Central bank refinancing, interbank markets, and the hypothesis of liquidity hoarding: evidence from a euro-area banking system

by Massimiliano Affinito*

Abstract

This is the first paper to analyse the relationship between single banks' positions vis-à-vis the central bank and the interbank market and to perform an extensive test of the liquidity hoarding hypothesis using micro data. According to the most critical version of the hypothesis, during the crisis, central banks have been ineffective because banks hoarded the liquidity injected rather than channelling it on to other banks and the real economy. The results show that in Italy during the 2007-2011 financial crisis, contrary to widespread conjecture, the liquidity injected by the Eurosystem was intermediated among banks and towards the economy.

JEL Classification: G21, E52, C30.
Keywords: liquidity, financial crisis, central bank refinancing, interbank market.

Contents

* Bank of Italy, Economic Research Department. Email address: massimiliano.affinito@bancaditalia.it. I would like to thank for their comments, without implicating them in responsibility, Filippo Altissimo, Paolo Angelini, Mascia Bedendo, Luigi Cannari, Giuseppe Cappelletti, Falko Fecht, Giovanni Guazzarotti, Michele Manna, David Marqués-Ibañez, Stefano Neri, Matteo Piazza, Alberto Franco Pozzolo, Michela Rancan, Alessandro Secchi, and participants at the seminar held at the Bank of Italy (Rome, September 2012); at the ECB-FED Conference "Bank Funding - Markets, instruments and implications for corporate lending and the real economy" (Frankfurt, October 2012); at the ECB Workshop "Excess Liquidity and Money Market Functioning" (Frankfurt, November 2012); at the Università Bicocca Workshop "Macro Banking and Finance" (Milan, September 2013); at the "Paris Financial Management Conference" (Paris, December 2013). The opinions expressed are only mine and do not necessarily reflect those of the Bank of Italy or the Eurosystem.

1. Introduction

The global financial crisis erupted in the summer of 2007 has reminded everyone of the crucial role played by liquidity markets. This paper enlists in the academic and policy debate analysing jointly the two main wholesale liquidity markets: the central bank refinancing and the interbank market.

The literature typically shares the idea that banks' demand for central bank liquidity and interbank markets are to be analysed jointly (e.g. Furfine, 2003; Craig and Fecht, 2007; Bindseil *et al.*, 2009). An adequate amount of liquidity in the economy and its efficient intermediation through the banking system are both crucial for the correct functioning of the financial system, the implementation of monetary policy, the orderliness of the payment system and the financing of the real economy. Central bank refinancing is often viewed as the primary liquidity market, and the interbank market as the secondary liquidity market, where the liquidity obtained in the primary market is reallocated. However, to my knowledge, this is the first paper to analyse the relationship between single banks' positions vis-à-vis the central bank and the interbank market with micro data. The aim is to perform the first extensive test of the liquidity hoarding hypothesis using micro data.

The liquidity hoarding hypothesis has been very common in the specialized press as well as in the academic literature since the inception of the crisis. However, this literature is not unanimous, in particular on the role of central banks in crises. It is unanimous when suggests that banks might hoard liquidity and interbank market might freeze, either because of a general heightened (perceived) riskiness of the borrowing banks (counterparty credit risk), or for a precautionary accumulation of liquidity by the lending banks (liquidity risk).[1] But, as far as the role of central banks is concerned, it splits into two views. The bulk of the literature holds that central bank intervention remains warranted even when liquidity hoarding occurs; while the most critical part of the literature on liquidity hoarding (e.g. The Economist, 2007; Financial Times, 2008; Edlin and Jaffee, 2009; Heider *et al.*, 2009; Brunetti *et al.*, 2011) posit that central banks are ineffective in times of crisis for two reasons. First, because large liquidity injections increase the excess reserves held by banks, which tend to accumulate liquidity in periods of uncertainty and not to lend to other banks or to real economy. Second, because liquidity injections are not effective in restoring interbank lending as the central bank crowds out the interbank market by becoming counterparty in all liquidity transactions.

[1] Diamond and Rajan (2005); Wu (2008); Michaud and Upper (2008); Diamond and Rajan (2008); Taylor and Williams (2008, 2009); Schwarz (2009); Heider *et al.* (2009); Gale and Yorulmazer (2010); Acharya and Skeie (2011); De Haan and Van den End (2011); Wolman and Ennis (2011); Berrospide (2012).

This paper tests this critical version of the liquidity hoarding hypothesis extensively in order to shed light on the conflicting views of the literature[2], and to verify empirically whether central banks have been ineffective during the crisis or effective in sustaining liquidity among banks and, ultimately, credit to the real economy. The analysis has significant policy implications given the need for a better understanding of the markets for liquidity and effectiveness of monetary policy during financial crises.

My empirical test is carried out on the policy of the Eurosystem. The test is executed using a unique micro database containing data at banking group level on all the relationships of each banking group with the central bank and interbank counterparties along with a large set of bank-level characteristics. Such a database does not exist for the euro area as a whole (indeed a similar database exists only in few countries around the world). However, the paper has the advantage of analysing a major euro-area country, Italy, where supervisory reporting requirements make such a database available. The Italian banking system is an interesting case for two reasons: it is a leading euro-area banking system; and, given Italy's bank-based economy, the interbank and bank credit markets are crucial to the financing of the private sector. The sample period spans 152 months from the introduction of the single euro-area monetary policy in January 1999 to the onset of the most acute phase of the euro-area sovereign debt crisis in August 2011. After the summer of 2011, the sovereign debt crisis affected the Italian banking system severely, sovereign bond yields rose, sovereign ratings deteriorated, and banks' ability to access and accumulate collateralized lending and liquidity decreased (Bank of Italy, 2012). Therefore, excluding the most acute phase of the sovereign debt crisis enables me to focus the analysis on the part of the crisis in which liquidity hoarding was most likely (because possible in abstract), and when exactly the literature and the press insisted on the issue, including precisely the Italian case (e.g. Brunetti *et al.*, 2011; Bagliano and Monticini, 2013).

The paper carries out a composite test. First, since liquidity decisions are taken at very short maturities and the direction of casual nexus is uncertain, the paper investigates both possible casual directions between the two wholesale liquidity markets. Second, since in both cases the interdependence between the two markets remains an issue, the paper constantly controls for their mutual endogeneity by means of instrumental variable regressions. Third, as the hypothesis refers mainly but not exclusively to the wholesale liquidity markets, the paper examines the connections between them but also with bank lending to the real economy. Fourth, in order to explore the role of

[2] The supporters of the effectiveness are however prevailing: Flannery (1996); Freixas *et al.* (2000); Acharya *et al.* (2008); McAndrews *et al.* (2008); Ashcraft *et al.* (2009); Allen *et al.* (2009); Keister and McAndrews (2009); Acharya and Merrouche (2010); Matin *et al.* (2010); Freixas *et al.* (2011); Gorton and Metrick (2011); Afonso *et al.* (2011); Matin et al. (2013).

different possible liquidity redistribution channels, the paper breaks down and studies the separate segments of the interbank market: extra-group and intra-group; domestic and across borders; bilateral and via central counterparties.

The results clearly and robustly contradict the most critical version of the liquidity hoarding hypothesis. They show that central bank liquidity is not accumulated but rather channelled to the banking system and the economy. Therefore, they demonstrate that central bank interventions are not only warranted but also effective even in periods of crises. In particular, the results show that in Italy during the 2007-2011 crisis the banks that relied more on central bank refinancing lent more both to other banks and to firms and households, and that central bank liquidity injections were not accumulated but rather used to speed up both interbank and customer lending. Moreover, banks with copious retail funding lent even more, and did not apply for additional central bank refinancing, and thus did not hoard liquidity. These results provide a unique picture, confirming for the euro-area findings obtained so far only for the US and only by combining a set of papers: McAndrews *et al.*, 2008; Ashcraft *et al.* 2008; Ashcraft *et al.*, 2009; Christensen *et al.*, 2009; Afonso *et al.*, 2011.[3]

In addition to the referred literature on liquidity hoarding, the paper joins other fields of research. First, this paper draws on and contributes to the general literature on central bank interventions in the interbank market. This literature highlights that in a normally functioning interbank market, in which banks with a liquidity surplus transfer funds to those with a deficit and illiquid but solvent banks can obtain funding, central banks step in only to fine-tune liquidity conditions and, ultimately, very short-term interest rates (e.g. Selgin, 1993; Freixas *et al.* 1999). When the interbank market becomes dysfunctional because of asymmetric information, so that even solvent banks cannot get credit, central banks must step in to solve a market failure because have two unique abilities: to provide liquidity in sufficient amounts in response to abnormal shocks (Bhattacharya and Gale, 1987; Acharya *et al.* 2008) and to diversify risk across many illiquid banks (Flannery, 1996; Rochet and Vives, 2004). This paper contributes by showing that interventions in the interbank market are effective even during periods of crisis.

Second, this paper is related to the literature on banks' participation in central banks' operations.[4] It too uses bank-specific characteristics to explain the decision to access central bank

[3] McAndrews *et al.* (2008), Ashcraft *et al.* (2009), and Christensen *et al.* (2009) find that the liquidity measures adopted by the Federal Reserve were effective during the 2007-08 financial crisis. Afonso *et al.* (2011) find that liquidity hoarding is an unimportant factor in US interbank loans. Ashcraft *et al.* (2008) show that, during the first phase of the great financial crisis, the Federal Home Loan Bank System (a US government-sponsored liquidity provider alternative to the Fed) provided liquidity to depository institutions, which in turn financed the real economy.

[4] Peristiani (1998); Breitung and Nautz (2001); Nyborg *et al.* (2002); Furfine (2003); Nautz and Oechssler (2003); Nyborg and Strebulaev (2004); Bruno *et al.* (2005); Linzert *et al.* (2006); Linzert *et al.* (2007); Craig and Fecht (2007); Bindseil *et al.* (2009); Ennis and Weinberg (2009); Fecht *et al.* (2011); Armantier *et al.* (2011).

credit because banks' heterogeneous business activities and risk profiles generate different liquidity needs, but makes an original contribution in several respects. It utilizes micro data to explore the role played by bank-specific characteristics. It analyses banks' total borrowing from central bank, whereas the literature typically focuses on specific types of central bank loans (because of lack of data on total borrowing), which however is likely to mislead the real determinants and effects of central bank loans, given that the different types present evident substitute roles. It studies all interbank transactions, including over-the-counter, whereas the literature can typically explore only single segments of the interbank market. It covers all banks including those that never directly access the central bank's liquidity, thus obtaining complementary inferential information and avoiding sample-selection bias. It uses aggregated banking-group data, which are better suited to investigating liquidity needs and the decision to access central bank liquidity. These characteristics allow the paper to employ an accurate identification strategy, and thus to provide clear and robust evidence.

Finally, the paper is related to the literature on the functioning of the interbank markets (e.g. Rochet and Tirole, 1996; Furfine, 2001). My results show that the main interbank segment used to redistribute the central bank liquidity is the domestic extra-group segment. This outcome is in line with Affinito (2012), who demonstrates that the transactions in this segment are favoured by the presence of relationship interbank lending. However, my results indicate that banks redistribute also abroad, mainly to other members of their groups.

The rest of the paper is organized as follows. Section 2 describes the methodology. Section 3 presents the data. Sections 4-6 report the results, Section 7 summarizes robustness checks, and Section 8 concludes.

2. Empirical strategy

The paper conducts an empirical test of the hypothesis of liquidity hoarding in Italy during the crisis. The test is multi-sided, in the sense that it combines four features.

(1) My test explores both possible directions of the casual nexus between central bank refinancing and interbank market. Banks' liquidity decisions are typically taken at very short maturities, so it is not trivial to infer *a priori* whether a bank treasurer decides first central bank liquidity demand and then his interbank conduct, or vice-versa. It is likely that both may be the case at different moments depending on very short liquidity needs, surpluses, and opportunities. As a consequence, my test requires a two-way analysis and continuous control for endogeneity.

I start by following the standard literature, which generally estimates banks' demand for central bank liquidity and analyses its determinants (e.g. Peristiani, 1998; Breitung and Nautz, 2001; Nyborg *et al.*, 2002; Furfine, 2003; Linzert *et al.*, 2007; Craig and Fecht, 2007; Bindseil *et al.*, 2009; Armantier *et al.*, 2011; Afonso *et al.*, 2011). That is, I take central bank refinancing as the main dependent variable (on the left-hand side of my equation), and the interbank market as the explanatory variable (on the right-hand side). This estimation answers the general question of the characteristics (determinants) of the banks that ask for central bank liquidity. And, more specifically, whether they redistribute or hoard liquidity. To explicate, if I find that the banks that apply for central bank liquidity are net interbank lenders, I can conclude that central bank liquidity is likely to be demanded by redistributing banks.

Then, I reverse the experiment, estimating interbank market as the dependent variable, and central bank refinancing as the explanatory variable. This runs counter to the standard literature, but has the merit of explicitly addressing the question of whether central bank refinancing spurs interbank lending.

