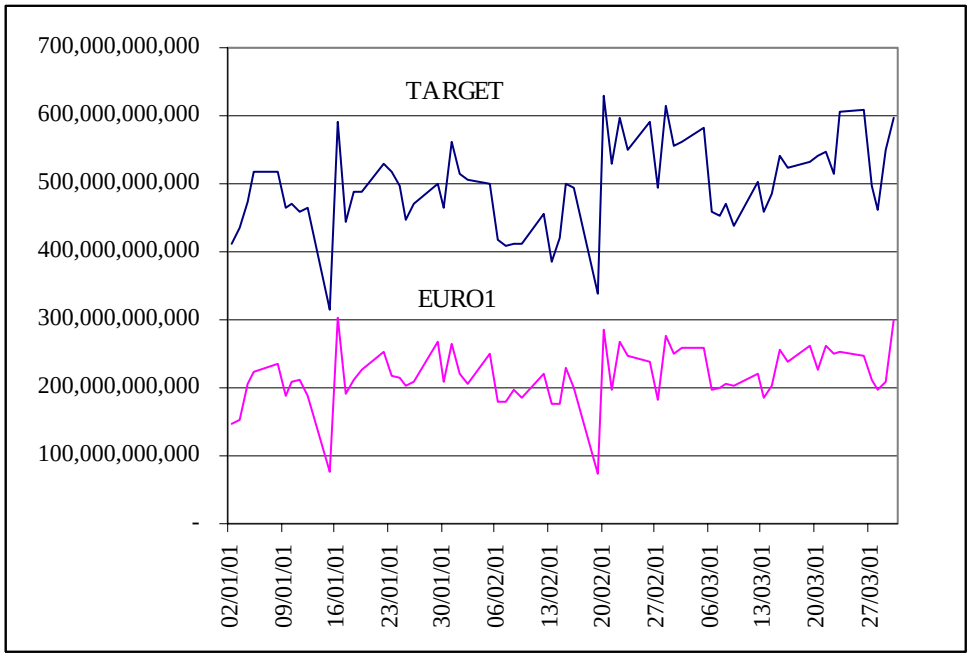



Table 1 gives an idea of the share of the various EU countries on the total TARGET cross-border payment flows, and, for the sake of comparison, provides also other measures of their relative size in terms of other economic and financial variables (i.e. GDP, stock market capitalization and size of the banking sector[3]). Overall, the EU countries show proportionate sizes in the considered variables, with the leading economies (DE, GB, and FR) playing a significant role also in terms of financial markets size indicators. However, for some other countries small differences may be identified. For example, for IT the values of financial market size seem under-proportioned to the weight of its real economy.

[3] Due to the limited availability of data related to the size of the banking sector, we are using 2000 data only. Additionally, using 2000 data, preceding the mergers of the various stock markets that subsequently formed the Euronext exchange, allows us to compare the various variables also with the size of the single stock markets of the EU.

By contrast, the opposite is true for the BENELUX countries, whose financial centres are relatively big compared to their respective GDP weights. GB shows a peculiar situation as, despite being a non-euro area Member State, it has a TARGET cross-border weight equivalent to the one of its GDP weight at EU level, which reflects the prominent role of the London financial centre in the euro-denominated market segment.

**Table 1- EU countries key figures**

| 2000 | GDP | | Stock market capitalization* | | Balance sheet total of credit institutions** | | Cross-border TARGET flows*** | |
|---|---|---|---|---|---|---|---|---|
| Country | EUR billions | Share in % EU | EUR billions | Share in % EU | EUR billions | Share in % EU | EUR billions | Share in % EU |
| AT | 205 | 2.4% | 32 | 0.4% | 516 | 2.5% | 2,594 | 2.4% |
| BE | 248 | 2.9% | 194 | 2.1% | 732 | 3.5% | 9,080 | 8.4% |
| DE | 2,026 | 23.8% | 1,353 | 15.0% | 6,494 | 31.2% | 28,306 | 26.3% |
| DK | 177 | 2.1% | 119 | 1.3% | 385 | 1.9% | 1,432 | 1.3% |
| ES | 609 | 7.1% | 537 | 6.0% | 1,006 | 4.8% | 4,096 | 3.8% |
| FI | 132 | 1.5% | 313 | 3.5% | 123 | 0.6% | 1,533 | 1.4% |
| FR | 1,405 | 16.5% | 1,541 | 17.1% | 2,859 | 13.8% | 15,352 | 14.3% |
| GB | 1,548 | 18.2% | 2,782 | 30.8% | 4,231 | 20.4% | 19,189 | 17.8% |
| GR | 123 | 1.4% | 114 | 1.3% | 133 | 0.6% | 205 | 0.2% |
| IE | 104 | 1.2% | 87 | 1.0% | 385 | 1.9% | 1,406 | 1.3% |
| IT | 1,166 | 13.7% | 818 | 9.1% | 1,718 | 8.3% | 9,308 | 8.6% |
| LU | 21 | 0.2% | 36 | 0.4% | 598 | 2.9% | 2,676 | 2.5% |
| NL | 401 | 4.7% | 682 | 7.6% | 905 | 4.4% | 9,859 | 9.2% |
| PT | 115 | 1.3% | 65 | 0.7% | 303 | 1.5% | 893 | 0.8% |
| SE | 248 | 2.9% | 350 | 3.9% | 393 | 1.9% | 1,718 | 1.6% |
| total | 8,528 | 100% | 9,024 | 100% | 20,781 | 100% | 107,647 | 100% |

* Shares of domestic companies. (Source: World Federation of Stock Exchanges).
**Source: Eurostat. For FI and IE we use the ECB data on the aggregated balance sheet of the Monetary and Financial Institutions (MFI sector)
*** Yearly figures – ECB flows excluded.

## 2 The geography of TARGET cross-border interbank payments

In this section we look at the destination and source countries of the TARGET cross-border payment traffic of each of the 15 EU countries. In the first place, this information is important for its implications in terms of payment systems efficiency, operational risk and systemic risk[4]. The basic idea here is that the existence of significant and stable patterns for sending and receiving funds from

[4] For a thorough review of the debate on systemic risk in payment and settlement systems, see De Bandt and Hartmann (2000).

one country to another could entail a dependence of one country/banking system on another for its liquidity provision. Such dependence could result in a possible channel of contagion of liquidity tensions in case of problems in one RTGS system (for example a major technical disruption, such as a computer breakdown). Indeed, under extreme circumstances a whole banking system could be isolated from the rest of the EU systems. As noted by De Bandt and Hartmann (2000), "in a way, looking at payment and settlement systems is like looking at the network of interbank exposures with a magnifying glass. Hence, depending on their internal organisation they also determine how shocks may propagate through the financial system, in particular how severe contagion can be" (p. 32).

Secondly, the geographical distribution of liquidity is also important in order to understand the organisation and functioning of the integrated euro area interbank market, of which TARGET represents a sort of "highway" mirroring the direction taken by liquidity flows. In principle, assuming that a common, euro-area wide atomistic market existed[5] any of the thousands of credit institutions connected to TARGET would have the possibility to settle trades with any other counterparty, irrespective of its location in the EU, thus exploiting any possible arbitrage opportunity. Indeed, one of the key features of the TARGET system is that its participants can address payments one to another without the need to pre-establish any additional business relation deriving from their participation in the payment system (like, for instance, assigning credit limits specifically related to TARGET activity, or establishing standing correspondent banking relations). In other words, the system provides the infrastructure for an "impersonal" settlement of euro cash transactions. In a way, under such setting "location should not matter". It should be noted that the focus of our analysis is not the efficiency and integration of the euro financial (money) market, which has been largely confirmed by empirical evidence of a very low dispersion of interbank deposit rates across countries[6]. Rather, we look at how the integrated market works from an organisational point of view, deriving some considerations based on the geographical distribution of interbank payment flows that reflect cross-border interbank trading.

Table 2 and Table 3 report the distribution of the daily average payments sent and received by each system expressed in percentage terms (absolute values are provided in Table 9 in the Annex). Already at a first glance, one can note that DE, FR and GB play a crucial role in the cross-border distribution of liquidity in the euro area interbank market, which is not surprising given their economic size. Payments sent (received) from these countries represent substantial shares of the payments received (sent) by the other countries.

In order to map the whole set of payment links throughout the EU we take countries two by two and compare the relative importance of the bilateral payment flows. This is done by considering jointly the proportion of payments sent by country i to another country j on the total payments sent by country i

[5] The market could evolve in this direction with the widespread development of trading platforms, where money market transactions are traded electronically in an anonymous way - an example could be set by the platform MID (Market for Interbank Deposits, run by e-MID S.p.A., Milan) which serves the Italian market.

[6] See, for instance, Ciampolini and Rohde (2000) and ECB (2003).

and the share the same payment flow represents on the total payments received by country j. For example, DE sends less than 4% of its payments to AT (see first column, third line of Table 2). Any problem preventing DE from executing those payments could be considered of little relevance from the DE system perspective, but it would have a sizeable impact if seen from AT's standpoint, where those same payments represent 49% of their total cross-border in-coming liquidity (see first column, third line of Table 3).