In both cases, I use instrumental variable (IV) regressions, which are well suited to joint analysis of the primary and secondary liquidity markets because they allow: (i) handling the endogeneity problem, which exists in both casual directions; and (ii) examining *all* the determinants of *all* liquidity markets at the same time. I complement the analysis with SUR model estimations, because, while the SUR model does not properly instrument the endogenous variable, it does allow for contemporaneous correlation across the different innovations, and estimation of the mutual effect of the different endogenous variables.

In formal terms, my empirical strategy is represented by a system of equations. In the simplest case, I have two equations:

$$y_{i,t} = \alpha'_1 x_{i,t} + \beta'_1 K^{R}_{i,t-1} + \eta'_1 b_i + \lambda'_1 p_t + \varepsilon_{i,t} \quad (1)$$

$$x_{i,t} = \beta'_2 K^{R}_{i,t-1} + \eta'_2 b_i + \lambda'_2 p_t + \varphi'_2 K^{I}_{i,t-1} + \xi_{i,t} \quad (2)$$

where $y_{i,t}$ is the dependent variable in equation 1 (second stage, in terms of the IV model), and $x_{i,t}$ is the endogenous covariate in equation 1 and the dependent variable in equation 2 (first stage in terms of the IV model), where it is instrumented by the matrix of instruments $K^{I}_{i,t-1}$. As noted above, $y_{i,t}$ may represent central bank refinancing (to bank i in month t), and $x_{i,t}$ the interbank market position; or vice-versa. Of course, the matrix of instruments $K^{I}_{i,t-1}$ differs between the two versions of the IV estimations. In the SUR estimation, $y_{i,t}$ appears simultaneously as a regressor in the second equation of the system. The matrix of regressors $K^{R}_{i,t-1}$, included in both equations, contains many bank

characteristics. α_1, β_1, η_1, λ_1, β_2, η_2, λ_2, φ_2 are vectors of coefficients; α_1 is the coefficient of interest; $\varepsilon_{i,t}$ and $\xi_{i,t}$ are idiosyncratic errors ~ i.i.d. Bank fixed effects b_i and month fixed effects p_t are always included in order to control for bank-level unobservable characteristics, such as the extent to which different intermediaries are hit by the financial crisis, and to take into account macroeconomic trends and all unobservable time-varying variables.[5]

(2) My test studies − simultaneously and separately − five segments of the interbank market and the three positions for each (debt, credit, and net). I split the interbank market into the following five segments.

(i) Domestic Extra-Group, i.e. the traditional *bilateral* interbank transactions carried out *domestically* among banks not belonging to any banking group or belonging to different banking groups.

(ii) Domestic Intra-Group, i.e. domestic transactions among banks belonging to the same group.

(iii) Cross-Border Extra-Group.

(iv) Cross-Border Intra-Group.

(v) Central Counterparties (CCPs), i.e. *trilateral* extra-group interbank (anonymous and guaranteed) transactions via domestic central counterparties, in which the ultimate counterparty can be a domestic or a non-domestic bank or another non-domestic central counterparty.

The distinction between Extra-Group and Intra-Group exposures is essential in my analysis because only Extra-Group exposures constitute a real liquidity redistribution through the banking system.[6] The distinction between Domestic and Cross-Border exposures is used to investigate whether liquidity redistribution occurs and whether it occurs domestically and/or cross-border (e.g. Schnabl, 2012). The distinction between bilateral and trilateral exposures enables to explore the role played by the new segment of CCPs, which is guaranteed, gained greatly in importance during the crisis and is purely neither domestic nor cross-border.

For each segment of the interbank market, I analyse singly the gross borrowing side (Debts), the gross lending side (Credits), and the Net Position (Credits less Debts). The purpose of the Net Position analysis is plain: to see whether the banks that borrow from the central bank are net interbank borrowers or lenders, hence whether central bank liquidity goes to liquidity redistributors or hoarders. To exemplify, when $y_{i,t}$ is central bank refinancing and $x_{i,t}$ is the interbank Net Position,

[5] The regressors in the matrixes $K^R_{i,t-1}$ and $K^I_{i,t-1}$ are lagged to avoid new endogeneity in estimating $x_{i,t}$, and to replicate the publication delay needed for mutual assessment by banks. In order to verify the presence of further endogeneity problems, I also experiment with the variable $x_{i,t-3}$, lagged by a quarter, and accordingly use $K^I_{i,t-4}$. See details in Section 7. On a similar use of both lags and (bank and time) fixed effects in a panel IV estimation, see for example Berger and Bouwman (2009).

[6] To exemplify, if banks paradoxically lent only within their own banking groups, the total interbank market would apparently be working, but actually there would be liquidity hoarding at banking group level.

$\alpha_1 > 0$ means that the banks asking for central bank liquidity are net interbank lenders, i.e. redistributors. Likewise, when $y_{i,t}$ is the interbank Net Position and $x_{i,t}$ is central bank refinancing, $\alpha_1 > 0$ means that central bank liquidity injections prompt liquidity redistribution among banks.

The gross variables Debts and Credits are useful as well, in that for the same Net Position they indicate the extent to which banks are using the interbank market.[7] And concurrent analysis of them provides a complete picture of liquidity markets, enabling me to estimate the determinants of all interbank positions and to check the stability of the control regressors.

In short, the interbank market is analysed using 13 different variables: 3 positions (Debts, Credits, and Net Position) for 4 segments (Domestic Extra-Group; Cross-Border Extra; Cross-Border Intra; and CCPs) plus 1 position for the Domestic Intra-Group segment.[8] In this sense, the system of equations 1-2 is only exemplificative of the many specifications I run. For example, when two interbank segments are analysed simultaneously, the system is composed of three equations: the first equation contains two endogenous regressors, and the matrix of instruments $K^I_{i,t-1}$ includes instruments for two segments of the interbank market.[9] In this case, the SUR model is again useful because it allows me to estimate the interactions between different endogenous segments.

(3) My empirical strategy allows analysis of bank characteristics in the matrix $K^R_{i,t-1}$ as determinants both of central bank refinancing and of all interbank market segments/positions. The inclusion of bank characteristics as explanatory variables is in line with all the literature and serves as a control. Moreover, it provides complementary information for testing the hypothesis of liquidity hoarding. In particular, when the central bank refinancing equation is estimated, three covariates are interesting. First, the variable measuring *loans to retail customers* tests whether the banks taking central bank liquidity are or not intermediating onward to the economy. This variable is so meaningful for testing the liquidity hoarding hypothesis that I reverse the experiment in analysing it such as in the case of the interbank market, that is to explore whether central bank refinancing prompts bank loans to retail customers. Second, the variable measuring *retail fundraising* ascertains whether the banks taking central bank liquidity are already liquid, and if they are thus accumulating further liquidity. Third, the *banks' health* variables (capital, profitability) verify whether sound

[7] To exemplify, let us assume a banking system composed of two banks (*A* and *B*) and two months (t_1 and t_2). During t_1, *A* and *B* do not exchange their liquidity at all, but during t_2, *A* lends to and borrows from *B* an amount equal to 100. At the end of both months, each bank's Net Position is zero, but in the first month the interbank market is frozen, whereas in the second it is fully operational (*A* and *B* may have mutually financed their temporary liquidity needs at different times during the month).

[8] In this segment, Credits and Debts are identical, and Net Position is zero by definition. In this case, I do not estimate the effect of the different positions, but I do retain the Domestic Intra-Group Credits (or Debts) to capture whether the banking groups with greater exchange of internal liquidity also have greater recourse to central bank refinancing and to the other segments.

[9] Alternatively, when tests of endogeneity allow, the system retains two equations, and one of the two interbank market segments is included as exogenous.

banks are forced to borrow from the central bank (suggesting a possible malfunctioning of the interbank market).

(4) As far as the impact of the crisis is concerned, I split my long sample period into two spans, before and after the onset of the crisis, and then repeat all the estimations of all determinants over the two sub-periods.[10] This helps to verify the liquidity hoarding hypothesis because it sheds light on the way in which the determinants of all liquidity markets change over the crisis.

3. The data

I have two kinds of key variables: central bank refinancing, and the set of variables on the five interbank market segments. The source of the data is the Bank of Italy's prudential supervisory reports.

My first key variable − central bank refinancing − is the ratio between the total exposures of each bank towards the central bank in each period (gross or net of amounts re-deposited at the central bank) and total assets. Since the Eurosystem implements its monetary policy operations in a decentralised manner (that is, the ECB coordinates the operations and the national central banks carry out the transactions), and banks having establishments (a head office or branches) in more than one member state may access the Eurosystem liquidity through different NCBs, my dataset on the one hand may exclude the liquidity obtained by an Italian bank through the NCB of another country; but on the other hand it includes the liquidity obtained through the Bank of Italy by, say, a French or a German bank that has a branch in Italy. My variable comprises all kinds of exposures: standing facilities, open market operations, and loans granted through the non-standard measures taken by the Eurosystem during the crisis.[11] The distinction by type of central bank loan is irrelevant for my purposes because I analyse the determinants and the effects of the overall central bank liquidity regardless of the substitute role of different instruments.[12]

[10] As a check, I also use a difference-in-difference approach. See details in Section 7.

[11] The Eurosystem conducts two standard types of operations: standing facilities and open market operations. Open market operations, the most important, include main refinancing, longer-term refinancing, fine tuning, and structural operations. Since August 2007, the Eurosystem has undertaken several temporary unconventional monetary policy measures. These measures include: (i) extension of the maturity of longer-term refinancing operations; (ii) increase in the amount of liquidity provided through longer-term operations; (iii) a fixed rate, full allotment tender procedure, which allows unlimited access to central bank liquidity for eligible institutions subject to adequate collateral; (iv) extension of the eligible collateral accepted in Eurosystem operations. Eurosystem liquidity may be obtained also by non-euro-area banks. For more details, see Cecioni *et al.* (2011); Eser *et al.* (2012); ECB (2012).

[12] There are different areas of the literature that deal with the types of central bank loans: to investigate banks' ability to use specific refinancing options; to ascertain whether stabilization can be achieved by open market operations (Goodfriend and King, 1988; Kaufman, 1991) or lending to individual banks (Flannery, 1996; Goodhart, 1999); to see whether a distinction can be made between monetary-policy and lender-of-last-resort operations (Freixas *et al.*, 1999). For my purposes, these distinctions would be misleading. To exemplify, even if one bank's bidding strategy fails or if the Eurosystem mistakenly injects too little liquidity by market operations, the bank can make up the difference by accessing the standing facilities.

My second set of key variables measures the three positions (Debts, Credits, and Net Position) in the five segments of the interbank market. The data cover all interbank exposures, including over-the-counter.

All the variables are computed aggregating at banking group or independent bank level monthly bank-by-bank data. The aggregation at group level results from the focus of the paper. First, the only proper way to investigate the decision and determinants of access to central bank liquidity is to refer to groups, insofar as a group comprising various banks may decide to resort to central bank liquidity through one, several or all of them, and in any case these transactions are likely to be decided by the parent bank, and to fit into a group-specific scheme. Second, as is argued in Section 2, the Intra-Group exposures must be removed from the interbank market in order to properly analyse the hypothesis of liquidity hoarding.[13]

My sample period runs from January 1999, when the single Euro-area monetary policy was established, to August 2011, as the sovereign debts crisis was growing more acute. The number of time periods (months) is therefore $t = 1, 2, \ldots, 152$. To determine the effect of the crisis, I split the sample period into two sub-periods: before and after August 2007, the consensus date for the onset of the crisis (although I experiment with alternative dates as a check). In the pre-crisis sample, T is equal to 103; in the post-crisis, 49. The total number of observations is around 44,500 in the pre-crisis sample and 16,000 in the post-crisis sample. These numbers reflect: (i) the variation in the number of banking groups and independent banks $i = 1, 2, \ldots, N_t$ in each t; (ii) the removal, in order to round off measurement errors and eliminate outliers, of 5 per cent tail observations for each variable.

Figure 1 shows that loans granted by the Eurosystem through the Bank of Italy increase during the crisis. Figure 2 shows that the share of central bank loans in total assets and the number of banks borrowing from the central bank also increase. With regard to interbank market segments, Figures 3 and 4 show that during the crisis: (i) Domestic Extra-Group interbank market exposures are stable; (ii) Cross-Border Extra-Group interbank exposures decrease; and (iii) exposures via CCPs increase (Cappelletti *et al.*, 2011). Table 1 reports the summary statistics of the key variables. Table 2 shows the correlations. Central bank loans tend to be correlated positively with interbank Debts and negatively with interbank Net Positions. However, there are also non-linear effects, indirectly confirming the need for more sophisticated statistical tools.

[13] The Bank of Italy collects information on gross bilateral interbank exposures (assets and liabilities of each bank), and the identity of every counterparty. In order to separate the Intra-Group exposures, I used information on the identity of each counterparty and its group of affiliation. For the banks that changed group during my sample period, I traced the current group of affiliation in each t. Likewise, I computed at banking group level the other regressors in the matrixes $K^R_{i,t-1}$ and $K^I_{i,t-1}$.

Table 3 lists the explanatory variables (aggregated at banking group level), tells how they are calculated, and gives their summary statistics. All regressors are natural logarithms, ratios or dummy variables. They include Loans (to customers); (retail) Fundraising; Capital; ROE; Bad Loans; and Size. All the explanatory variables in the matrix $K^R_{i,t-1}$ are again drawn from the Bank of Italy's prudential supervisory reports. The matrix $K^I_{i,t-1}$ includes my instruments, which change depending on the variable instrumented. When central bank refinancing is instrumented, I use its lagged values, and double-check with interbank segments. When the interbank market positions are instrumented, I use two variables on credit rating taken from Fitch.[14] The first variable Rating is coded so as to take values from 1 to 10, from best to worst, plus 11 to designate unrated banks. The second variable Banks without Rating, following Angelini *et al.* (2011), is a dummy that takes the value of 1 for banks with no rating and 0 otherwise.

Two further aspects are worth noting. First, I use quantitative measures of central bank policy and interbank market positions, a self-explanatory choice given that what distinguishes this crisis is the amount of liquidity offered by central banks. Moreover, the attention to quantitative aspects has been increasing in the literature on the interbank market (e.g. Furfine, 2003 and 2009; King, 2008; Dinger and von Hagen, 2009; Cocco *et al.*, 2009), and this approach permits analysis of all Italian interbank exposures, including over-the-counter exposures for which interest rate data are not available.[15] Second, I use end-of-month stocks for all variables because, apart from information on auctions, which could duplicate the frequency of the auctions themselves, the data are not available on a more frequent basis. All the relevant literature does the same; even when it uses data on single liquidity auctions as a dependent variable, it takes monthly or quarterly or yearly data for regressors. Moreover, as the repeated extraordinary injections of central bank liquidity and the non-standard monetary policy measures demonstrate, the central bank credit supplied during the crisis is intended to meet longer-term funding needs and accordingly has a more stable maturity.

4. The determinants of central bank refinancing

As described in Section 2, to test the hypothesis of liquidity hoarding, I start by following the standard literature, which means estimating the banks' demand for central bank refinancing. The determinants correspond to banks' individual characteristics, and crucially to their interbank positions. This estimation verifies how banks that seek central bank liquidity behave in the

[14] Angelini *et al.* (2011) find that Fitch ratings are the most informative in the assessment of banks and financial firms. I use four different kinds of credit scores taken from Fitch, all as monthly averages of daily ratings. My first choice is the overall individual rating; the other three (support, long-term and short-term) are used as controls. In the case of banking groups, I use the rating of the parent company.

[15] From an estimation perspective, all the effects of interest rate developments are captured by the bank and month dummies, which are always included.

interbank market, and in particular whether they hoard or redistribute. The results are reported in Table 4 (total interbank market as a sum of all interbank segments); Table 5 (split of interbank segments); Table 6 (corresponding marginal effects); and Table 7 (partial sum of interbank segments).

First of all, the problem of endogeneity between central bank refinancing and interbank positions, which potentially concerns all interbank segments, turns out to be empirically relevant for the interbank market as a whole (the sum of interbank segments), and separately for two segments: Domestic Extra-Group and CCPs. By contrast, the other three separate segments (Domestic Intra-, Cross-Border Extra- and Cross-Border Intra-) result exogenous, and the outcomes do not change whether or not they are instrumented.[16] This different endogeneity of the various interbank market segments is a first interesting outcome, which soon announces the lead role of the two endogenous segments. Indeed, Domestic Extra-Group and CCPs are the segments with the greatest economic impact (marginal effects), and therefore my analysis dwells on them at greater length. In particular, since the reliable results of endogenous regressors are obviously the instrumented ones, in Table 5 specifications (4)-(6) show the relevant IV outcomes of the Domestic Extra-Group positions (while crossing out the results of CCPs). By contrast, specifications (7)-(9) present the relevant IV outcomes of CCPs (and cross out the Domestic Extra-Group).[17] Finally, specifications (10)-(12) present the SUR results, where the two interbank segments are estimated simultaneously along with central bank refinancing, so neither is crossed out.[18] All the results of the other regressors are reliable and consistent across all specifications.[19]

Summing up, central bank liquidity is obtained by banks that are net interbank lenders (liquidity redistributors). In particular: (i) central bank liquidity is obtained by banks that redistribute it mainly domestically through the Domestic Extra-Group segment; (ii) banks do not

[16] As for Domestic Intra-, Cross-Border Extra- and Cross-Border Intra-, the Durbin-Wu-Hausman test cannot reject the null hypothesis of no endogeneity. But for Domestic Extra-Group, CCPs and the sum of all interbank segments, the test does reject the null. Since results do not change, for simplicity tables report non-instrumented results as for the exogenous segments.

[17] The standard statistical tests corroborate my choices also with regard to validity and strength of instruments. As for strength, the *F*-statistic of the reduced form is always sufficiently high, being the same also for the coefficients of the instruments (Table 7). As for validity, the Sargan test is passed, even if actually the greater number of instruments derives from the use of two related variables (Banks without Rating and Rating). In this light, in order to further check the robustness of my instruments, I used $x_{i,t-1}$ as an alternative, and results do hold.

[18] The pairs of variables "Debts and Net Position" and "Credit and Net Position" are never estimated in the same specification because of evident problems of collinearity. On the other hand, the two variables Debts and Credits can be included in the same specification, but this requires more instruments. In this case, in order not to weaken my instruments, I employed again $x_{i,t-1}$ as an additional instrument in the matrix $K^{I}_{i,t-1}$. Results are equivalent and unreported.

[19] In all my estimations, the observations are clustered at banking group level (and at bank level for independent banks), thus obtaining heteroskedasticity-robust standard errors and controlling for possible autocorrelations across the same banking group. Regressors across all estimation models and specifications are not always statistically significant, but they do provide clear indications because (i) they never change the statistical significance of their sign, even when tested by a broad range of estimation techniques, specifications and robustness checks; and (ii) the magnitude of the marginal effects (Table 6) furnishes univocal economic interpretations.

use the CCPs segment to redistribute the liquidity of the central bank, but essentially as an auxiliary funding source; however the redistribution effect of the other segments prevails; (iii) central bank liquidity is also obtained by banks that redistribute it abroad, mainly to banks belonging to the same group; (iv) the domestic internal capital market has negligible effects on resort to central bank liquidity; (v) the absence of liquidity accumulation is confirmed also by the fact that banks accessing central bank liquidity are those with less retail funding and more loans to the economy. All these outcomes contradict the liquidity hoarding hypothesis. Sub-Section 4.1 details the results for the key determinants of central bank refinancing (that is the interbank segments' positions); Sub-Section 4.2 discusses the results of the other determinants.

4.1 Key explanatory variables

Initially, I estimate the combined effect of the total interbank market as a sum of the single interbank segments and instrumenting this sum. This is done in two steps: first, adding-up all the variables measuring the external exposures (Domestic Extra-Group, CCPs, and Cross-Border Extra-Group variables), and then also the Cross-Border Intra-Group variables. In both cases, Total Interbank Credits and Net Position are significantly negative before the crisis, but become significantly positive after it. That is, banks asking for central bank liquidity were not redistributors before the crisis (when however banks' demand for central bank liquidity was low and the economic impact captured by marginal effects was negligible, Tables 4 and 6), while with the crisis (when exactly banks' demand increases) the banks more involved in central bank refinancing are those that redistribute, and the effect is also economically relevant (Table 6).

Then, I deepen the role of the single interbank segments. The two endogenous segments present opposite results The total positive redistribution effect is driven by the Domestic Extra-Group segment (Table 5, specifications 4-6 and 10-12). The effect is instead negative for CCPs (Table 5, specifications 7-12). However, the positive redistribution effect of the Domestic Extra-Group segment prevails, both in quantitative terms, measured by the marginal effects (Table 6), and when the figures of just the two segments are added up and a single IV regression is run instrumenting this sum (Table 7).

The other (non-endogenous) segments show a minor impact. The Domestic Intra-Group market has a negative (Tables 4 and 5), but minimal effect (Table 6). On the other hand, the effect is positive for the cross-border segments. After the onset of the crisis, Cross-Border Extra-Group interbank net-lenders have greater recourse to central bank refinancing (Table 5). Even more, banks borrow from the central bank when lending to foreign banks belonging to the same group. This confirms a cross-border redistribution of Eurosystem liquidity, and suggests that international

banking groups raise funds in a decentralised manner (Freixas and Holthausen, 2005; ECB, 2011). However, also the marginal effect of these variables is modest.[20]

4.2 The other determinants

The rejection of the liquidity hoarding hypothesis is confirmed also by the other determinants of central bank liquidity demand. In this respect, four outcomes are valuable: Loans (to customers); (retail) Fundraising; ROE and Capital; and Bad Loans.

The variable Loans is constantly positive after the crisis (Tables 4-7). This signals that the banks that get resources from the central bank are those with a higher incidence of loans not only to other banks but also to the economy. This positive effect may be explained in part by their use as collateral in central bank operations. However, while this use is minor as a matter of stylized fact (Bank of Italy, 2011b), the positive estimated economic effect is considerable: in the crisis, climbing from the 25th to the 75th percentile, the variable Loans produces the greatest percentage-point increase in the central bank loan share of total assets (Table 6).[21]

The variable Fundraising is always negative, and has a large economic impact (Tables 4-7). Banks with large-scale deposits and retail bond issues have less need for central bank liquidity, even in the crisis, and thus do not accumulate further liquidity.

ROE and Capital are banks' health measures. According to Afonso et al. (2011), since banks only resort to the central bank if other forms of funding are not accessible, one can argue that if banks with good past performance are forced to borrow from the central bank, this is an alarming sign of dysfunction in the interbank market. My results show that this is not the case. The variable ROE is statistically insignificant in both the pre- and post-crisis periods (as in Cassola *et al.*, 2011); the variable Capital is always negative.

The variable Bad Loans is the only that supports the liquidity hoarding prediction that the liquidity requirement mainly affects the banks that perform worse (Allen *et al.*, 2009; Acharya *et al.*, 2009; Heider *et al.*, 2009; Acharya and Merrouche, 2010; Acharya and Skeie, 2011), as it tends to be negative before the crisis (as in Fecht *et al.*, 2011) and positive in the post-crisis period. It could also signal a risk of moral hazard and/or a risk-taking channel effect (Adrian and Shin, 2009; Borio and Zhu, 2008). In any case, over my sample period the economic impact of Bad Loans on

[20] The presence of foreign banks impacts on all the variables of my estimations, but it is more likely to matter for the covariates capturing the non-domestic transactions. However, the presence of foreign banks is taken into account through the inclusion of bank fixed effects. Moreover, I run on the issue several robustness checks detailed in Section 7.

[21] In any case, even if the positive effect of Loans were partially due to their use as collateral, my results would still indicate a virtuous circle between central banks' liquidity provisions and Loans, and in any case absence of liquidity hoarding.

central bank refinancing is modest (Table 6). Therefore, my results counsel a simple early warning to avert the creation of perverse incentives during phases of massive liquidity injection.

The remaining determinants complement my analysis. The variable Size tends to be negative before and positive after the crisis. This confirms that in the pre-crisis period the larger banks get funding more easily (Kashyap *et al.* 2002), and are less dependent on participation in central bank auctions (Linzert *et al.*, 2006; Bindseil *et al.*, 2009). By contrast, in the post-crisis period, the larger banks are more severely affected by the restrictive conditions in funding markets and have a greater recourse to central bank refinancing (Ashcraft *et al.*, 2008; Fecht *et al.*, 2011). The other variables concern the kinds of collateral: Portfolio of Government Debt Securities, Bank Bonds and Securitized Loans. Borrowing from central banks is typically collateralized. However, the Eurosystem accepts a broad range of assets as collateral, and during the crisis it extended the range, so collateral is unlikely to be a limiting factor. Their inclusion is interesting to see which of the eligible assets are most commonly posted. The variable Portfolio of Government Debt Securities tends to be positive before the crisis and negative after; that is, the use of government bonds as collateral decreases in the crisis, in part simply because the Eurosystem extended eligibility to other securities (typically, in operations with the central bank, "bad collateral drives out good"; see Ewerhart and Tapking, 2008; ECB, 2012). Conversely, the variables Portfolio of Bank Bonds and Securitized Loans tend to be negative before and positive after the crisis.

5. The determinants of interbank market positions

So far, I have explored the determinants of central bank refinancing and shown that the banks that apply for it are not those that accumulate but those that redistribute their liquidity surpluses. Notably, this is found in a panel context, so the redistribution effect concerns the entire period 2007-2011. Nevertheless, as explained in Section 2, one could still argue that the liquidity hoarding hypothesis must be subjected to a reverse-causation test with central bank refinancing as the determinant/driver of interbank positions.