**Table 2 – Destination of cross-border Payments sent by each country connected to TARGET, average of daily data 1999-2002 (ECB flows excluded)**

*(percentage on total payments **sent** - in value - by each country)*

| Average 1999-2002 | RECEIVER (j) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SENDER (Sij) | AT | BE | DE | DK | ES | FI | FR | GB | GR | IE | IT | LU | NL | PT | SE |
| AT | | 5.3% | 49.0% | 0.5% | 2.6% | 0.7% | 10.5% | 12.1% | 0.5% | 0.6% | 7.7% | 1.9% | 4.6% | 1.1% | 1.1% |
| BE | 1.4% | | 29.3% | 1.2% | 3.3% | 0.9% | 16.0% | 18.1% | 0.5% | 1.1% | 8.6% | 4.9% | 11.2% | 1.2% | 0.7% |
| DE | 3.9% | 11.2% | | 2.0% | 4.7% | 1.1% | 19.7% | 25.4% | 0.9% | 1.4% | 9.7% | 3.9% | 12.1% | 0.7% | 1.7% |
| DK | 1.0% | 6.3% | 42.1% | | 0.9% | 12.0% | 5.8% | 8.0% | 0.2% | 0.2% | 1.8% | 1.7% | 9.3% | 1.0% | 2.6% |
| ES | 1.5% | 7.5% | 29.2% | 0.3% | | 0.2% | 17.0% | 15.6% | 0.2% | 1.1% | 12.7% | 0.8% | 5.4% | 3.0% | 0.4% |
| FI | 1.2% | 5.4% | 23.5% | 13.4% | 0.7% | | 5.8% | 10.6% | 0.2% | 0.5% | 5.0% | 0.3% | 5.7% | 0.2% | 25.6% |
| FR | 1.5% | 8.8% | 37.4% | 0.6% | 3.9% | 0.5% | | 22.3% | 0.5% | 0.8% | 9.9% | 1.9% | 7.9% | 0.6% | 0.4% |
| GB | 1.4% | 5.5% | 39.0% | 0.6% | 3.6% | 0.8% | 21.0% | | 0.5% | 2.4% | 6.5% | 1.3% | 12.9% | 0.5% | 0.7% |
| GR | 2.2% | 5.9% | 53.2% | 0.4% | 1.2% | 0.3% | 8.6% | 12.8% | | 1.2% | 6.1% | 0.8% | 3.6% | 0.8% | 0.4% |
| IE | 1.0% | 7.2% | 31.1% | 0.3% | 3.2% | 0.5% | 9.2% | 34.2% | 0.8% | | 2.2% | 0.8% | 4.9% | 1.4% | 1.1% |
| IT | 2.1% | 9.2% | 32.4% | 0.3% | 5.8% | 0.8% | 18.0% | 18.2% | 0.7% | 0.4% | | 2.2% | 6.8% | 0.9% | 0.4% |
| LU | 2.3% | 15.5% | 44.4% | 1.4% | 1.2% | 0.2% | 11.3% | 9.7% | 0.3% | 0.3% | 6.8% | | 4.1% | 0.8% | 0.7% |
| NL | 0.9% | 9.6% | 35.8% | 1.5% | 2.5% | 0.7% | 13.2% | 26.0% | 0.3% | 0.7% | 5.6% | 0.9% | | 0.4% | 1.1% |
| PT | 2.6% | 12.0% | 25.0% | 1.5% | 14.4% | 0.3% | 10.9% | 12.5% | 0.8% | 2.2% | 9.3% | 2.5% | 4.1% | | 0.7% |
| SE | 1.7% | 2.8% | 37.0% | 3.1% | 1.1% | 23.2% | 4.0% | 7.8% | 0.3% | 1.1% | 1.9% | 1.0% | 6.2% | 0.4% | |

The table describes the destination of the cross-border payments sent by each national component of TARGET. For instance, 1.4% of the payments by Belgium (second row) are addressed to credit institutions based in Austria, while 29.3% are sent to banks located in Germany.

**Table 3 – Origin of cross-border payments received by each country connected to TARGET, average of daily data 1999-2002 (ECB flows excluded)**

*(percentage on total payments **received** – in value - by each country)*

| Average 1999-2002 | RECEIVER (Rji) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SENDER (i) | AT | BE | DE | DK | ES | FI | FR | GB | GR | IE | IT | LU | NL | PT | SE |
| AT | | 1.3% | 4.0% | 0.8% | 1.5% | 1.2% | 1.5% | 1.5% | 1.7% | 1.0% | 2.1% | 1.7% | 1.1% | 2.8% | 1.7% |
| BE | 5.3% | | 9.1% | 7.8% | 7.1% | 5.5% | 8.8% | 8.4% | 4.7% | 7.0% | 9.0% | 16.4% | 10.1% | 12.0% | 4.2% |
| DE | 48.6% | 36.2% | | 40.8% | 32.5% | 21.8% | 35.4% | 38.4% | 53.2% | 29.1% | 33.1% | 41.9% | 35.2% | 22.9% | 35.2% |
| DK | 0.6% | 1.0% | 2.1% | | 0.3% | 12.9% | 0.5% | 0.6% | 0.4% | 0.2% | 0.3% | 0.9% | 1.4% | 1.5% | 2.3% |
| ES | 2.5% | 3.5% | 4.2% | 1.0% | | 0.7% | 4.4% | 3.4% | 1.1% | 3.2% | 6.2% | 1.2% | 2.3% | 13.8% | 1.2% |
| FI | 0.7% | 0.9% | 1.1% | 12.8% | 0.2% | | 0.5% | 0.7% | 0.5% | 0.5% | 0.8% | 0.1% | 0.8% | 0.3% | 24.6% |
| FR | 10.3% | 16.0% | 20.8% | 6.9% | 15.0% | 5.8% | | 18.7% | 8.1% | 8.8% | 18.6% | 11.6% | 12.7% | 10.6% | 4.3% |
| GB | 11.5% | 11.9% | 25.9% | 8.8% | 16.5% | 11.6% | 25.0% | | 12.0% | 33.1% | 14.7% | 9.1% | 25.0% | 11.1% | 9.3% |
| GR | 0.7% | 0.6% | 0.9% | 0.2% | 0.3% | 0.1% | 0.5% | 0.5% | | 0.7% | 0.7% | 0.2% | 0.3% | 0.8% | 0.3% |
| IE | 0.6% | 1.1% | 1.5% | 0.3% | 1.1% | 0.5% | 0.8% | 2.5% | 1.3% | | 0.4% | 0.4% | 0.7% | 2.2% | 1.2% |
| IT | 7.7% | 8.8% | 9.5% | 1.5% | 11.8% | 5.0% | 9.5% | 8.1% | 6.1% | 2.2% | | 6.9% | 5.8% | 8.7% | 2.3% |
| LU | 2.6% | 4.6% | 4.2% | 2.6% | 0.8% | 0.3% | 1.9% | 1.4% | 1.4% | 0.6% | 2.1% | | 1.1% | 2.5% | 1.3% |
| NL | 3.8% | 10.5% | 12.3% | 9.9% | 5.8% | 4.9% | 8.1% | 13.5% | 3.2% | 5.0% | 6.6% | 3.3% | | 3.9% | 6.9% |
| PT | 1.0% | 1.2% | 0.8% | 1.0% | 3.1% | 0.2% | 0.6% | 0.6% | 0.8% | 1.4% | 1.0% | 0.9% | 0.4% | | 0.4% |
| SE | 1.1% | 0.5% | 1.8% | 3.3% | 0.4% | 24.2% | 0.4% | 0.6% | 0.4% | 1.1% | 0.3% | 0.5% | 0.9% | 0.6% | |

The table describes the origin of the total payments received by each national component of TARGET. For instance, 1.3% of the payments received by Belgium (second column) come from Austria, while 36.2% come from Germany.

## 2.1 TARGET cross-border payments are geographically concentrated

The bilateral relations among the 15 EU countries taken two by two reported in Tables 2 and 3 can be easily visualised in the scatter graph in annex (Chart 3). Based on this representation, we can observe the following. First, cross-border distribution of liquidity seems to take place mostly through banks based in DE, and to a lesser extent - but still large in absolute terms - through the banks based in FR and GB. These three countries can be seen as the "heart" of the market, since the links to these countries (particularly DE) seem to be vital for all the other systems. In addition, they show reciprocal dependence. This result is in line with the data reported by Banque the France (1999) and Deutsche Bundesbank (2000), which comment on the importance of the French and German euro money markets for the distribution of liquidity in euro. According to our data, it is Germany that acts as the major hub for the cross-border distribution of liquidity. Moreover, our data also confirm the evidence reported by the Deutsche Bundesbank that the German market also acts as gateway for euro liquidity transfers between the euro area and the EU countries that have not adopted the euro, particularly the London financial market (everyday, a 30,000 million euro payments flow, the largest within the whole TARGET, takes place in fact between Frankfurt and London. See Table 9 in the annex). As already mentioned, the prominence of GB in terms of euro flows of liquidity can be put in relation to the importance of London as international financial centre for the trades denominated in the major currencies.

Second, a somewhat significant cross-border role seems to be played also by the banks based in IT, BE and NL. These countries have important links among themselves and with DE, FR and GB. On the other hand, they have some influence on the remaining countries: links with BE are important for LU and PT; those with NL for DK, IE and ES; and IT impacts somewhat on LU, PT, ES and AT. Overall, the six countries DE, FR, GB, IT, NL, and BE are linked one to another by significant financial flows, in what seems a well integrated interbank market.

Third, the other countries (GR, AT, IE PT, and LU) remain somehow at the periphery of the cross-border market. In addition to DE, these countries have strong links to a "preferred partner": for IE this is GB, for PT it is ES, and for LU it is BE. Finally, a sort of "Scandinavian" local circuit links FI, SE and DK.