Such a test can be carried out in the context of the previous exercise exploiting the proprieties of the SUR model. Indeed, as is clarified in Section 2, once suitably specified, the SUR model allows simultaneous estimation of central bank refinancing both as dependent variable and as regressor (i.e. the SUR specifications can include both variables $y_{i,t}$ and $x_{i,t}$ in both equations 1 and 2). Table 8 reports the results for equation 2, which couple with those of equation 1 reported in Table 5. The specifications correspond: specifications (4)-(6) are the first stage IV results of the Domestic Extra-Group positions; specifications (7)-(9) are the first stage IV results of the CCPs positions. Specifications (10)-(12) are the SUR results of a system of three equations, and refer to

both Domestic Extra-Group and CCPs positions. Here the inverted relations show that during the crisis central bank liquidity affects the Domestic Extra-Group Credits and Net Position positively. Again, the outcomes are the opposite of those for CCPs, which however (again) have a much smaller marginal effect (Table 10).

However, the SUR model does not permit instrumentation, so I also run a reversed IV experiment, instrumenting central bank refinancing in the first stage by its lagged values, and then using it as the key explanatory variable to estimate the interbank positions in the second stage.[22] The results are reported in Table 9. During the crisis, central bank refinancing spurs interbank lending significantly, both for the Total Interbank market and the Domestic Extra-Group segment, both for gross Credits and Net Position. The economic impact is also notable (Table 10).

Further, I conducted also a new test. So far, I have taken the interbank positions as ratios to total assets, for two reasons: first, in analogy with central bank refinancing, which is normalized by total assets; and second because, given the panel context, the ratios capture at least in part the development. However, as a further check, in Table 11 the interbank positions are again used as dependent variables, but measured as growth rates. The results are substantially equivalent. Some minor changes involve a few control regressors, and are explained by the different measure of the dependent variable. Most important, liquidity injections are found to speed up interbank lending, which rebuts the liquidity hoarding hypothesis, and demonstrates the effectiveness of monetary policy.

Furthermore, such as for central bank refinancing, my estimations also show the other determinants of interbank market positions (Tables 8-11). It is worthwhile highlighting that the sign of the most of the determinants does not change with the crisis, another outcome that contradicts the thesis of a malfunctioning interbank market. The pre- and post-crisis results' change is evident only for the variable Size, which confirms that larger banks have greater liquidity needs in the crisis. Another result indicating that the more liquid banks do not hoard is the fact that banks with more funds from their retail customers result to lend more in the Total Interbank market (Table 9).

The remaining covariates complement the analysis of the determinants of interbank market positions. Five further findings emerge. (i) When the figures for the various segments are added together, the determinants of the sum substantially replicate the determinants of the Domestic Extra-Group segment, which therefore again drives all the others. (ii) Banks that are net lenders externally are net borrowers domestically. (iii) The effect of a larger Domestic Intra-Group segment on presence in other segments is negligible (as was found in the estimation of central bank

[22] Even in the reversed experiment, the standard statistical tests reject the null hypothesis of no endogeneity and suggest that my instruments are valid and not weak. However, as a further check, I also used the other interbank market segments as instruments for central bank refinancing, and the results do still hold.

refinancing). (iv) The relationship between the traditional bilateral Domestic Extra-Group and the trilateral CCPs segments tends to be positive. (v) The determinants of the positions in the two interbank market segments do not always coincide, which explains why the mutual relationship is positive but the impact on central bank refinancing conflicts. Interestingly, the effect is common for the variables Rating and Banks without Rating (which are to be considered together), and corroborates the hypothesis of peer monitoring (e.g. Furfine, 2001; King, 2008), as lower-rated banks receive less funds, both bilateral and trilateral. At the same time, the variable Bad Loans suggests that the peer monitoring thesis is more valid in the traditional bilateral segment than via central counterparties, which in fact were created precisely in order to attenuate counterparty risk.

6. Central bank refinancing and customer loans

A last step of my analysis concerns the Loans to bank customers. In analogy with interbank positions, one might argue that in order to show that central bank liquidity injections are effective even with regard to customer credit, the variable Loans should depend on and not cause the banks' demand for central bank refinancing. In this vein, I run a new inverse regression with Loans to the economy as the dependent variable and the central bank refinancing as the key regressor.

This exercise also has the merit of 'consolidating' my test of the liquidity hoarding hypothesis, verifying whether the hypothesis holds for the banking system as a whole. In fact, to this point, I have shown that banks lend to one another, hence that the liquidity hoarding hypothesis does not hold among banks. But it could still hold for the relationship between the entire banking system and the rest of the economy. This new exercise shows that this is not the case (Table 12). Central bank refinancing turns out to prompt Loans to the economy: (i) both instrumenting the central bank loans (with its lagged figures) and not; (ii) taking Loans as a ratio to total assets (specification 28); and (iii) using its annual growth rate (specification 29).

7. Robustness checks

I further verified the robustness of the results in several ways.[23]

7.1 Different estimation methods: difference-in-difference and Tobit models

Table 13 presents the determinants of central bank refinancing using (i) a difference-in-difference estimation (instead of the sample time splitting) to control for the impact of the crisis; (ii) a *tobit*-IV (instead of the *ordinary*-IV and the SUR) as regression model; and (iii) lagged interbank positions (see Section 7.2).

[23] Since results always remained very similar to those reported in Tables 4-11, for brevity I limit the use of additional tables, but all the robustness checks are available from the author upon request.

Regarding the impact of the crisis, so far I have used a sample time splitting (repeating the same estimations before and after the onset of the crisis). In the difference-in-difference framework, I consider the crisis as a treatment event, and analyse its effects on all the variables. Equations 1-2 are supplemented by inclusion of an interaction term between the same regressors and a time-dummy variable c_t that takes the value of 1 during the crisis and 0 before.[24]

Regarding the regression models, the Tobit model is well suited to one of the key-variables (central bank refinancing) because it is continuous and has a constrained range. In fact, central bank refinancing is zero for a substantial part of the sample population as my data refer to all banks in Italy, including those that never directly access it; this provides complementary inferential information and avoids biased sample selection. It is worth emphasizing that the tobit model is run in its IV version.[25]

Remarkably, these estimation changes do not alter the results at all, either in statistical significance or in the magnitude of marginal effects. In particular, interacted with the dummy variable c_t capturing the crisis phase, Domestic Extra-Group Credits and Net Position are again significantly positive.

7.2 Different lags and the persistence of interbank market positions

I ran checks using $x_{i,t-3}$ instead of $x_{i,t}$. This specification makes for better control of endogeneity but estimates a longer-term impact, while liquidity choices tend to be made at very short maturities. In any case, in Table 12 the interbank positions are lagged by one quarter and the results remain equivalent. This long-lasting effect is likely to depend on the persistence of interbank positions. I also verified this persistence empirically in two ways. First, I ran a probit model in which the dependent variable was the share of banks changing total net interbank position compared with the previous period. The estimated share was very low, around 3 per cent during the crisis. Second, I estimated a dynamic panel including the lagged interbank positions as regressors, which always proved to be highly significant.

Likewise, since my estimations compute the regressors in the matrixes $K^R_{i,t-1}$ and $K^I_{i,t-1}$ as lagged by one period (to avoid new endogeneity in estimating $x_{i,t}$, and to replicate the publication delay needed for mutual assessment by banks), longer lags were used as a robustness check. Again the results remained stable, probably because of the persistence of interbank positions.

[24] On a similar use of the dif-in-dif approach, see for example Cetorelli and Strahan (2006).

[25] In this framework, I carried out a Wald test of the null hypothesis of no endogeneity. The null was not rejected for all the interbank market segments (interacted with the dummy variable c_t). Things are more differentiated for the variables not interacted with the dummy, which however are not the focus of the diff-in-diff. However, as a check, I also instrumented for the interaction term adding a further equation. By analogy with the other estimations, in Table 12 the instrumented variables are, alternatively, the three Domestic Extra-Group positions.

7.3 Net central bank refinancing, and secured versus unsecured interbank exposures

I handled my key variables. First, as noted, in my basic estimations, the key variable 'central bank refinancing' is measured as *gross* loans. I re-measured it as *net* loans, subtracting (from the gross loans that the central bank grants to each bank) the amounts that each bank re-deposits at the central bank. The results do not change. However, I preferred to use the gross variable because deposits at the central bank (i) are typically very low in Italy, even during the crisis; and (ii) as they are basically driven by the euro-area reserve requirement, their inclusion is inconsistent with the variable Fundraising, which is worth keeping because it provides very meaningful results.

Concerning my second key variable, I further broke down the interbank market into sub-segments. My analysis already investigates the role of the guaranteed exposures, those through the CCPs. However, to further deepen the role of collateralized transactions, I split the Domestic Extra-Group segment into two sub-segments: secured versus unsecured. The two sub-segments present identical results, which coincide with those of their sum, and thus are not reported. However, this outcome shows that, in spite of their differences, complementary trends, and sometimes substitute roles, the two sub-segments are both used to redistribute the central bank liquidity.

7.4 Cooperative banks and branches of foreign banks

A set of checks was run on cooperative banks and branches of foreign banks, which are considered to be unlike other credit institutions. In particular, since I analyse the Eurosystem's liquidity provision, which is decentralized, foreign banks could influence the results if they massively exploit the option to refinance at a given central bank. However, the results remain unchanged when both types of bank are dropped either in turn or jointly. Since the basic results hold even when foreign banks are excluded, this means that the liquidity redistribution towards Cross-Border interbank segments is carried out also by domestic banks. Moreover, since in my framework the number of observations is too small to repeat my exercises only on the two types of banks, I estimated the basic specifications adding the impact of two dummies, for cooperative and foreign banks (but renouncing the fixed effects b_i). This check suggests some observations on the role played by foreign banks, but this calls for specific research. In estimating central bank refinancing, the dummy for foreign banks tends to be positive, both before and after the crisis. The marginal effects indicate that the economic impact is negligible before but sizable after the onset of the crisis, reconfirming that international banking groups raise funds in a decentralised manner.

7.5 Controlling for the endogeneity of other covariates

To verify the stability of the explanatory variables and test for possible collinearity, I adopted two methods: (i) discarding each of the regressors in turn; and (ii) using the IV estimator

for Loans and Fundraising, with a single or a multiple IV estimator. As a vector of instruments, I used the same regressors computed with a two-quarter lag. The results were again confirmed.

7.6 Changing starting dates and periods

In addition to time fixed effects, to test the sensitivity of my results to different dates and periods, I employed two kinds of check. First, I experimented with starting dates other than August 2007 (bringing it forward by one or two months, and postponing it by one to four months); other dates tested were September 2008 (the Lehman Brothers failure), and October 2008 (introduction of the Eurosystem full allotment procedure).[26] Second, I tested the stability of the results of the pre-crisis sample period, which is much longer, juxtaposing two periods of equal length (that is, comparing the last 49 months prior to the critical point with the 49-month-long post-crisis period). In all cases, the results remain substantially stable.

7.7 Changing definitions of covariates

Further, I defined some regressors in a different way. First, I focused on three interrelated explanatory variables: Loans, Bad Loans, and Securitized Loans. In the estimations, I separated Loans and Bad Loans from Securitized Loans in order to isolate the effect of the latter (which are more likely to be used as collateral), and at the same time to specifically investigate the pure effect of Loans and Bad Loans (which otherwise could reflect, at least partially, the effect of securitizations). On the other hand, measuring Loans and Bad Loans net of all securitizations decreases their level without reducing credit granted. I verified the results of these variables in three ways. First, I eliminated the variable Securitized Loans and reassigned them as appropriate to either Loans or Bad Loans. Second, I split the variable Securitized Loans between derecognized and non-derecognized loans; attributing the former to Loans (and to Bad Loans), and leaving the latter as Securitized Loans.[27] Third, I added non-derecognized loans to Loans (and Bad Loans), and left derecognized loans as Securitized Loans. The results never change, probably because the signs of the three variables are identical, both before and after the crisis. My approach definitely demonstrates the positive relationship between central bank liquidity and the variable Loans even net of securitizations.

[26] Furthermore, since the Bank of Italy's new prudential supervisory reports went into effect as of December 2008, which could have produced some discontinuities in my time-series, I repeated all estimations of my post-crisis period starting from that month onwards.

[27] Securitized loans are said to be "derecognized" when they are deleted from the balance sheet of the originator bank because there is a complete transfer of risks, costs, and benefits. Since the breakdown between derecognized and non-derecognized securitized loans is not available from banks for all my sample period, I extended my time series using a bank-level estimation obtained at the Bank of Italy. Likewise, since the Bank of Italy's statistical reports went into effect as of June 2010, and the adoption of the new criteria implied the re-recognition of loans that had previously been removed from the balance sheet, with a corresponding increase in the stock of loans, I restored the continuity of my time series by using the same estimations.

Finally, to assess the effect of capital adequacy, I calculated the numerator of the ratio as either capital and reserves or mandatory capital, and the denominator as either total assets or risk-weighted assets. The results always stand confirmed.

8. Conclusions

Since the outbreak of the financial crisis, liquidity and the functioning of interbank markets have been causes of concern and have been at the centre of the academic and policy debate. This paper contributes to the debate by investigating the determinants and the interrelations between the two main wholesale markets for liquidity: central bank refinancing (the primary liquidity market) and the various segments of the interbank market (the secondary liquidity market).