## 2.2 Tiered market and payment systems operational risk

The implications of the above findings give some insight about the possible contagion risk among those countries sharing strong payment relations. Although TARGET has shown a high level of operational robustness and reliability, let us see what could be the effects of a major operational problem occurring in a national TARGET component

Indeed, funds related to large value transactions are not supposed to remain idle on payment accounts and, normally, the incoming funds are immediately employed to execute outgoing payments relating to financial transactions where the party has an obligation to pay. In terms of possible cross-border contagion of liquidity problems, this means that, although TARGET has a decentralised structure running on 16 different platforms, and even if systemic relevance is normally recognised to all large-value payment systems, in the end the functioning of the euro market relies mainly on a few, crucial TARGET components[7]. As noted above, the most important one is clearly the German system. Let's consider, as an example, how the effects of operational risk materialisation may (or may not) propagate at level of interconnected EU systems. Should the German system experience a prolonged, serious malfunctioning, such as an event that - for whatever reason- results in the disconnection of Germany from TARGET for a whole business day, then the functioning of the whole euro interbank market might be impaired. A similar systemic relevance can be recognised to FR and the GB. In the period 1999-2002, every day the banks located in these three countries sent (and received) cross-border payments for almost EUR 260 billion in total (about 60% of the total cross-order traffic). By contrast, the geographical segmentation suggests that, for instance, a problem originated in BE would propagate mainly to NL[8]. Similarly, a black out of the Spanish system is likely to propagate mainly to Portugal. Problems in FI would remain confined to the Scandinavian Peninsula. Due to the absence of liquidity transfer relations, there would be virtually no possibility of contagion among the payment systems of PT, GR, and DK. Similar conclusions could be drawn on the propagation of effects of other events having possible systemic relevance (e.g. the failure of a major banking group operating at EU level).

## 3 A gravity model for TARGET cross-border interbank payments

In the previous paragraphs we found that payments are geographically concentrated, and may reflect a tiered market structure for liquidity. One explanation for this structure might be found in the existence of well-established pre-existent business relations. The TARGET system makes it possible to settle euro transfers with virtually any counterpart in the EU, without the need to establish any bilateral business relation beforehand. However, banks' business habits do not change overnight. Based on our analysis, we concluded that cross-border liquidity circulates at different levels, and in particular that first, size does matter: there is a circuit bilaterally linking each banking systems with those of the countries with the bigger economies, primarily with the German banking system, but also with the French and British banking systems. Furthermore, there is a network of liquidity transfers linking the large and middle size countries in a single circuit composed of the (presumably large) credit

[7] The seriousness of contagion for the different countries involved would also depend on the relative importance of the respective cross-border flows compared to the domestic flows (degree of "openness"). However, in our study we do not consider this dimension, and limit the analysis to cross-border flows.

[8] When a member of the core integrated market is involved, second-round effects cannot be excluded due to the possible dependence of satellite countries. In this paper we do not consider explicitly second-round effects.

institutions of DE, FR, GB, IT, BE and NL. Additionally liquidity is traded in local (though cross-border) circuits, and it seems reasonable to assume that here the business relations linking the different banking systems draw on geographical proximity. This is evident when considering the rather high integration of (i) PT and ES, (ii) BE, NL and LU, and (iii) FI, SE and DK. Another possible explanation is that trading is easier between countries showing linguistic, cultural and/or institutional similarities. This is for instance the case again for (iv) IE-GB, and (v) AT-DE, although also the size of GB and DE may play a significant role.

In order to test the empirical foundation of this intuitive conclusion in a rigorous manner, we develop a cross-section model drawing on the literature of gravity equations. Although this is traditionally used to explain bilateral (real goods) trade relations among countries, it has also been recently applied – with good results – to financial assets trading. In short, a gravity model is a model that explains trade flows between two countries i and j by the size of the two countries (for example as measured by GDP) and distance (which in goods trade applications caters for transportation costs). In addition to such physical geography variables, a gravity model may also contain variables associated with "psychological geography", like sharing a common border, a common language, and so on. In particular, Portes and Rey (2000) and, Portes, Rey and Oh (2001), show that a gravity model explains international transactions in financial assets at least as well as goods trade transactions, finding a negative relationship between asset trade and distance. In their applications of gravity models to financial assets trading, distance is essentially a proxy for informational asymmetries. Grinblatt and Keloharju (2001) document an influence of distance, language and culture on stockholdings and trades of the Finnish investors, and consider these elements as potential barriers to inter-European investments. Flavin et al. (2002) use the gravity model approach to explain cross-country stock market correlations, and find that geographical variables matter in explaining equity market linkages. In particular, gravity models offer a possible explanation of the stylised fact that investors tend to bias their portfolios in favour of domestic assets, failing to take opportunity of international diversification benefits. This literature suggests that informational asymmetries may not necessarily relate in a strict sense only to information of financial nature, but more broadly to other elements facilitating communication (like knowledge of the language[9]), or act as a possible informational barrier (like having different accounting standards and practices).

The rationale for our model is that since interbank cross-border payment traffic reflects cross-border interbank trading activity, a gravity model may explain well, in the light of the observations of the previous paragraph, the possible role of size, geographical proximity and cultural-linguistic similarities in the geographic distribution of TARGET flows.

[9] See Hau (1999), who shows that foreign traders make significantly less profit than German traders when they transact on the German stock market, while at the same time there is some evidence that German-speaking traders perform in markets of German speaking countries better than their non-German-speaking colleagues.

We use cross-section data of EU-15 TARGET payment flows (sample average of daily total payments sent from each country to each of the others, 1999-2002), a total of 210 cross-section observations.

We estimate the following model:

$$\ln(p_{ij}) = c + aD_{ij} + bB_{ij} + dL_{ij} + k\ln(size_i * size_j) + \varepsilon_{ij} \qquad (1)$$

where $\boldsymbol{p_{ij}}$ is the average payment flow in EUR billion from country i to country j. $\boldsymbol{D_{ij}}$ is the distance between country i and country j (measured as km between key financial centres[10]). $\boldsymbol{B_{ij}}$ is a dummy variable taking value 1 if the two countries share a common border and 0 otherwise (in standard gravity models, countries connected by a bridge [i.e. DK and SE], or a tunnel [GB and FR], and or a strait of water are considered to share a border) $\boldsymbol{L_{ij}}$ is a dummy variable taking value 1 if countries i and j share a common language and zero otherwise (it should be noted that Luxembourg and Finland have two official languages (respectively French and German the former, Finnish and Swedish the latter), and we assume that Belgium (whose official languages are French and Dutch) shares a language with France and the Netherlands). *Size* is measured by the total balance sheet of credit institutions[11], which is considered to be consistent with the fact that the flows are mainly related to an interbank market. However, we also use real GDP (measured at PPP exchange rates) and stock market capitalisation[12] as a measure of size, which leads to broadly similar results.

The results of the estimation of the model (1) on cross section EU-15 data are reported in Table 4.

**Table 4 - Cross-section regression of model (1)**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| **Distance** ($D_{ij}$) | -0.0003 | 0.000 | -5.277 | 0.000 |
| **Border** ($B_{ij}$) | 0.5361 | 0.123 | 4.368 | 0.000 |
| **Language** ($L_{ij}$) | 0.5808 | 0.240 | 2.420 | 0.016 |
| **Size** ($size_i * size_j$) | 0.9515 | 0.005 | 203.231 | 0.000 |
| R-squared | 0.822 | Mean dependent var | | 25.338 |
| Adjusted R-squared | 0.819 | S.D. dependent var | | 1.913 |
| S.E. of regression | 0.813 | Akaike info criterion | | 2.443 |
| Sum squared resid | 136.196 | Schwarz criterion | | 2.507 |

Note: Standard errors are HAC (White).

The diagnostic statistics of the model are satisfactory. Due to some evidence of heteroskedasticity of residuals in the OLS estimates, measured by means of the White test, we use White heteroskedasticity-adjusted standard errors. Our main result is that all variables are statistically significant and have the expected sign. Cross-border payment flows are comparatively bigger if (i) the two countries are big,

[10] Source: www.mapblast.com, ADAC Atlas.

[11] Source: Eurostat (average 2002). For Ireland and Finland we use the monthly average of the assets of the MFI sector in 2000, source ECB.

[12] Source: World Federation of Stock Exchanges.

(ii) are geographically close, (iii) share the same language (e.g. IE-GB, DE-AT, FR-BE, FI-SE), (iv) share a common border. The coefficient of 0.95 indicates that the elasticity of TARGET flows to the size variable is very close to 1, indicating an approximately proportional relationship between the two variables. In addition, although the size variable plays a dominant role in explaining the cross-section variability of TARGET flows, it is interesting to note that there are other location-related variables which have a statistically significant impact on interbank payment flows, notably distance, border and language. The result obtained for the language variable is somewhat surprising, because one could have expected language to be irrelevant given that the widespread use of the English language in the international wholesale financial markets. It has been widely recognised that, in the euro area, TARGET has been instrumental in allowing the full integration of the interbank market for banks reserves. Financial integration may be defined as "a situation whereby there are no frictions that discriminate between economic agents in their access to – and their investments of – capital, particularly on the basis of location", (ECB 2003, p. 53 and 57). However, our gravity model supports the hypothesis that, even in the absence of any friction discriminating market actors based on location, market players have organised the interbank business relations in such a way that location nevertheless matters, without prejudice for the law of one price.

# 4 The determinants of TARGET cross-border payment flows: a time series analysis

After looking at the cross-section distribution of cross-border TARGET flows in the previous sections, we now turn to analyse the time series behaviour of the aggregate cross-border payment traffic in TARGET.