The paper features several distinctive characteristics. It studies the determinants and the effects of the crisis on central bank refinancing and interbank market jointly. It investigates both the casual directions of their mutual relationship, controlling constantly for mutual endogeneity. It examines the relationships between the two wholesale liquidity markets as well as between those markets, bank loans to the economy and retail bank liquidity, and controls for many bank-specific characteristics.

The analysis does not provide support to the liquidity hoarding hypothesis, which in its most negative version asserts that during periods of crisis the interbank market ceases to function correctly and central bank injections of liquidity are useless because banks simply build up their liquidity reserves rather than redistributing it to other banks or the real economy. This paper shows clearly and robustly that in Italy the interbank markets functioned properly even during the financial crisis, and that the central bank's liquidity circulated among banks and reached the economy.

Further research should quantify the impact of the Italian sovereign debt crisis since the summer of 2011, with its significant fall in the value of government bonds, which are typically used in the interbank market, on the banks' demand for central bank liquidity. Another issue that repays further investigation is the role of foreign banks in cross-border demanding and redistributing central bank liquidity.

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Figure 1. Loans granted to banks by the Eurosystem through the Bank of Italy
(as a percentage share of total Eurosystem loans)

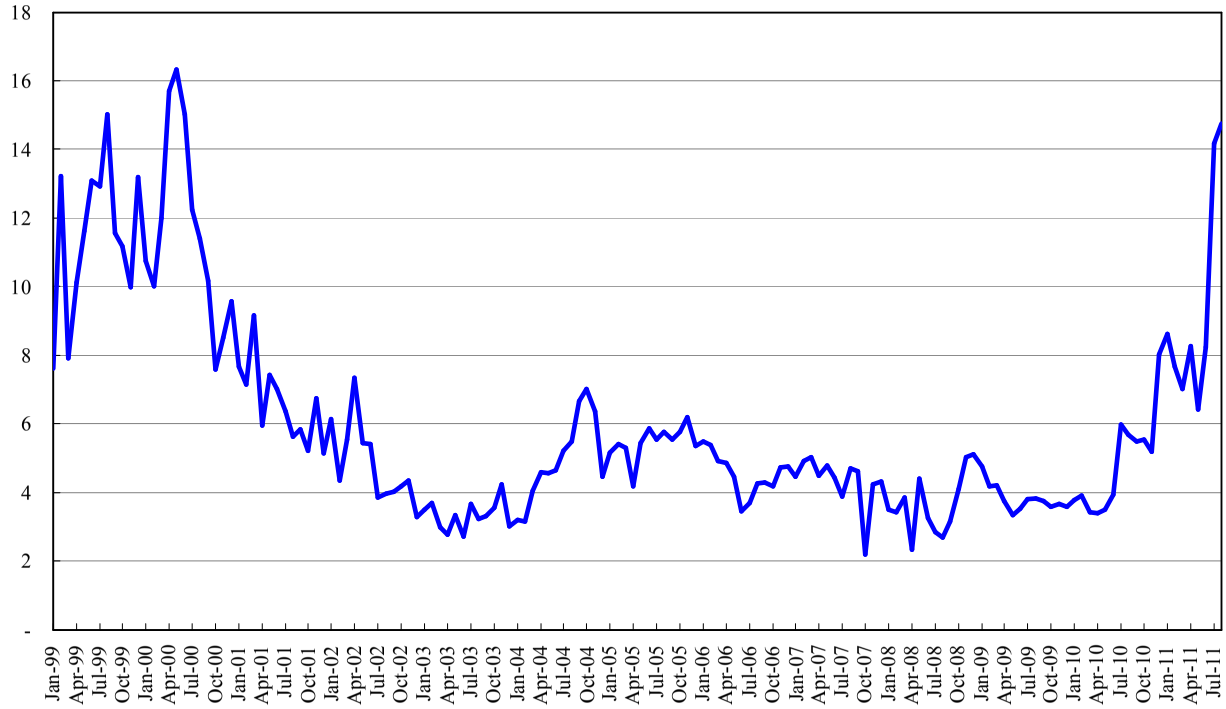

Figure 2. Central bank refinancing and borrowing banks operating in Italy

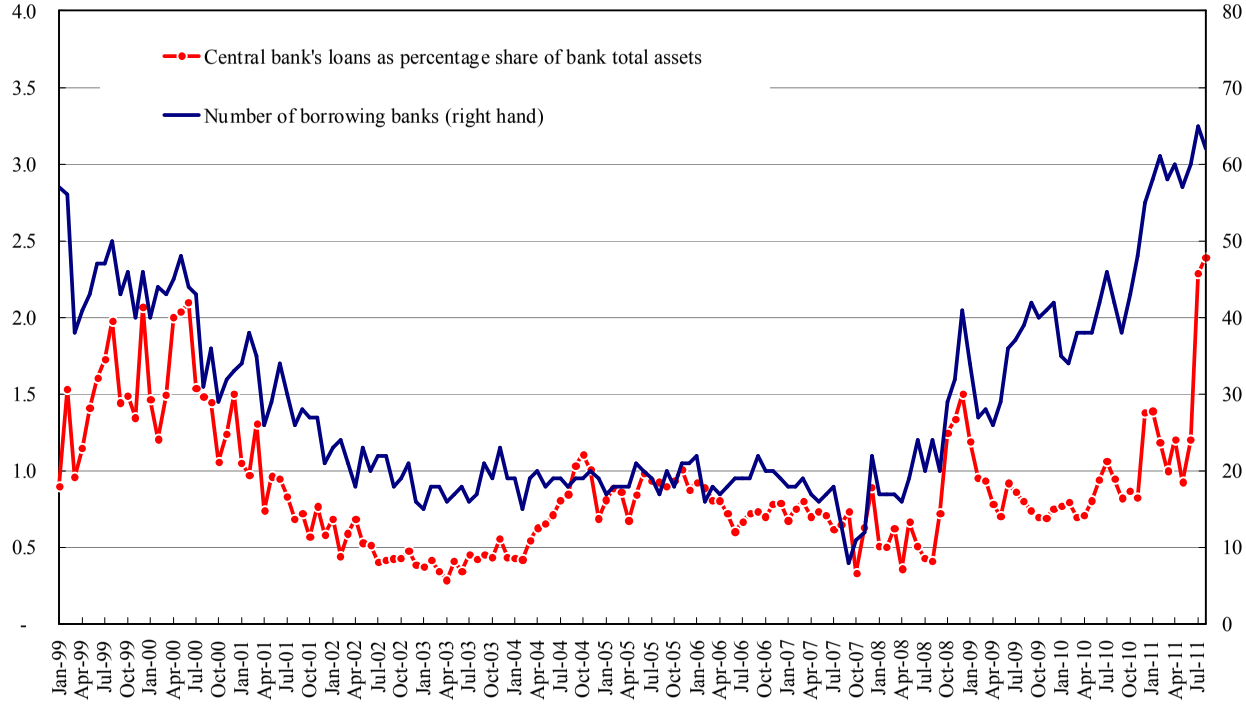

Figure 3. Italian interbank market segments: Debts as percentage shares of bank total assets

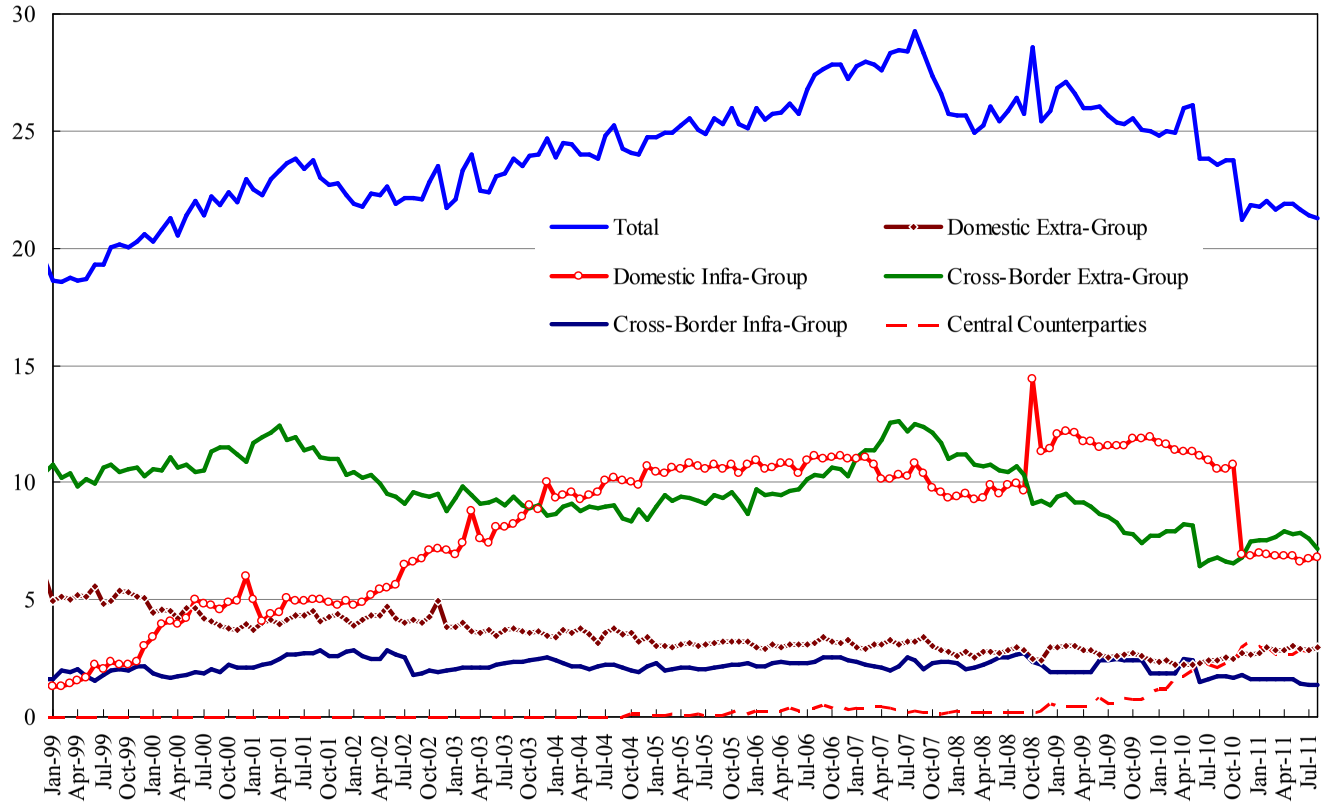

Figure 4. Italian interbank market segments: Credits as percentage shares of bank total assets

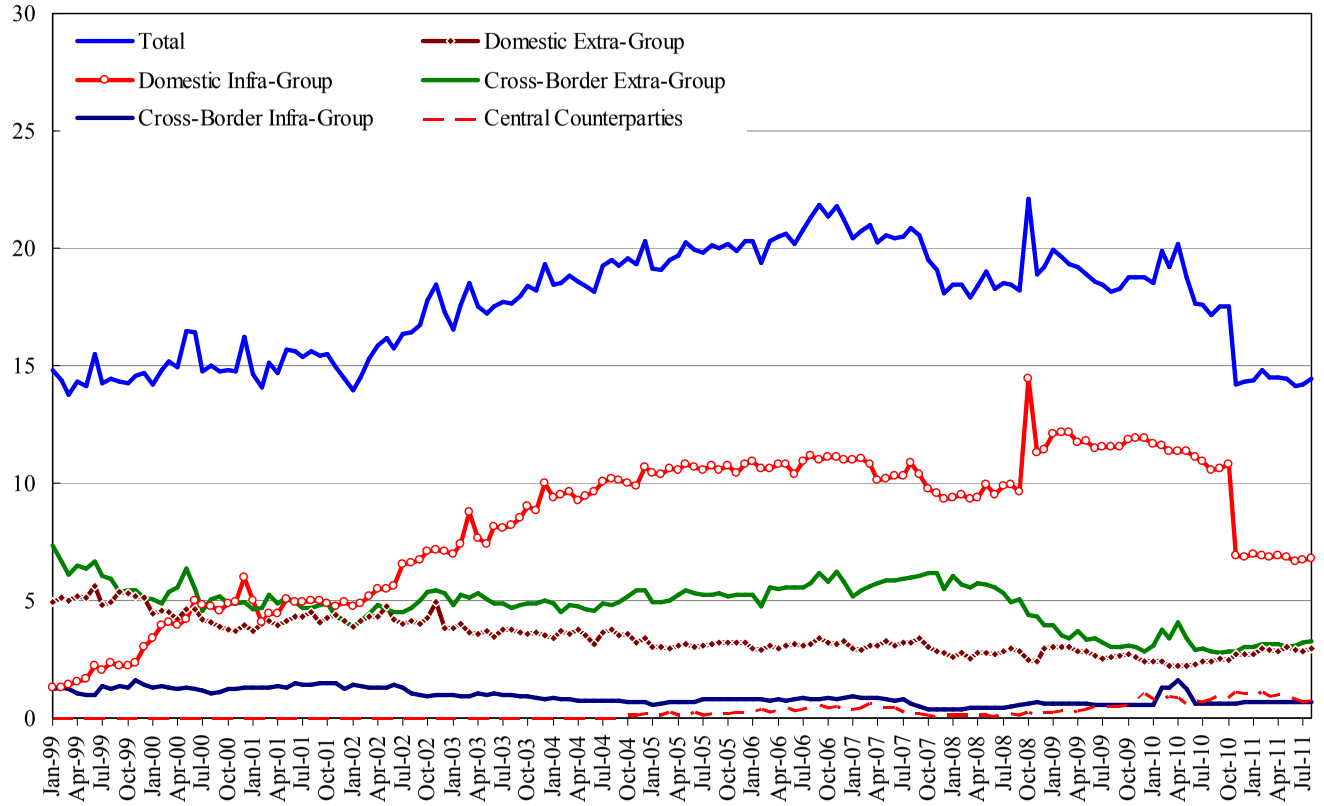

Table 1. Summary statistics of key variables

Key variables (scaled by total assets)			Obs	Mean	Sd. Dev.	Min	Max
Loans form central bank			61,196	0.009	0.005	0.000	0.132
Interbank market sections	Domestic Extra-Group	*Debts*	61,196	0.029	0.021	0.000	0.110
		Credits	61,196	0.036	0.041	0.000	0.220
		Net	61,196	0.003	0.048	-0.110	0.200
	Domestic Infra-Group	*Debts or Credits*	61,196	0.037	0.022	0.000	0.389
	Cross-Border Extra-Group	*Debts*	61,196	0.058	0.034	0.000	0.756
		Credits	61,196	0.049	0.010	0.000	0.149
		Net	61,196	-0.015	0.013	-0.190	0.199
	Cross-Border Infra-Group	*Debts*	61,196	0.001	0.005	0.000	0.146
		Credits	61,196	0.002	0.003	0.000	0.065
		Net	61,196	-0.001	0.004	-0.134	0.031
	Central Counterparties	*Debts*	61,196	0.0040	0.001	0.000	0.074
		Credits	61,196	0.0038	0.001	0.000	0.051
		Net	61,196	-0.0002	0.001	-0.068	0.051

Table 2. Relations among key variables

		Loans from central bank	Domestic Extra-Group			Domestic Infra-Group	Cross-Border Extra-Group			Cross-Border Infra-Group			Central Counterparties		
			Debts	*Credits*	*Net*		*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*
Loans from central bank		**1**													
Domestic Extra-Group	*Debts*	0.0931*	**1**												
	Credits	-0.0612*	**-0.1799***	**1**											
	Net	-0.0912*	**-0.5752***	**0.9016***	**1**										
Domestic Infra-Group	*Debts or Credits*	0.1392*	0.1054*	-0.0809*	-0.1125*	**1**									
Cross-Border Extra-Group	*Debts*	0.0848*	0.1499*	-0.0516*	-0.1088*	**0.1715***	**1**								
	Credits	0.1460*	0.1875*	0.0170*	-0.0676*	**0.3809***	**0.5112***	**1**							
	Net	-0.0961*	-0.1914*	0.0695*	0.1399*	**-0.1710***	**-0.6615***	**0.0311***	**1**						
Cross-Border Infra-Group	*Debts*	0.1546*	0.0976*	-0.0411*	-0.0759*	0.4840*	0.2214*	0.4568*	-0.2263*	**1**					
	Credits	0.1534*	0.1119*	-0.0238*	-0.0672*	0.2594*	0.2448*	0.4450*	-0.2878*	**0.6476***	**1**				
	Net	-0.0970*	-0.0511*	0.0372*	0.0530*	-0.4520*	-0.1220*	-0.2942*	0.0995*	**-0.8590***	**0.1661***	**1**			
Central Counterparties	*Debts*	0.1086*	0.0130*	-0.0436*	-0.0422*	0.2443*	0.0469*	0.0715*	-0.0027	0.1273*	0.2367*	0.0230*	**1**		
	Credits	0.1141*	0.0292*	-0.0358*	-0.0425*	0.2400*	0.0745*	0.1286*	0.0063	0.1235*	0.1874*	-0.0079	**0.5071***	**1**	
	Net	-0.0432*	0.006	0.0245*	0.0181*	-0.1092*	-0.0726*	-0.0960*	0.0149*	-0.0818*	-0.1804*	-0.0350*	**-0.7872***	**0.1323***	**1**

***, **, and * denote statistical significance at 1, 5 and 10 % level.

Table 3. Summary statistics of explanatory variables

	Name	Definition	Obs	Mean	Sd. Dev.	Min	Max
Matrix $K^{R}_{i,t-1}$: banks' characteristics/ regressors	Size	Log (Total assets)	61,196	5.674	1.650	1.386	13.662
	Loans	Total performing (non-securitized) loans to the domestic private sector / Total assets	61,196	0.559	0.137	0.003	0.790
	Bad Loans	Total non-performing (non-securitized) loans (private sector) / Total performing (non-securitized) loans (private sector)	61,196	0.046	0.049	0.000	0.300
	Portfolio of Government Debt Securities	Holdings of Euro-area Government bonds / Total assets	61,196	0.022	0.006	0.000	0.150
	Portfolio of Bank Bonds	Holdings of their own bonds and of other banks' bonds / Total assets	61,196	0.025	0.029	0.000	0.160
	Securitized Loans	Total (dereconized and non-dereconized) securitized loans / Total assets	61,196	0.010	0.027	0.000	0.220
	ROE	Net profits / (Capital and reserves)	61,196	0.007	0.029	-0.048	0.140
	Capital	Regulatory capital / Total risk weighted assets	61,196	0.124	0.037	0.068	0.339
	Fundraising	(Total deposits and bonds) / Total assets	61,196	0.732	0.087	0.000	0.961
Matrix $K^{I}_{i,t-1}$: instruments	Rating	Rating agency scores	61,196	7.724	1.309	2	11
	Banks without rating (0-1)	Banks without rating (0-1)	61,196	0.587	0.199	0	1

Table 4. Determinants of central bank refinancing

Results of equation 1. Sample time splitting: each specification is identically repeated before and after the crisis. Dependent variable $y_{i,t}$: ratio of total gross loans from central bank to total assets. Estimation method: *ordinary*-IV. Endogenous and instrumented set of regressors $x_{i,t}$: Total interbank market positions. Corresponding IV first stage results are equivalent to those of Table 9 (specifications 19-21).

Dependent variable:		***Loans from central bank***					
Sample period:		**Pre-crisis period**			**Post-crisis period**		
Estimation method:		**IV (1)**			**IV (1)**		
Specifications:		**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
Total interbank market (i.e. Domestic Extra-Group + CCPs + Cross-Border Extra-Group + Cross-Border Infra-Group)	*Debts*	-0.0246***			0.022		
		0.003			*0.044*		
	Credits		-0.0615***			0.546 ***	
			0.015			*0.178*	
	Net			-0.0541***			0.681 *
				0.012			*0.353*
Domestic Infra-Group	*Debts or Credits*	-0.0158***	-0.0138	-0.0201***	-0.016	0.082	0.101
		0.003	*0.008*	*0.003*	*0.018*	*0.055*	*0.070*
Size		-0.002***	0.000	0.000	0.001	-0.001	-0.014
		0.000	*0.000*	*0.000*	*0.002*	*0.002*	*0.009*
Loans		-0.004***	-0.008***	-0.007**	-0.002	0.182 ***	0.268 **
		0.001	*0.001*	*0.003*	*0.002*	*0.058*	*0.100*
Bad Loans		0.000	-0.0034**	0.000	0.016 ***	0.172 ***	-0.027
		0.001	*0.002*	*0.002*	*0.004*	*0.041*	*0.048*
Portfolio of Government Debt Securities		0.0145***	-0.006	-0.005	-0.082 ***	0.106	-0.484 **
		0.002	*0.007*	*0.006*	*0.020*	*0.086*	*0.214*
Portfolio of Bank Bonds		-0.00861**	-0.00315**	-0.0061**	0.007	0.256 ***	0.022
		0.004	*0.001*	*0.003*	*0.008*	*0.078*	*0.014*
Securitized Loans		-0.003***	-0.003***	-0.003**	0.112 ***	0.191 ***	0.082 **
		-0.001	*-0.001*	*-0.001*	*0.005*	*0.024*	*0.039*
ROE		0.000	0.000	0.000	0.000	0.006	-0.010
		0.001	*0.001*	*0.001*	*0.002*	*0.005*	*0.008*
Capital		-0.0234***	-0.0252***	-0.00756***	-0.026 ***	0.034	0.021
		0.003	*0.002*	*0.003*	*0.008*	*0.024*	*0.033*
Fundraising		-0.022***	-0.0173***	-0.0215***	-0.015	-0.056 ***	-0.309 *
		0.004	*0.001*	*0.005*	*0.012*	*0.016*	*0.175*
Constant		0.041***	0.071***	0.056***	-0.051 **	-0.274 ***	0.095
		0.003	*0.001*	*0.003*	*0.020*	*0.059*	*0.089*
Bank fixed effects		yes	yes	yes	yes	yes	yes
Time fixed effets		yes	yes	yes	yes	yes	yes
Number of observations		44,336	44,145	43,852	16,466	16,417	16,292
Dependent variable in the first stage:		*Total interbank market*					
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level.

Table 5. Determinants of central bank refinancing

Results of equation 1. Sample time splitting: each specification is identically repeated before and after the crisis. Dependent variable $y_{i,t}$: ratio of total gross loans from central bank to total assets. Estimation method: *ordinary*-IV and SUR. Endogenous and instrumented set of regressors $x_{i,t}$: in Specifications (4)-(6): Domestic-Extra-Group positions; in Specifications (7)-(9): Central Couterparties positions. Specifications (10)-(12) report the SUR results of the first equation of a system of three equations (the other two equations refer to both Domestic Extra-Group and CCPs positions). Endogenous regressors are crossed out when not instrumented and unreliable. Corresponding IV first stage results, and results of the other two equations of the SUR estimation are reported in Table 8.

Dependent variable:		***Loans from central bank***																		
Sample period:		**Pre-crisis period**									**Post-crisis period**									
Estimation method:		**IV (2)**			**IV (3)**			**SUR**			**IV (2)**			**IV (3)**			**SUR**		
Specifications:		**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Domestic Extra-Group	*Debts*	-0.0426***			0.000			0.055			-0.022			-0.066***			0.480		
		0.003			*0.001*			*0.089*			*0.145*			*0.004*			*0.453*		
	Credits		-0.0412***			0.000			-0.021**			0.618***			0.005			0.208*	
			0.012			*0.000*			*0.009*			*0.222*			*0.004*			*0.123*	
	Net			-0.0668***			0.002***			-0.034**			0.269*			0.0204***			0.865**
				0.019			*0.001*			*0.016*			*0.138*			*0.002*			*0.376*
Domestic Infra-Group	*Debts or Credits*	-0.0170***	-0.0215***	-0.0301***	-0.015***	-0.018***	-0.010***	-0.007	-0.021***	-0.019***	-0.015	-0.121**	-0.019	-0.020	-0.112	-0.003	-0.096**	-0.084**	-0.246*
		0.003	*0.004*	*0.004*	*0.002*	*0.002*	*0.002*	*0.007*	*0.004*	*0.004*	*0.014*	*0.059*	*0.018*	*0.022*	*0.030*	*0.032*	*0.037*	*0.041*	*0.133*
Cross-Border Extra-Group	*Debts*	-0.001			0.003			0.003			-0.03***			-0.0298***			-0.0512***		
		0.002			*0.003*			*0.006*			*0.004*			*0.004*			*0.010*		
	Credits		-0.00673**			-0.010			-0.005**			-0.132***			-0.581***			-0.497***	
			0.003			*0.025*			*0.003*			*0.041*			*0.117*			*0.095*	
	Net			-0.0226***			-0.016***			-0.022***			0.129***			0.0848***			0.227***
				0.006			*0.002*			*0.005*			*0.027*			*0.010*			*0.076*
Cross-Border Infra-Group	*Debts*	-0.018***			-0.006			0.003			-0.005			-0.015			-0.172		
		0.005			*0.004*			*0.016*			*0.028*			*0.044*			*0.180*		
	Credits		0.0195**			0.0250**			0.026***			0.798**			0.364*			0.341*	
			0.010			*0.008*			*0.009*			*0.315*			*0.177*			*0.207*	
	Net			0.0199**			0.0243***			0.023***			0.187**			0.038			0.016
				0.008			*0.007*			*0.007*			*0.083*			*0.060*			*0.138*
Central Counterparties	*Debts*	-0.142***			0.382			0.528			0.225***			0.175			-0.845		
		0.052			*0.241*			*0.814*			*0.036*			*0.222*			*0.583*		
	Credits		-0.146***			0.464**			0.063			0.222**			-0.815***			-0.564***	
			0.030			*0.168*			*0.048*			*0.108*			*0.189*			*0.141*	
	Net			-0.022			0.136**			0.168*			-0.194***			-0.355			-0.372**
				0.079			*0.048*			*0.092*			*0.065*			*0.376*			*0.162*

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level.