## 4.1 The data

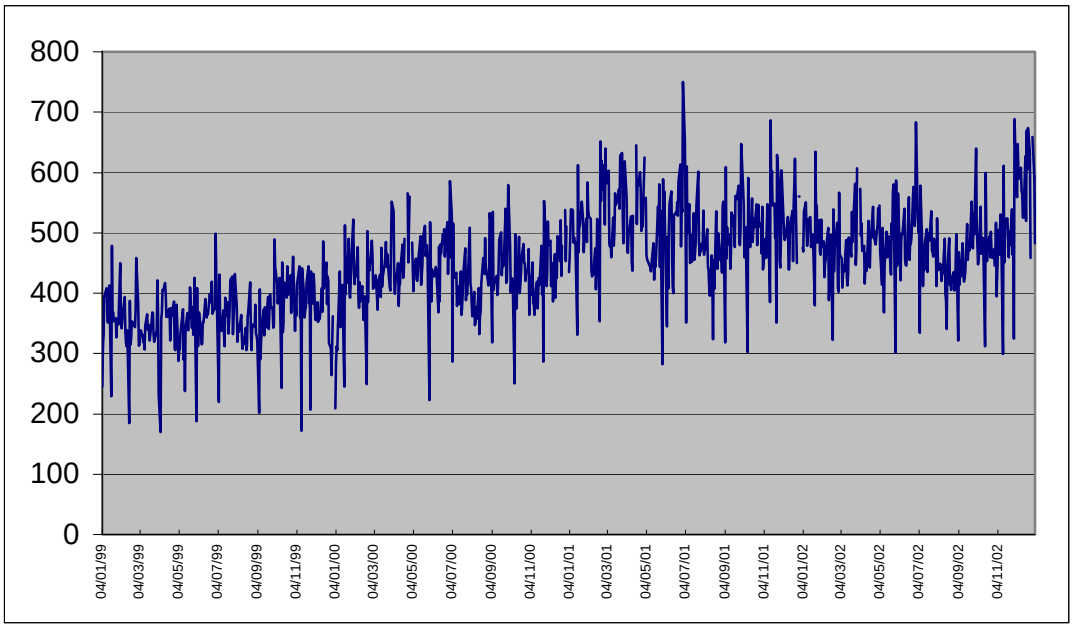
In this section, calculations are based on payments sent (received) for each bilateral relation, covering the period 1999-2002. At the end of each business day, the ECB collects data about the total value of payments sent by each NCB to each of the other systems linked to TARGET, having deducted those sent to (and received from) the EPM of the ECB. These data have been used to build the set of time series of the daily amount of TARGET cross-border payments.

It should be noted that TARGET payments can be classified into three categories: (i) interbank payment transfers (which, in the period under consideration, represented between 96% and 98% of handled values), (ii) customer payment transfers represented by payments made to (or on behalf of) non-financial institutions. Thus, intra-EU trade flows may be the underlying determinant of only 2 to 4% of the TARGET cross-border payments; and (iii) inter-NCB payments, which occur among the central banks and represented a negligible part of the total (about 0.1%). Therefore, even though TARGET can be used to settle transactions stemming both from the financial and real economy, its cross-border flows reflect the settlement of financial transactions. Considering the overwhelming

prevalence of interbank payments and in order to ease the data handling, the present analysis is conducted directly on the total value of TARGET cross-border payments. Chart 2 reports the total TARGET cross-border payment traffic in the period 1999-2002. The TARGET cross-border traffic appears to be very volatile on a day-to-day basis. Moreover, it appears to be characterised by periodical (seasonal) spikes. Finally, the variable clearly has an upward trend, more evident in the period 1999 - mid 2001.

**Chart 2 - Total cross-border payment flows in TARGET, EU-15, 1999-2002**

**(EUR billions)**




## 4.2 Background

We identify the following categories of possible determinants of the cross-border payment flows.

First, cash transfers represent in principle "the other side of the coin" of a variety of possible financial transactions, and we would expect most of interbank payment activity to reflect underlying operations originating in the various segments of the financial market (e.g. cash deposits, securities, foreign currencies, equities, and so on).

Second, cross-border transfers could originate from the need of internationally active banks or groups to move cash funds for liquidity management reasons, for instance to fund settlement positions in securities settlement systems abroad, or to cover obligations on specific accounts of the same bank/group with its home National Central Bank, as it is the case for the fulfilment of minimum reserve requirement.

Third, we have observed that TARGET cross-border payments are affected by certain technical deadlines like end of the month peaks, or decreases on occasion of banking holidays in the major financial centres.

Fourth, it is reasonable that treasurers' activity be influenced by the liquidity conditions of the market, and might be affected by the amount of reserves available to the banking sectors, as well as by its variations, for instance on occasion of the implementation of central bank's monetary policy operations.

Finally, the volume of payments processed may be affected by technical disturbances in the functioning of the payment systems, for instance, the rare cases when for technical reasons a national RTGS system remains disconnected from the rest of TARGET for several hours or even most of a business day.

In sum, as noted above, theoretically, the financial transaction underlying a payment order might be related to trading in any segment of the financial market, notably in money, bond, foreign exchange or equity instruments. In other words, interbank payment flows are derived from (and explained by) the underlying financial transactions. In the explanation of the determinants of TARGET flows, we therefore turn first to proxy measures for trading volume (in practice, turnover data) in different segments of the financial market (money, bond, stock). This is our "direct" line of investigation, and we expect a positive relation between TARGET flows and turnover data of the euro area main financial markets. Additionally, as noted, cross-border payment flows are likely to be positively related to the liquidity conditions of the market (the amount of bank reserves). Finally, we expect to see some effects for a set of technical deadlines (calendar effects, mainly due to the business holidays, technical incidents in a national component of TARGET, and so on).

After estimating a model reflecting these considerations (see the next paragraph), however, we also expand the set of variables of possible economic significance, going beyond the financial market turnover data. The rationale for this is that due to uncertainty about the measurement of the trading volume and/or about the functional relation linking trading turnover with payment flows, it is possible that turnover figures may not be encompassing indicators in explaining the relationship between the activities of the "underlying" markets served by the payment infrastructure and the TARGET flows. Therefore, in a second step of analysis we try to see if there is any relation between *other* economic variables, which should have an impact on trading turnover in financial markets, and which may have, from an empirical viewpoint, an indirect relevance for payment flows, and TARGET payments. This is the "indirect" approach which we also follow.

What variables may affect trading volume or turnover in financial markets, and so TARGET flows? We build on a literature which has emphasised the idea that trading volume increases when new information arrives, because of the existence of informed and uninformed traders (Admati and Pfleiderer, 1988). So, proxies for the arrival of new information (e.g. changes in volatility and prices)

should be able to partly explain trading volume. The literature has typically identified a positive relation between the volume of trade in financial assets and *price volatility* (see for example Gallant, Rossi and Tauchen, 1992).

Establishing a relationship between trading volume and *price levels or changes* (beyond the effect that price changes may have on volatilities) is less clear-cut from a theoretical perspective. Empirically, however, it has been found that especially stock trading volume appears to be higher in bull than in bear markets. Some authors interpret this evidence as signalling agent overconfidence in good times, which encourages agents to trade more in good times (Statman and Thorley, 1999).

A more direct relationship between payment flows and the *short-term interest rates* has also been investigated. For the US, Furfine (1999) showed that the log of total Fed-wire fund transfers is positively significant in explaining federal fund rate changes. In a subsequent contribution (Furfine, 2000), the same author verified a significant positive correlation within the maintenance period between the federal funds daily rate and payment transfers, both in levels and volatility. However, for the case of the Italian overnight deposit market and payment transfers, a similar study by Barucci, Impenna and Reno (2003) found negative correlation between the two. It should be noted that these contributions include payment traffic as an explanatory variable in studying the behaviour of overnight rates, while our purpose is to identify the possible determinants of payment traffic, so as to understand whether and how rates levels and variations have impacts on the payments traffic mirroring trading activity on the interbank market.

Against this backdrop, we regress the log of the total TARGET cross-border traffic (in addition to on a set of dummy variables catering for the technical deadlines), firstly on measures of turnover of the money and bond markets, and subsequently on measures of price (or interest rate) and implied volatility in money market, bond and stock markets in the euro area. We then try to assess whether extending the set of variables of economic significance to include also prices and volatilities adds any significant amount of information that may be valuable from an economic perspective.

### 4.3 The empirical model (daily frequency)

Reflecting these considerations, the basic setting of our model is as follows:

$$LT_t = \theta(L)LT_{t-1} + \rho\, x_t + \varpi D_t + \upsilon_t \qquad (2)$$

where LT is the log of the total traffic in TARGET, $\theta(L)$ is a polynomial in the lag operator, x is a vector of variables of economic significance (defined below), D is a vector of dummy variables reflecting technical and special conditions (see below), and $\upsilon$ is a disturbance term. Finally, $\rho$ and $\varpi$ are vectors of coefficients.

As regards the lag structure, we consider up to 5 lags to cater for possible day-of-the-week effects. We estimate the model on daily data from 1999 to 2002. Note that LT is clearly a stationary variable, so we have no problem to apply standard inference.

#### *4.3.1 Variables of economic significance*

In our first version of the model, in the vector *x* we include the following variables:

- Measures of the *turnover* (in logs) in the overnight unsecured segment of the money market (TURN_EONIA[13]), in the Euribor futures market (TURN_MM) and in the bond futures market (TURN_BOND). These measures are the best empirical proxies available for the trading volume in euro area money and bond markets, although turnover is of course not directly comparable to the trading volume. Unfortunately, we find no euro area wide daily trading volume or turnover measure for stock markets.
- The *total amount of bank reserves* (required and excess reserves), LIQUIDITY (also in log); the idea is that if more liquidity is available (for example as supplied by the ECB through open market operations), *ceteris paribus* more cross border trading should take place in the TARGET system (intuitively, the more liquidity is around, the more liquidity should be redistributed via interbank flows through the banking system).