(to be continued)

Table 5. Determinants of central bank refinancing (*continued*)

Dependent variable:	***Loans from central bank***																	
Sample period:	**Pre-crisis period**									**Post-crisis period**								
Estimation method:	**IV (2)**			**IV (3)**			**SUR**			**IV (2)**			**IV (3)**			**SUR**		
Specifications:	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Size	-0.001***	0.000	0.000	-0.001***	-0.001***	-0.001***	-0.0005***	-0.0004***	0.000	0.002	0.000	0.008**	0.003***	0.002	0.002**	-0.003	0.003**	0.019**
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.003*	*0.002*	*0.003*	*0.001*	*0.001*	*0.001*	*0.008*	*0.001*	*0.008*
Loans	-0.005***	-0.009***	-0.010***	0.001	0.002	0.002	0.001	-0.003*	-0.006*	0.000	0.20***	0.095**	0.001	0.003	0.011***	-0.009	0.069*	0.298**
	0.001	*0.001*	*0.003*	*0.000*	*0.000*	*0.000*	*0.003*	*0.002*	*0.003*	*0.003*	*0.071*	*0.042*	*0.002*	*0.003*	*0.002*	*0.013*	*0.041*	*0.128*
Bad Loans	0.000	-0.0049***	0.000	0.002	0.002	0.002	0.004	0.000	-0.001	0.012	0.15***	0.045***	0.009*	0.053***	0.024***	0.034***	0.077***	0.123**
	0.001	*0.002*	*0.002*	*0.000*	*0.001*	*0.001*	*0.004*	*0.001*	*0.001*	*0.008*	*0.046*	*0.015*	*0.003*	*0.011*	*0.004*	*0.011*	*0.026*	*0.049*
Portfolio of Government Debt Securities	0.0137***	-0.011	-0.008	0.015***	0.019***	0.015***	0.014***	0.007	-0.006	-0.0615***	0.157	0.026	-0.071***	-0.073**	-0.034*	-0.021	0.004	0.190
	0.002	*0.006*	*0.007*	*0.002*	*0.003*	*0.005*	*0.002*	*0.005*	*0.006*	*0.019*	*0.098*	*0.042*	*0.014*	*0.027*	*0.015*	*0.030*	*0.057*	*0.130*
Portfolio of Bank Bonds	-0.00986***	-0.002	-0.004	0.000	0.003	-0.011	0.008	0.002	-0.005**	-0.003	0.151***	0.007	-0.009	0.037	0.004	0.085**	0.081***	-0.018
	0.004	*0.001*	*0.003*	*0.001*	*0.001*	*0.001*	*0.014*	*0.001*	*0.003*	*0.018*	*0.058*	*0.006*	*0.004*	*0.011*	*0.004*	*0.032*	*0.029*	*0.015*
Securitized Loans	-0.0023***	-0.004***	0.000	-0.002**	-0.004***	0.000	-0.0009	-0.003***	0.000	0.106***	0.175***	0.121***	0.103***	0.168***	0.122***	0.177***	0.173***	0.090***
	-0.001	*-0.001*	*-0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*-0.013*	*-0.029*	*0.009*	*0.007*	*0.017*	*0.007*	*0.026*	*0.018*	*0.020*
ROE	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	-0.001	0.008	0.003	-0.001	0.001	0.000	0.000	0.002	0.003
	0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.002*	*0.001*	*0.001*	*0.002*	*0.006*	*0.003*	*0.002*	*0.003*	*0.002*	*0.004*	*0.004*	*0.005*
Capital	-0.0172***	-0.0146***	-0.00996***	-0.008***	-0.009***	-0.016***	-0.001	-0.011***	-0.012***	-0.0306**	0.056	-0.0456**	-0.036***	-0.057***	-0.028***	0.030	-0.024	-0.124**
	0.003	*0.002*	*0.003*	*0.001*	*0.001*	*0.001*	*0.012*	*0.001*	*0.002*	*0.015*	*0.034*	*0.015*	*0.006*	*0.015*	*0.008*	*0.025*	*0.034*	*0.046*
Fundraising	-0.0122***	-0.000973*	0.006	-0.002***	-0.002***	-0.009***	0.006	-0.002***	0.002	-0.028	-0.0705***	-0.135***	-0.039***	0.004	-0.024***	-0.102**	-0.021	-0.396**
	0.004	*0.001*	*0.005*	*0.000*	*0.000*	*0.001*	*0.015*	*0.000*	*0.004*	*0.029*	*0.022*	*0.040*	*0.003*	*0.006*	*0.003*	*0.048*	*0.013*	*0.164*
Constant	0.021***	0.017***	0.005	0.014***	0.015***	0.016***	0.003	0.013***	0.009**	-0.019	-0.179***	-0.095***	-0.025*	-0.026	-0.033***	-0.0016	-0.096**	-0.211***
	0.003	*0.001*	*0.004*	*0.001*	*0.001*	*0.002*	*0.014*	*0.001*	*0.004*	*0.016*	*0.033*	*0.031*	*0.009*	*0.017*	*0.011*	*0.018*	*0.036*	*0.082*
Bank fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effets	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations	44,641	44,526	44,029	43,544	43,323	43,027	44,336	44,145	43,852	16,545	16,459	16,343	16,545	16,459	16,343	16,466	16,417	16,292
Dependent variable in the first stage:	*Domestic Extra-Group*			*Central Counterparties*			*Domestic Extra-Group and Central Counterparties*			*Domestic Extra-Group*			*Central Counterparties*			*Domestic Extra-Group and Central Counterparties*		
	Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level

Table 6. Determinants of central bank refinancing

Marginal effects, averaged across the specifications, of the estimations of Tables 4 and 5.

Dependent variable:		***Loans from central bank***					
Sample period:		**Pre-crisis period**			**Post-crisis period**		
Estimation method:		**IV (1-2)**	**IV (3)**	**SUR**	**IV (1-2)**	**IV (3)**	**SUR**
Specifications:		1-6	7-9	10-12	1-6	7-9	10-12
Total interbank market (i.e. Domestic Extra-Group + CCPs + Cross-Border Extra + Cross-Border Infra)	*Debts*	-0.1			ns		
	Credits	-0.4			3.0		
	Net	-0.4			1.7		
Domestic Extra-Group	*Debts*	-0.2	ns	ns	ns	-0.2	ns
	Credits	-0.5	ns	-0.3	3.7	ns	2.9
	Net	-0.4	0.0	-0.4	2.1	1.9	2.0
Domestic Infra-Group		-0.1	-0.1	-0.1	-0.1	ns	-0.1
Cross-Border Extra-Group	*Debts*	ns	ns	ns	-0.4	-0.4	-0.5
	Credits	-0.1	ns	-0.1	-0.1	-0.6	-0.5
	Net	0.0	-0.1	-0.1	0.1	0.1	0.1
Cross-Border Infra-Group	*Debts*	-0.1	ns	ns	ns	ns	ns
	Credits	0.1	0.1	0.1	0.4	0.2	0.3
	Net	0.1	0.1	0.1	0.2	ns	ns
Central Counterparties	*Debts*	-0.5	ns	ns	2.2	ns	ns
	Credits	-0.5	0.5	ns	0.1	-1.0	-1.1
	Net	ns	1.0	0.2	-1.3	ns	-1.4
Size		-0.2	-0.2	-0.2	1.6	1.2	1.5
Loans		-0.3	ns	-0.2	3.5	3.2	4.4
Bad Loans		-0.1	ns	ns	0.4	0.2	0.5
Portfolio of Government Debt Securities		0.1	0.1	0.1	-0.1	-0.1	ns
Portfolio of Bank Bonds		-0.1	ns	-0.1	0.5	ns	0.3
Securitized Loans		-0.1	-0.1	-0.1	0.1	0.2	0.2
ROE		ns	ns	ns	ns	ns	ns
Capital		-0.1	-0.2	-0.2	-0.3	-0.3	-0.5
Fundraising		-0.2	-0.2	-0.2	-1.8	-1.4	-2.3

Table reports marginal effects, averaged across the specifications, of all estimations shown in Tables 4 and 5. The marginal effects quantify the estimated economic impact of each regressor on the dependent variable 'central bank refinancing', other things being equal. The estimated effect of each determinant is computed as the change in the percentage share of the total loans from central bank to total assets between the 25th to the 75th percentile of each variable. Like in Table 5, endogenous but non-instrumented regressors are crossed out because unreliable. ns denotes statistically non-significant regressors.

Table 7. Determinants of central bank refinancing

Results of equation 1. Sample time splitting: only post-crisis results are reported. Dependent variable $y_{i,t}$ ratio of total gross loans from central bank to total assets. Estimation method: *ordinary*-IV. Endogenous and instrumented set of regressors $x_{i,t}$: sum of Domestic-Extra-Group + CCPs positions. Corresponding IV first stage results are not reported because substantially equivalent to those of Table 8 as for Domestic Extra-Group segment.

Dependent variable:		***Loans from central bank***		
Sample period:		**Post-crisis period**		
Estimation method:		**IV(4)**		
Specifications:		**(13)**	**(14)**	**(15)**
Domestic Extra-Group + Central Counterparties	*Debts*	0.040		
		0.085		
	Credits		0.692**	
			0.258	
	Net			0.154**
				0.071
Domestic Infra-Group	*Debts or Credits*	-0.022	0.105	-0.042
		0.019	*0.068*	*0.063*
Cross-Border Extra-Group	*Debts*	-0.032***		
		0.004		
	Credits		-0.106***	
			0.033	
	Net			0.097***
				0.019
Cross-Border Infra-Group	*Debts*	-0.029		
		0.033		
	Credits		0.992***	
			0.350	
	Net			0.175***
				0.062
Size		0.001	0.000	0.006***
		0.002	*0.002*	*0.002*
Loans		-0.001	0.202**	0.047*
		0.002	*0.082*	*0.026*
Bad Loans		0.015**	0.138***	0.033***
		0.006	*0.043*	*0.008*
Portfolio of Government Debt Securities		-0.052***	0.153	-0.009
		0.015	*0.141*	*0.028*
Portfolio of Bank Bonds		0.007	0.152**	0.007
		0.010	*0.061*	*0.004*
Securitized Loans		0.151***	0.191***	0.120***
		0.007	*0.029*	*0.007*
ROE		0.000	0.008	0.002
		0.002	*0.006*	*0.002*
Capital		-0.023**	0.058	-0.032***
		0.011	*0.047*	*0.009*
Fundraising		-0.019	-0.082***	-0.067**
		0.017	*0.025*	*0.032*
Constant		-0.289**	-0.377***	-0.185***
		0.113	*0.020*	*0.025*
Bank fixed effects		yes	yes	yes
Time fixed effets		yes	yes	yes
Number of observations		16,466	16,417	16,292
Dependent variable in the first stage:		*Domestic Extra-Group + CCPs*		
		Debts	*Credits*	*Net*

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level.

Table 8. Determinants of interbank market positions

Results of equation 2. Table 8 couples with Table 5 (i.e. it contains the corresponding IV first stage results, and results of the second and third equation of the SUR estimation of a system of three equations). Sample time splitting: the specifications of Table 8, repeated before and after the crisis, correspond to the specifications of Table 5. Set of dependent variables $x_{i,t}$: Specifications (4)-(6): Domestic-Extra-Group positions; Specifications (7)-(9): Central Couterparties positions; Specifications (10)-(12): both Domestic-Extra-Group and CCPs positions. Estimation method: *ordinary*-IV and SUR. Corresponding IV second stage results, and results of the first equation of the SUR estimation are reported in Table 5.