In our second version of the model, we additionally include also:

- *Price variables*: the spread between the EONIA and the rate on fixed rate tenders (from January 1999 to June 2000) and the minimum bid rate, D_EONIA_MRO (from June 2000); the daily change in the euro area 10-year government bond yield (DB); and the daily change in the Eurostoxx index (DS);
- *Price volatility variables*: MM_IMPL_VOL, BOND_IMPL_VOL and STOCK_IMPL_VOL are the implied volatilities respectively on three-month Euribor futures with constant six months to maturity, on euro bond futures and on the Eurostoxx 50 index[14]. These are measures of market uncertainty in these three segments of the financial market; all the three measures have unit standard deviation to ensure comparability of results.

#### *4.3.2 Dummy variables catering for technical and special conditions*

In addition to underlying structural (economic) factors, the traffic in TARGET may certainly be influenced by technical and special conditions. We therefore regress the log of the value of total cross border flows also on a vector of dummy variables, taking into account:

[13] The euro overnight index average (EONIA) is disseminated by the European Banking Federation (EBF). It is the weighted average of all uncollateralised overnight loans made by a panel of the banks most active in the money market.

[14] Source: ECB based on Bloomberg data.

– *business conditions*: banking holidays in the three major markets possibly affecting the euro market, ( i.e. US, DE and GB), and last business day of the month, quarter and semester;

– *payment systems relevant events*: cases of technical problems originated in one RTGS connected to TARGET, which had a certain impact on TARGET operations[15];

– *market liquidity conditions*: the end date of the reserve maintenance period, and Eurosystem's open market operations, in particular the dates of announcements, allotment and settlement of the main refinancing operations (MROs).

Specifically, we consider the following dummy variables:

– HOLUS is a dummy variable taking into account banking holidays in the US (it takes value 1 on a day of the business holiday, and 0 otherwise);

– HOLDE is a dummy variable taking into account banking holidays in DE;

– HOLGB is a dummy variable taking into account banking holidays in GB;

– MONTH_END, QUARTER_END and SEMESTER_END are dummy variables taking into account expected payments traffic increases on the last day of each month, quarter and semester;

– TECHFR and TECHDE are dummy variables taking into account the incidents in the French and German RTGS systems;

– END_RP is a dummy variable taking into account the end date of the reserve maintenance period;

– MANN, MALLOT and MSETTL are dummy variables taking into account, respectively, the dates of the announcement, allotment and settlement of the Eurosystem's main refinancing operations (MROs).

### *4.3.3 Results*

We first estimate the full model in (2), and then follow a general-to-specific approach in order to select a more parsimonious specification. The latter is shown in Table 5 below. There is some evidence of serial correlation in the model, albeit weak, and we take this into account and report HAC (Newey-West) standard errors. There is, moreover, some evidence of ARCH effects. However, re-estimating the model as a GARCH(1,1) process does not materially change the results of the estimation, so we present the GLS estimate here. It is interesting to note that the result of ARCH effects in payment

[15] We do not put a dummy for the September 11 events, because on that day TARGET volumes were not affected. The reason is that the tragedy happened at a time which corresponds to 3.00 pm CET, a time when about 70% of TARGET payments in value (and 85% in volume) have already settled. The intraday distribution (but not the total daily amounts) of payments changed on the following three days, compared to normal patterns, with a smaller share of payments settled during the morning, as banks held back payments fearing possible developments. However, the prompt intervention of the ECB ensuring enough liquidity would be made available if needed, and confirming TARGET was running smoothly both at cross-border and domestic level, dissolved possible fears. The intraday distribution returned to its normal pattern in the following week. For further details see ECB (2002a), and the press releases issued in 2001 on Sept 11, 12 and 13, available on www.ecb.int. On the liquidity effects of the September 11 events on the US payment systems, and the reaction of the Federal Reserve, see Mac Andrews, J.J., and Potter, S.M., (2002).

volumes is in a way not new, as ARCH effects were already reported by Hartmann (1999) for foreign exchange market trading volumes.

We now turn to describe and comment the main results of this estimation exercise. We first discuss the dummy variables catering for technical conditions, and then the variables of economic significance.

*Dummy variables*

The estimated model provides some interesting insights over the behaviour of the cross border flows in TARGET in special circumstances.

First, business holidays in the US exert a very significant *downward* impact on cross border flows (the traffic decreases by a half on days when the US markets are closed). This drop in activity is in part balanced by a significant increase of traffic on the day preceding the banking holiday, and is also recovered, but only with a slight increase of activity, on the following day the holiday (we tested for further lags of the business holidays variables, but these were insignificant). The fall in TARGET activity on US business holidays is especially interesting, because it shows (and quantifies) the strong links between the EUR and USD money and financial markets. In particular, the decrease could give an indication of the relevance, in the euro interbank market, of the operations related to the US-based banks. More importantly, the decrease could represent the share of TARGET cross-border flows reflecting the (non) settlement of USD/EUR forex operations (settlement of the two legs of the trades needs to take place in CHIPS and TARGET on the same value date. Therefore, on the days when the US payment systems do not settle, the operations involving the two currencies cannot be settled). As regards the drop experienced on the German and British business holidays (the latter was significant at a 10% confidence level), this is much weaker than in the case of the US. The slight drop could be due to the absence of the major London and Frankfurt based players from the market scene. A possible explanation for the weak effect could be that in these cases TARGET as a whole is open, therefore all the necessary transactions can still be performed. On the day before these holidays there is a slight increase of activity. However, this is smaller compared to the volumes settled before a US holiday. This is reasonable because the general level of activity in the country on holiday is lower than on normal days so the need to bring forward payments is smaller.

**Table 5 - Parsimonious specification of model (2)**

Sample (adjusted):11/01/1999-23/12/2002

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 4.085 | 0.721 | 5.661 | 0.000 |
| LT(-1) | 0.377 | 0.028 | 13.537 | 0.000 |
| LT(-2) | 0.196 | 0.017 | 11.064 | 0.000 |
| LT(-3) | 0.057 | 0.018 | 3.227 | 0.001 |
| LT(-4) | 0.034 | 0.017 | 1.976 | 0.048 |
| LT(-5) | 0.093 | 0.018 | 5.008 | 0.000 |
| END_RP(-1) | 0.058 | 0.010 | 5.703 | 0.000 |
| END_RP | 0.060 | 0.009 | 6.353 | 0.000 |
| END_RP(1) | 0.032 | 0.010 | 3.211 | 0.001 |
| HOLUS(-1) | 0.388 | 0.023 | 17.073 | 0.000 |
| HOLUS | -0.507 | 0.023 | -21.950 | 0.000 |
| HOLUS(1) | 0.027 | 0.012 | 2.194 | 0.028 |
| HOLDE(-1) | 0.098 | 0.026 | 3.833 | 0.000 |
| HOLDE | -0.138 | 0.023 | -5.940 | 0.000 |
| HOLGB(-1) | 0.065 | 0.030 | 2.176 | 0.030 |
| MANN | 0.067 | 0.007 | 9.591 | 0.000 |
| MALLOT | -0.065 | 0.007 | -8.661 | 0.000 |
| MSETTL | -0.029 | 0.007 | -4.253 | 0.000 |
| SEMESTER_END | 0.261 | 0.049 | 5.335 | 0.000 |
| MONTH_END(-1) | -0.040 | 0.018 | -2.224 | 0.026 |
| MONTH_END | 0.149 | 0.020 | 7.493 | 0.000 |
| QUARTER_END | 0.249 | 0.021 | 12.097 | 0.000 |
| QUARTER_END(1) | 0.052 | 0.021 | 2.436 | 0.015 |
| LOG_TURN_EONIA | 0.074 | 0.014 | 5.238 | 0.000 |
| LOG_TURN_MM | 0.034 | 0.007 | 4.698 | 0.000 |
| LOG_LIQUIDITY | 0.123 | 0.040 | 3.101 | 0.002 |
| R-squared | 0.856 | Mean dependent var | | 26.757 |
| Adjusted R-squared | 0.852 | S.D. dependent var | | 0.192 |
| S.E. of regression | 0.074 | Akaike info criterion | | -2.340 |
| Sum squared resid | 5.036 | Schwarz criterion | | -2.206 |
| Log likelihood | 1130.719 | F-statistic | | 218.048 |
| Durbin-Watson stat | 1.908 | Prob(F-statistic) | | 0.000 |

Note: Newey-West HAC Standard Errors & Covariance

Second, with regard to the impact of technical difficulties on payment flows, we expected estimates consistent with the underlying assumption that, such events being unpredictable and therefore impossible to be anticipated by the banking community, any possible decrease of activity due to unprocessed payments could result in a corresponding increase on the following day, when the

postponed payments are processed. During the very first months of production life, TARGET suffered technical difficulties on three dates, due to technical problems originated respectively in France (29 January 1999) and Germany (25 February and 8 March 1999). TARGET has proved to be very reliable, showing no significant effects on the settled volumes also in those extreme cases when the most important systems remained disconnected from the rest of TARGET for several hours[16].

Third, the estimates confirm the a priori expectation that values processed rise significantly on the last business day of June and December (plus 0.26), as well as of March and September (plus 0.24) and any remaining month (plus 0.14).

Fourth, coming to Eurosystem's monetary policy operations variables, our goal was to verify any relevant impact of the liquidity conditions of the market on cross-border redistribution of liquidity, and in particular whether an increase of cross-border activity takes place further to a change in local liquidity conditions due to the execution of monetary policy operations. Our estimates show an increase of cross-border activity on the day of *announcement* of monetary policy operations, which is somewhat surprising because until June 2000 such announcement did not contain any new information for the market. A possible explanation could be that market operators had strong expectations about the outcome of the tender, and giving for granted the result of the allotment on the following day they started immediately to distribute liquidity. After June 2000, the result might indicate that the market immediately reacts to the new information by adjusting cross-border positions in order to be ready for the possible allotment. Cross-border transfers then *decrease* on the days when the allotment and settlement take place (it should be noted that monetary policy operations are settled using the accounts of the banks at the respective home national central banks, thus it is the national components of TARGET that are involved).

Finally, the impact of the end of the maintenance period on liquidity flows between the countries connected to TARGET is found to be positive and significant. This suggests that financial intermediaries exchange liquidity cross-border in order to comply with the Eurosystem's reserve requirement. In particular, it seems reasonable to assume that intermediaries (or countries) in surplus will send liquidity to intermediaries (countries) in deficit with respect to the reserve requirement. Indeed, such movements of liquidity could also be due to the adjustment of reserve positions of the large banking groups with subsidiaries established in different European countries.

*Economic variables*

As regards the turnover variables, only the money market turnover measures (LOG_TURN_MM and LOG_TURN_EONIA) are significant and positive (as expected), while the bond turnover measure is not significant at the 5% level. This information suggests that, quite reasonably, cross-border interbank payment flows are mainly related to transactions in euro area money market instruments.

[16] However, some kind of negative impact cannot be completely excluded, as the dummies for the days of the incidents were

Total bank reserves (LOG_LIQUIDITY) are strongly statistically significant and positive, suggesting that the intuition that liquidity conditions matter in the payment flows in TARGET is correct. In other words, the more liquidity around, the more liquidity is ceteris paribus redistributed cross-border through the TARGET system.

*Expanding the set of economic variables*

The results of re-estimating our second version of the model following the "indirect" approach, which includes among the economic variable also financial price changes and volatilities, are reported in Table 6.

The positive effect of the turnover variables of the money market and EONIA continue to be valid, and it is confirmed that the turnover of the bond market is not. We find that price level or change variables are not significant in the time series model. This is not difficult to explain and not a surprising result, since – as noted above – there is not a clearly established link in the literature, also from a theoretical perspective.

As regards the price volatility measures, only bond implied volatility is statistically significant while money market implied volatility and stock implied volatility are not. In addition, only money market implied volatility has the expected positive sign, while (somewhat puzzling at least *prima facie*) bond implied volatility has a negative sign which remains statistically significant even when the money market volatility variable is included. It is not easy to find a plausible explanation for this result.

In any event, the "indirect" inclusion of the financial price change and volatility variables in the model does not seem to add explicatory power, as it is shown by the decrease in the adjusted R-squared in the new specification compared with the estimation reported in Table 5. We conclude that it is not possible to improve on the results of the direct approach which links TARGET flows to turnover activity in money and bond markets, at least using the set of variables considered in this paper.

significant at 10% confidence level.

**Table 6 Variant of the parsimonious specification of model (2), which includes financial price changes and volatilities**

Sample (adjusted): 01/03/1999 – 20/12/2002

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 5.507 | 0.983 | 5.603 | 0.000 |
| LT3(-1) | 0.363 | 0.028 | 12.937 | 0.000 |
| LT3(-2) | 0.188 | 0.020 | 9.581 | 0.000 |
| LT3(-3) | 0.050 | 0.018 | 2.738 | 0.006 |
| LT3(-4) | 0.029 | 0.018 | 1.620 | 0.106 |
| LT3(-5) | 0.086 | 0.019 | 4.413 | 0.000 |
| END_RP | 0.057 | 0.010 | 5.786 | 0.000 |
| END_RP(-1) | 0.061 | 0.010 | 6.111 | 0.000 |
| END_RP(1) | 0.035 | 0.011 | 3.3135 | 0.001 |
| HOLUS(-1) | 0.388 | 0.023 | 16.866 | 0.000 |
| HOLUS | -0.504 | 0.025 | -20.384 | 0.000 |
| HOLUS(1) | 0.031 | 0.013 | 2.275 | 0.023 |
| HOLDE(-1) | 0.105 | 0.024 | 4.373 | 0.000 |
| HOLDE | -0.143 | 0.025 | -5.686 | 0.000 |
| HOLGB(-1) | 0.056 | 0.026 | 2.152 | 0.032 |
| MANN | 0.065 | 0.007 | 9.146 | 0.000 |
| MALLOT | -0.066 | 0.008 | -8.496 | 0.000 |
| MSETTL | -0.029 | 0.007 | -3.830 | 0.000 |
| SEMESTER_END | 0.259 | 0.051 | 5.019 | 0.000 |
| MONTH_END(-1) | -0.045 | 0.018 | -2.462 | 0.014 |
| MONTH_END | 0.151 | 0.022 | 6.961 | 0.000 |
| QUARTER_END | 0.247 | 0.021 | 11.679 | 0.000 |
| QUARTER_END(1) | 0.050 | 0.022 | 2.318 | 0.021 |
| LOG_LIQUIDITY | 0.094 | 0.039 | 2.427 | 0.015 |
| LOG_TURN_EONIA | 0.081 | 0.015 | 5.277 | 0.000 |
| LOG_TURN_MM | 0.031 | 0.009 | 3.395 | 0.001 |
| LOG_TURN_BOND | 0.004 | 0.010 | 0.409 | 0.682 |
| DS | 0.014 | 0.158 | 0.086 | 0.931 |
| DB | -0.055 | 0.061 | -0.914 | 0.361 |
| D_EONIA_MRO | 0.008 | 0.016 | 0.506 | 0.613 |
| MM_IMPL_VOL | 0.002 | 0.001 | 1.618 | 0.106 |
| BOND_IMPL_VOL | -0.011 | 0.005 | -2.192 | 0.029 |
| STOCK_IMPL_VOL | -0.000 | 0.000 | -1.004 | 0.316 |
| R-squared | 0.851 | Mean dependent var | | 26.765 |
| Adjusted R-squared | 0.846 | S.D. dependent var | | 0.187 |
| S.E. of regression | 0.073 | Akaike info criterion | | -2.347 |
| Sum squared resid | 4.710 | Schwarz criterion | | -2.172 |
| Log likelihood | 1095.179 | F-statistic | | 156.319 |
| Durbin-Watson stat | 1.916 | Prob(F-statistic) | | 0.000 |

Note: Newey-West HAC Standard Errors & Covariance

### 4.4 Re-estimating the model at monthly frequency

As mentioned in paragraph 4.2, in principle the large value payments may be determined by trading activity conducted on various segments of the euro financial market (money, bond or equity markets). At a daily frequency we can verify the existence of a clear link between cross-border payments and the money market turnovers. However, we cannot say anything about the possible role played by the settlement of the cash leg of transactions concluded on equity markets, due to the absence of suitable daily turnover data. Since turnover data for equity markets are available at a monthly frequency, we thus estimate a variant of model (2) on the log of the monthly turnover for the three market segments (for TURNOVER_EQUITY we build the series by summing the monthly average value of shares trading of the stock exchanges of the euro area countries[17]). Additionally we keep the dummies catering for the end of semester and end of (other) quarters, and we add a dummy taking into account the typical decrease of volumes observed during the month of August. The results are reported in Table 7. There is no evidence of serial correlation (as signalled by the LM test).

**Table 7 - Estimation of model (2) at monthly frequency. Version with only turnover data as economic variables**.

Sample period: January 2000 – December 2002

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 11.459 | 1.921 | 5.964 | 0.000 |
| LT(-1) | 0.484 | 0.134 | 3.625 | 0.001 |
| END_SEMESTER | 0.063 | 0.022 | 2.903 | 0.007 |
| END_QUARTER | 0.052 | 0.013 | 3.936 | 0.001 |
| AUGUST | -0.082 | 0.017 | -4.834 | 0.000 |
| LOG_LIQUIDITY | 0.058 | 0.279 | 0.207 | 0.838 |
| LOG_TURN_MM | 0.162 | 0.045 | 3.601 | 0.001 |
| LOG_TURN_EONIA | 0.173 | 0.045 | 3.880 | 0.001 |
| LOG_TURN_BOND | -0.089 | 0.064 | -1.378 | 0.180 |
| LOG_TURN_EQUITY | -0.024 | 0.045 | -0.550 | 0.587 |
| R-squared | 0.881 | Mean dependent var | | 26.837 |
| Adjusted R-squared | 0.840 | S.D. dependent var | | 0.089 |
| S.E. of regression | 0.036 | Akaike info criterion | | -3.601 |
| Sum squared resid | 0.033 | Schwarz criterion | | -3.161 |
| Log likelihood | 74.819 | F-statistic | | 21.456 |
| Durbin-Watson stat | 1.292 | Prob(F-statistic) | | 0.000 |

It should be emphasised that we also include the financial price change and volatilities variables in the monthly specification, finding confirmation of the result already seen at the daily frequency, namely

[17] Source: www.fese.be. Monthly statistics are available for downloading starting from January 2000 (values for Euronext Lisbon were not available).

that these variables do not seem to add any valuable information to that which is already contained in the turnover variables (direct approach).

As evident in Table 7, we do not find any significant effect for the equity market, while the money market and EONIA segments continue to show their positive effect also at a monthly frequency. We have argued that, in principle, we would expect internationally active market players to shift liquidity cross-border to cover the cash obligations they assume when acting on various equity markets, and such liquidity transfers could have been relevant for TARGET cross-border payments.

However, there could be various reasons why equity trading is eventually not directly reflected into TARGET cross-border payments flows. First, it is possible that, in general terms, cross-border trading in equities markets is smaller than on money markets because of the lower level of integration reached so far (at least considering the extent to which counterparties engage in cross-border trading as a sign of market integration) [18]. Second, it is possible that for a large part of the securities transactions the cash leg settlement takes place in the books of a commercial bank acting as settlement agent, i.e. in commercial bank money. For instance, this is the case when securities trades are settled at the two International Central Securities Depositories (ICSDs), Euroclear Bank and Clearstream Luxembourg, which provide do not provide facilities for settlement in central bank money (therefore the resulting cash transfers orders do not end up into the TARGET system). Third, the undoubtedly large cash obligations deriving from trading in equity markets do not necessarily end up in corresponding large cash transfers, because of the possible use of netting arrangements, either at clearing (CCP[19]) and/or settlement level (if the so-called DVP models 2 and 3 are used[20]). Fourth, even for trades settled at the Central Securities Depositories (CSDs), which typically provide central bank money settlement facilities, the payment orders originated by equity trading that, possibly after clearing and netting, end up into the RTGS systems are likely to be settled locally, via *domestic* interaction between the securities settlement system and the payment system, and thus, involve only the domestic components of TARGET, while we have looked at *cross-border* transfers data.

[18] See for instance ECB (2003), p. 63, where comparing the money, bond and equity markets, it is concluded that "it seems that equity markets may be the least integrated markets of the three (…)".

[19] A central counterparty clearing house is a financial intermediary that interposes itself between the trading parties (its members), becoming the seller to the buyer and the buyer to the seller, through a process of netting by novation which extinguishes the original obligations between the parties and replaces the original single contract with two separate contracts: the CCP becomes the single counterparty for all participants. Central counterparty clearing houses use multilateral netting because it minimizes the number of obligations to be settled. See ECB, Monthly bulletin, October 2001. Although originally used in derivative markets (mainly for futures), CCPs are increasingly active also in the underlying securities markets. In Europe for example LCH.Clearnet offer CCPs services covering a broad range of products (equities, exchange traded derivatives, OTC derivatives, bonds, commodities and energy). CCPs may achieve high netting ratios. For instance, in 2002 Clearnet SA showed a netting ration of 65.6% for the cash and 97% for the securities over year. The same values for LCH were respectively 65% and 95% (the two CCPs merged in 2003).

[20] The Committee on Payment and Settlement Systems of the central banks of the Group of Ten countries has identified three DVP models (BIS, Report on Delivery-versus-Payments models in securities settlement, September 1992): in model 1 both the cash and securities legs are settled on a gross basis. In Model 2, securities are settled on a gross basis while cash is settled on a net basis. In Model 3, both securities and cash are settled on a net basis. In 2002, in ten EU countries DVP was organised as models 2 or 3 (see ECB 2004, Blue Book incorporating 2002 figures – EU countries, Table 17, p.28).

# 5 The determinants of payments settled in EURO 1

As we noted in Section 2, TARGET and EURO 1 payments traffic are significantly correlated, (see Chart 1). Therefore, we test whether model (2) explain also the determinants of the payments settled through the net system.

We now use as independent variable the log of the gross value of EURO 1 payments (i.e. value of payments submitted to the system, *before* netting. The results, reported in Table 8, show that our specification performs well. In short, also EURO 1 payment traffic:

- *decreases* on occasion of banking holidays in the US, in GB and DE, in the case of the US with part of the traffic being settled on the previous day;
- *increases* at the end of the month, of the quarter, and of the semester, as well as with the approaching of the end of the reserves maintenance period and of its beginning;
- it also *increases* when banks reserves increase (more liquidity is available), and with the activity on the overnight segment of the money market;
- finally, it *increases* on the days of announcement of Eurosystem monetary policy operations, and decreases on days of their allotment and settlement.

Therefore, we can generalise the main conclusions of the previous analysis on TARGET cross-border payments determinants to the cross-border large value payment systems in general.

Comparing the EURO 1 results with those obtained on TARGET flows it is worth noting that while the impact of German holidays is similar, the impact of US holidays is stronger on EURO 1 settlement activity than on that of TARGET (-1.20 compared to -0.50). This might suggest the presence of a large weight, in relative terms, of settlement of forex transactions on EURO 1's transactions (this would confirm the presence of foreign exchange-related payments being channelled through the system reported by Bank of England, 2001, p.50). The strong impact of the business holidays in GB on EURO1 transactions is also interesting recalling that this was rather weak in the case of TARGET. This seems to confirm that in routing payments to the various euro payment systems they participate in, "UK banks are heavy users of other euro payment systems (such as EURO 1)" (see Bank of England, 1999), which would explain why their absence has a strong negative impact on EURO1 activity. It should be noted that, belonging to non euro area country, these banks have only limited access to euro intraday credit in TARGET, hence their heavy use of EURO 1, where a netting mechanism and deferred settlement result in payment capacity with a lower liquidity requirement.

Finally, the impact of transactions originated on the money market seems a bit smaller (also in relative terms).

## Table 8 – Parsimonious specification of model (2) on EURO 1 payments (gross value)

Sample (adjusted) 11/01/1999 – 23/12/2002

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 10.562 | 0.745 | 14.179 | 0.000 |
| LOG_EURO1(-1) | 0.221 | 0.024 | 9.366 | 0.000 |
| LOG_EURO1 (-2) | 0.167 | 0.013 | 13.344 | 0.000 |
| LOG_EURO1 (-3) | 0.071 | 0.013 | 5.501 | 0.000 |
| LOG_EURO1 (-4) | 0.038 | 0.012 | 3.102 | 0.002 |
| LOG_EURO1 (-5) | 0.034 | 0.012 | 2.835 | 0.005 |
| HOLUS | -1.209 | 0.018 | -65.658 | 0.000 |
| HOLGB | -0.204 | 0.040 | -5.081 | 0.000 |
| HOLDE | -0.102 | 0.028 | -3.651 | 0.000 |
| HOLUS(-1) | 0.601 | 0.034 | 17.645 | 0.000 |
| SEMESTER_END | 0.348 | 0.043 | 8.174 | 0.000 |
| QUART_END | 0.351 | 0.036 | 9.701 | 0.000 |
| MONTH_END | 0.235 | 0.018 | 12.807 | 0.000 |
| MANN | 0.073 | 0.009 | 7.760 | 0.000 |
| MALLOT | -0.089 | 0.009 | -9.705 | 0.000 |
| MSETTL | -0.078 | 0.009 | -9.045 | 0.000 |
| END_RP | 0.036 | 0.015 | 2.434 | 0.015 |
| END_RP(-1) | 0.059 | 0.015 | 3.806 | 0.000 |
| END_RP(1) | 0.039 | 0.014 | 2.735 | 0.006 |
| LOG_TURN_MM | 0.023 | 0.007 | 3.449 | 0.001 |
| LOG_TURN_EONIA | 0.055 | 0.014 | 3.883 | 0.000 |
| LOG_LIQUIDITY | 0.081 | 0.032 | 2.498 | 0.013 |
| R-squared | 0.870 | Mean dependent var | | 25.944 |
| Adjusted R-squared | 0.867 | S.D. dependent var | | 0.258 |
| S.E. of regression | 0.094 | Akaike info criterion | | -1.865 |
| Sum squared resid | 8.170 | Schwarz criterion | | -1.752 |
| Log likelihood | 902.332 | F-statistic | | 293.134 |
| Durbin-Watson stat | 1.873 | Prob(F-statistic) | | 0.000 |

# 6 Conclusions

In this paper we analyse TARGET cross-border payment flows, assuming that it could provide interesting information for understanding the functioning of the euro area interbank market.

The results of our analysis show that TARGET cross-border payments are geographically concentrated, and seem to reflect a tiered market structure for liquidity, where the big countries (DE, FR and GB) play a crucial role, where a core integrated market is composed of the big players plus IT, BE and NL, and where there is a sort of "periphery" composed of the smaller countries. In addition, our gravity model supports the hypothesis that market players have organised the interbank business relations in such a way that "location matters". In this sense, bilateral cross-border payment flows increase with the size of the counterparty country, its geographical and cultural proximity.

Through a time series analysis, we identify the determinants of the TARGET cross-border flows, and distinguish between economic variables and other (technical and special) conditions. Among the first, our regression model shows that TARGET flows are positively related mainly to the trading volumes in the euro money market, more specifically in its overnight unsecured segment. As regards the technical and special conditions, TARGET cross-border flows suffer a downward effect in case of business holidays in the US, DE and GB, and undergo a positive one in correspondence with some recurrent events (i.e. last day of each month/quarter, last day of the minimum reserve maintenance period). Our estimates show somewhat surprisingly that that the cross-border activity increases on the day of the announcement of the Eurosystem's main refinancing operations, as if banks started redistributing liquidity anticipating the results of allotment of the following day.

The model maintains a good explanatory power also when applied to the analysis of the determinants of interbank payments settled in the other main large value payment system for the euro currency, EURO 1. Compared to the results obtained for TARGET, the estimates suggests a possible higher use of EURO 1 (in relative terms), particularly by GB banks, and a significant presence of transactions related to activities in the US, like forex transactions that are not settled on the days of US banking holidays.

The analysis of the determinants of TARGET cross-border payments at a monthly frequency confirms the link between TARGET and the turnover of the money market. We did not find evidence of a possible link between cross-border cash payments and the securities markets (bond and equity turnovers are not significant). Various possible explanations could be considered, including some institutional settings of the securities infrastructure industry, which may involve netting procedures for the cash leg of the transactions either at clearing and or at settlement level. Moreover, the interaction between securities settlement systems and payment systems takes place mostly at level of the domestic components of TARGET, while we looked at cross-border data.

Our analysis is based on daily data. However, it would be interesting to repeat the exercise on intra-day data, to study how liquidity circulates from one country to another during the business day. By matching this information with the data of possible temporary deviations of money market rates, one could have a fair picture of how the tiered, "intermediated" market model enables the exploitation of the arbitrage opportunities possibly arising during the day.

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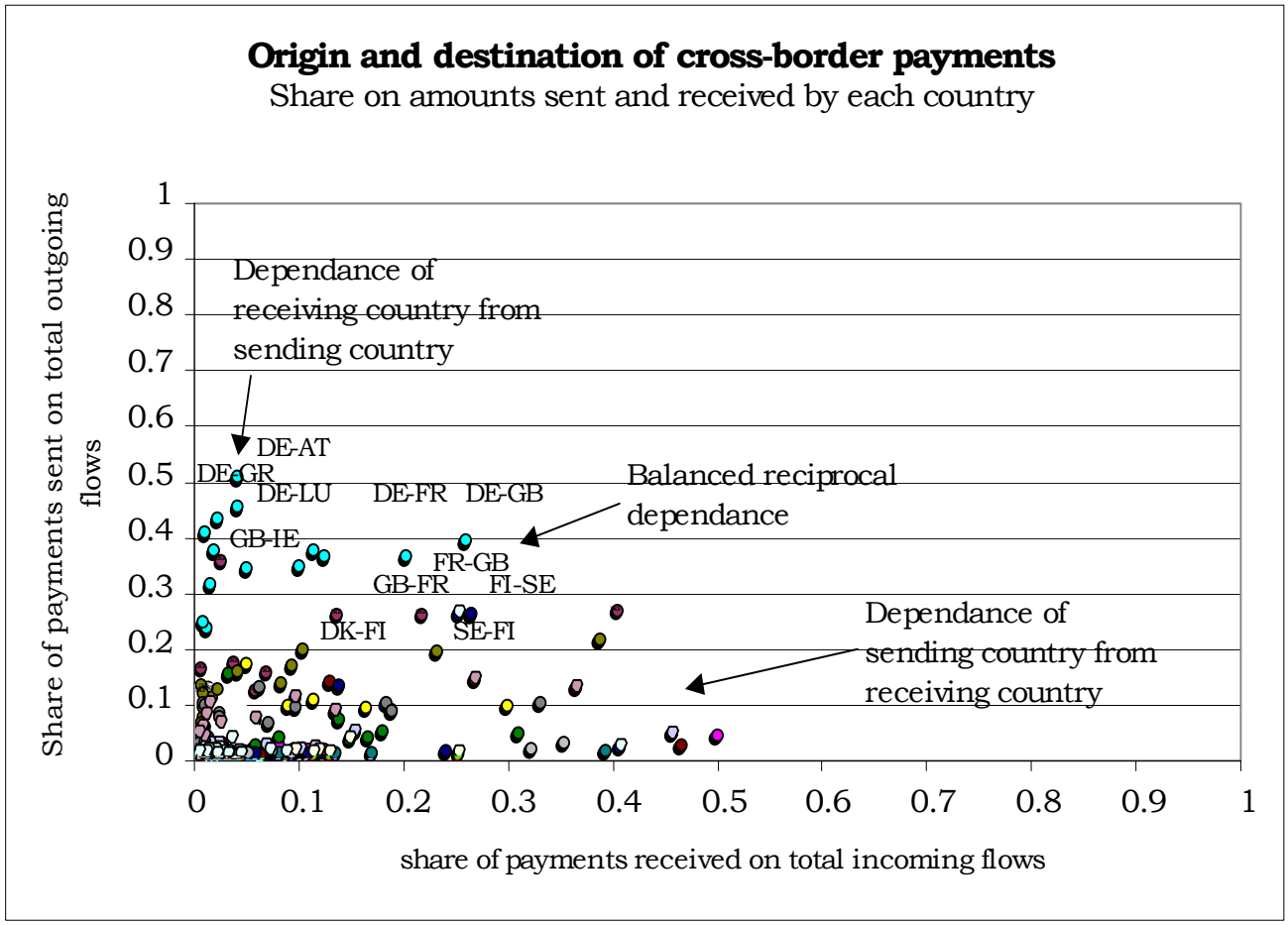
# Annex

**Table 9 - Cross-border Payments sent by each country connected to TARGET, average of daily data 1999-2002, EUR million**

(ECB flows excluded)

| | RECEIVER (j) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SENDER (Sij)** | **AT** | **BE** | **DE** | **DK** | **ES** | **FI** | **FR** | **GB** | **GR** | **IE** | **IT** | **LU** | **NL** | **PT** | **SE** | **TOTAL SENT** |
| **AT** | - | 491.72 | 4,548.72 | 56.34 | 238.87 | 66.58 | 964.56 | 1,086.10 | 65.16 | 57.15 | 726.95 | 240.10 | 354.87 | 94.34 | 98.09 | **9,089.55** |
| **BE** | 488.68 | - | 12,986.80 | 355.01 | 1,259.10 | 298.22 | 5,717.34 | 4,316.08 | 214.52 | 401.35 | 3,162.89 | 1,643.22 | 3,753.40 | 424.67 | 162.75 | **35,184.04** |
| **DE** | 4,584.35 | 10,494.46 | - | 2,476.48 | 4,930.95 | 1,275.47 | 24,210.50 | 30,236.87 | 1,059.22 | 1,777.31 | 11,037.61 | 4,910.00 | 14,457.79 | 905.56 | 2,135.98 | **114,492.55** |
| **DK** | 46.38 | 441.83 | 2,409.04 | - | 56.22 | 725.51 | 393.87 | 509.96 | 13.90 | 17.31 | 90.04 | 145.88 | 536.80 | 55.89 | 180.08 | **5,622.73** |
| **ES** | 249.23 | 1,195.80 | 5,491.91 | 49.19 | - | 37.33 | 2,514.32 | 2,770.19 | 46.62 | 182.35 | 2,021.29 | 133.29 | 971.96 | 529.83 | 61.11 | **16,254.43** |
| **FI** | 67.24 | 301.70 | 1,185.57 | 687.74 | 38.32 | - | 302.59 | 634.28 | 7.41 | 25.88 | 273.17 | 18.04 | 264.53 | 12.51 | 1,324.96 | **5,143.94** |
| **FR** | 983.30 | 5,743.05 | 22,931.61 | 333.99 | 2,844.22 | 307.90 | - | 16,255.29 | 359.50 | 511.58 | 6,091.55 | 1,233.54 | 5,299.82 | 401.67 | 229.22 | **63,526.25** |
| **GB** | 1,131.80 | 6,557.58 | 29,637.39 | 463.45 | 2,620.92 | 573.16 | 14,473.61 | - | 451.63 | 1,952.55 | 6,281.25 | 1,079.15 | 10,562.40 | 458.57 | 454.47 | **76,697.93** |
| **GR** | 49.35 | 181.17 | 1,044.05 | 13.45 | 44.55 | 9.47 | 334.70 | 413.87 | - | 49.32 | 247.96 | 31.86 | 118.13 | 32.58 | 16.50 | **2,586.96** |
| **IE** | 55.62 | 395.48 | 1,660.63 | 13.14 | 182.10 | 29.03 | 483.27 | 1,880.01 | 48.41 | - | 127.65 | 34.01 | 276.69 | 82.70 | 64.63 | **5,333.37** |
| **IT** | 726.70 | 3,082.60 | 11,268.64 | 105.38 | 2,182.69 | 272.80 | 6,363.80 | 5,076.18 | 243.34 | 124.00 | - | 738.04 | 2,247.21 | 340.62 | 113.43 | **32,885.43** |
| **LU** | 180.42 | 1,735.25 | 4,650.56 | 100.93 | 126.49 | 15.72 | 1,260.01 | 1,011.22 | 18.44 | 46.10 | 742.02 | - | 365.70 | 91.60 | 58.33 | **10,402.80** |
| **NL** | 433.25 | 3,984.50 | 14,154.60 | 500.77 | 903.66 | 304.43 | 5,143.58 | 10,105.55 | 131.10 | 274.69 | 2,346.37 | 454.92 | - | 149.75 | 373.35 | **39,260.52** |
| **PT** | 103.46 | 425.63 | 829.39 | 55.03 | 508.72 | 12.46 | 386.60 | 405.12 | 31.01 | 83.10 | 316.63 | 89.28 | 142.08 | - | 21.07 | **3,409.57** |
| **SE** | 101.62 | 243.90 | 2,029.86 | 135.55 | 71.17 | 1,404.34 | 248.10 | 535.70 | 18.66 | 67.62 | 133.79 | 77.78 | 416.95 | 25.18 | - | **5,510.23** |
| **TOTAL RECEIVED** | **9,201.39** | **35,274.68** | **114,828.77** | **5,346.45** | **16,007.98** | **5,332.42** | **62,796.86** | **75,236.43** | **2,708.92** | **5,570.32** | **33,599.19** | **10,829.13** | **39,768.33** | **3,605.46** | **5,293.97** | **425,400.29** |

**Chart 3 - Map of payment-flows bilateral relations**



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