Dependent variable:		*Domestic Extra-Group*			*Central Counterparties*			*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*	*Central Counterp.*
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*		*Credits*		*Net*	
Sample period:		**Pre-crisis period**											
Estimation method:		**IV (2)**			**IV (3)**			**SUR**					
Specifications:		**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**		**(11)**		**(12)**	
Loans from central bank								-0.648***	-0.059	-0.323***	0.693	0.132***	0.137***
								0.239	*0.078*	*0.057*	*0.582*	*0.040*	*0.049*
Domestic Extra-Group	*Debts*				0.006***				0.115***				
					0.001				*0.016*				
	Credits					0.000					0.204		
						0.000					*0.304*		
	Net						0.000						0.058
							0.000						*0.035*
Domestic Infra-Group	*Debts or Credits*	-0.127***	-0.318***	-0.159***	0.006***	0.0069***	0.003***	-0.039	0.009***	0.131	0.167	0.007	0.028**
		0.007	*0.015*	*0.016*	*0.000*	*0.000*	*0.000*	*0.032*	*0.002*	*0.088*	*0.179*	*0.058*	*0.012*
Cross-Border Extra-Group	*Debts*	-0.092***			0.0010***			-0.073***	0.0072***				
		0.008			*0.000*			*-0.008*	*0.001*				
	Credits		-0.168***			0.0067***				-0.120***	0.045		
			0.022			*0.000*				*0.044*	*0.053*		
	Net			-0.318***			0.000					-0.115**	0.033**
				0.013			*0.000*					*0.054*	*0.015*
Cross-Border Infra-Group	*Debts*	-0.146***			-0.0030***			-0.096***	-0.020***				
		0.021			*0.001*			*-0.035*	*0.003*				
	Credits		-0.165*			0.002				-0.118***	-0.173		
			0.090			*0.002*				*0.024*	*0.135*		
	Net			-0.111*			-0.001					-0.479***	-0.031**
				0.064			*0.001*					*0.139*	*0.013*
Central Counterparties	*Debts*	0.529***											
		0.152											
	Credits		-0.411										
			0.256										
	Net			0.446									
				0.436									

Dependent variable:		*Domestic Extra-Group*			*Central Counterparties*			*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*	*Central Counterp.*
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*		*Credits*		*Net*	
Sample period:		**Post-crisis period**											
Estimation method:		**IV (2)**			**IV (3)**			**SUR**					
Specifications:		**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**		**(11)**		**(12)**	
Loans from central bank								0.144	-0.104*	0.198***	-0.178***	0.336***	-0.269***
								0.165	*0.060*	*0.068*	*0.054*	*0.121*	*0.060*
Domestic Extra-Group	*Debts*				0.008***				0.502**				
					0.001				*0.190*				
	Credits					0.000					0.037		
						0.000					*0.029*		
	Net						0.0021***						0.232***
							0.001						*0.046*
Domestic Infra-Group	*Debts or Credits*	-0.066***	-0.418***	-0.058	-0.0971***	-0.0216***	0.0716***	-0.007	-0.099***	-0.108	-0.015***	0.152	0.066***
		0.029	*0.046*	*0.049*	*0.003*	*0.002*	*0.003*	*0.041*	*0.030*	*0.319*	*0.005*	*0.393*	*0.009*
Cross-Border Extra-Group	*Debts*	0.015*			-0.0103***			0.0627**	-0.053**				
		0.009			*0.001*			*0.023*	*0.023*				
	Credits		0.097			-0.0716***				0.312	-0.088***		
			0.086			*0.002*				*0.773*	*0.008*		
	Net			-0.507***			-0.0068***					-0.448	-0.061***
				0.057			*0.002*					*0.514*	*0.014*
Cross-Border Infra-Group	*Debts*	-0.038			-0.175***			0.034	-0.194***				
		0.062			*0.010*			*0.078*	*0.059*				
	Credits		-1.430**			-0.012				-0.206	0.061		
			0.513			*0.030*				*0.128*	*0.041*		
	Net			-0.456***			-0.1385***					-0.828	0.004
				0.158			*0.009*					*0.944*	*0.037*
Central Counterparties	*Debts*	0.518***											
		0.095											
	Credits		0.070										
			0.264										
	Net			0.420***									
				0.121									

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level.

(to be continued)

Table 8. Determinants of interbank market positions (*continued*)

Dependent variable:	*Domestic Extra-Group*			*Central Counterparties*			*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*			*Central Counterparties*			*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*	*Central Counterp.*	*Domestic Extra-Group*	*Central Counterp.*
	Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*		*Credits*		*Net*		*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*		*Credits*		*Net*	
Sample period:	**Pre-crisis period**												**Post-crisis period**										
Estimation method:	**IV (2)**			**IV (3)**			**SUR**						**IV (2)**			**IV (3)**			**SUR**					
Specifications:	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**		**(11)**		**(12)**		**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**		**(11)**		**(12)**	
Size	0.011**	0.013***	0.024***	-0.0005***	-0.0003***	-0.000***	0.0036**	-0.0001	0.0365***	-0.0024**	0.023***	0.000	0.020***	0.004	-0.022***	0.0009***	0.000	-0.0010***	0.017***	0.007*	0.004	0.0000***	-0.035	-0.0052***
	0.005	*0.001*	*0.002*	*0.000*	*0.000*	*0.000*	*0.001*	*0.000*	*0.005*	*0.001*	*0.003*	*0.000*	*0.001*	*0.003*	*0.004*	*0.000*	*0.000*	*0.000*	*0.002*	*0.003*	*0.021*	*0.000*	*0.238*	*0.046*
Loans	0.029***	-0.175***	-0.218***	-0.0003***	-0.0004***	0.000	0.023***	0.002	-0.205***	0.030	-0.218***	0.010	0.027***	-0.332***	-0.348***	-0.0021***	0.000	0.0030***	0.026***	-0.0157***	-0.332***	0.012	-0.340***	0.080***
	0.001	*0.003*	*0.003*	*0.000*	*0.000*	*0.000*	*-0.001*	*-0.001*	*0.007*	*0.050*	*0.006*	*0..007*	*0.003*	*0.007*	*0.008*	*0.001*	*0.000*	*0.001*	*0.003*	*0.006*	*0.018*	*0.009*	*0.024*	*0.015*
Bad Loans	-0.039***	-0.116***	-0.076***	-0.0002**	0.000	0.000	-0.051***	-0.0047***	-0.180***	0.010	-0.081***	0.001	-0.061***	-0.198***	-0.098***	-0.001	0.0043***	0.0053***	-0.069***	0.0358**	-0.229**	0.014**	-0.150	0.033***
	0.003	*0.006*	*0.005*	*0.000*	*0.000*	*0.000*	*-0.005*	*-0.001*	*0.015*	*0.023*	*0.010*	*0.001*	*0.007*	*0.014*	*0.017*	*0.001*	*0.001*	*0.001*	*0.009*	*0.006*	*0.088*	*0.006*	*0.094*	*0.006*
Portfolio of Government Debt Securities	-0.009	-0.472***	-0.329***	0.000	-0.001	-0.001**	-0.099***	0.000	-0.990***	-0.0171	-0.385***	0.011	-0.112***	-0.380***	-0.255***	-0.004	0.000	0.006	-0.044	0.002	-0.262	0.007	-0.103	0.050***
	0.012	*0.029*	*0.029*	*0.000*	*0.001*	*0.000*	*0.036*	*-0.001*	*0.106*	*0.053*	*0.044*	*0.010*	*0.024*	*0.054*	*0.067*	*0.005*	*0.003*	*0.004*	*0.049*	*0.037*	*0.524*	*0.011*	*0.302*	*0.017*
Portfolio of Bank Bonds	-0.160***	-0.091***	0.154***	0.000	0.000	0.000	-0.162***	-0.018***	-0.186***	-0.0051	0.293***	0.006**	-0.148***	-0.240***	-0.004	0.010	0.004	-0.0026**	-0.154***	0.039***	-0.246***	0.014**	-0.011	-0.0048
	0.004	*0.010*	*0.010*	*0.000*	*0.000*	*0.000*	*-0.004*	*-0.002*	*0.025*	*0.008*	*0.046*	*-0.003*	*0.006*	*0.015*	*0.017*	*0.001*	*0.001*	*0.001*	*0.007*	*0.029*	*0.033*	*0.006*	*0.043*	*0.003*
Securitized Loans	-0.014***	-0.037***	-0.011	0.0010***	0.0015***	0.001***	-0.005	0.007	-0.038**	0.021	-0.018	0.000	-0.102***	-0.109***	-0.023	0.0190***	0.0071***	-0.0106***	-0.260***	0.134**	-0.328	0.031***	-0.404	-0.024***
	0.004	*0.008*	*0.010*	*0.000*	*0.000*	*0.000*	*-0.005*	*0.000*	*0.019*	*0.021*	*0.012*	*-0.001*	*0.010*	*0.022*	*0.025*	*0.001*	*0.001*	*0.001*	*0.073*	*0.080*	*0.753*	*0.008*	*0.823*	*0.008*
ROE	0.001	0.007	0.004	0.000	0.000	0.000		0.000		-0.0024		0.000	-0.005	-0.011	-0.010	0.0012*	0.000	-0.0011*		0.006		0.000		0.000
	0.004	*0.010*	*0.011*	*0.000*	*0.000*	*0.000*		*0.000*		*0.008*		*0.000*	*0.004*	*0.007*	*0.008*	*0.001*	*0.000*	*0.001*		*0.000*		*0.000*		*0.000*
Capital	-0.127***	-0.088***	0.120***	0.000	-0.0004**	0.000*	-0.082***	-0.017***	-0.241***	0.080	0.344***	0.016***	-0.116***	-0.122***	0.088***	0.0043**	-0.0061***	-0.0115***	-0.074***	0.031	-0.089	-0.001	0.161	-0.033***
	0.005	*0.011*	*0.010*	*0.000*	*0.000*	*0.000*	*0.022*	*-0.003*	*0.059*	*0.078*	*0.069*	*-0.005*	*0.012*	*0.027*	*0.031*	*0.002*	*0.001*	*0.002*	*0.025*	*0.022*	*0.184*	*-0.004*	*0.203*	*0.007*
Fundraising	-0.187***	0.011**	0.258***	0.000	0.000	0.000	-0.148***	-0.019***	0.0912***	0.013	0.365***	0.002	-0.236***	0.099***	0.410***	0.0089***	0.0025***	-0.0052***	-0.222***	0.107	0.123	0.000	0.471***	-0.106***
	0.002	*0.004*	*0.006*	*0.000*	*0.000*	*0.000*	*0.007*	*-0.003*	*0.016*	*0.010*	*0.036*	*-0.003*	*0.003*	*0.007*	*0.010*	*0.001*	*0.000*	*0.001*	*0.016*	*0.139*	*0.108*	*-0.003*	*0.120*	*0.020*
Rating	0.003***	0.002**	-0.001	-0.0003***	-0.0005***	-0.000***	0.003***		0.0075***		0.000		0.006***	0.003	-0.011**	0.0041***	0.0006**	-0.0025***	0.008***		0.013		-0.014***	
	0.000	*0.001*	*0.001*	*0.000*	*0.000*	*0.000*	*0.000*		*0.002*		*0.001*		*0.002*	*0.006*	*0.005*	*0.000*	*0.000*	*0.000*	*0.002*		*0.013*		*-0.004*	
Banks without Rating	-0.022***	0.002	0.020***	0.0019***	0.0030***	0.001***	-0.018***		-0.001		0.013*		-0.066***	-0.057	0.079**	-0.0331***	-0.003	0.0219***	-0.070***		-0.090		0.108**	
	0.002	*0.006*	*0.006*	*0.000*	*0.000*	*0.000*	*-0.003*		*-0.006*		*0.008*		*0.015*	*0.046*	*0.039*	*0.002*	*0.002*	*0.002*	*0.016*		*0.060*		*0.053*	
Constant	0.417***	-0.030	-0.612***	0.004	0.007	0.002***	0.038	0.019***	-0.509***	-0.095	-0.452***	-0.010**	-0.410***	0.214***	0.680***	-0.033	-0.002	0.026	0.053**	-0.001	-0.025	-0.017*	0.447***	0.0565***
	0.006	*0.139*	*0.015*	*0.000*	*0.000*	*0.000*	*0.034*	*0.003*	*0.094*	*0.086*	*0.078*	*0.004*	*0.020*	*0.041*	*0.053*	*0.003*	*0.002*	*0.003*	*0.021*	*0.022*	*0.266*	*0.009*	*0.264*	*0.015*
Bank fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effets	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations	44,641	44,526	44,029	43,544	43,323	43,027	44,336		44,145		43,852		16,545	16,459	16,343	16,545	16,459	16,343	16,466		16,417		16,292	

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level.

Table 9. Determinants of interbank market positions

Results of equation 1. Sample time splitting: each specification is identically repeated before and after the crisis. Estimation method: *ordinary*-IV. Dependent variable $y_{i,t}$: Specifications (16)-(18): Domestic-Extra-Group positions; Specifications (19)-(21): Total interbank positions (i.e. sum of Domestic-Extra-Group + CCPs + Cross-Border Extra-Group + Cross-Border Infra-Group positions). Endogenous and instrumented regressor $x_{i,t}$: ratio of total gross loans from central bank to total assets. Corresponding IV first stage results are not reported because equivalent to those of Table 4.

Dependent variable:		*Domestic Extra-Group (scaled by total assets)*			*Total interbank market (scaled by total assets)*			*Domestic Extra-Group (scaled by total assets)*			*Total interbank market (scaled by total assets)*		
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*
Sample period:		**Pre-crisis period**						**Post-crisis period**					
Estimation method:		**IV (5)**			**IV (6)**			**IV (5)**			**IV (6)**		
Specifications:		**(16)**	**(17)**	**(18)**	**(19)**	**(20)**	**(21)**	**(16)**	**(17)**	**(18)**	**(19)**	**(20)**	**(21)**
Loans from central bank		-0.049 ***	-0.108 **	0.344 ***	-0.518 ***	-0.222 ***	0.242 ***	-0.350 ***	0.191 *	0.463 ***	-0.436 ***	0.079 **	0.512 ***
		0.018	*0.040*	*0.065*	*0.021*	*0.041*	*0.066*	*0.018*	*0.104*	*0.040*	*0.025*	*0.036*	*0.041*
Domestic Infra-Group	*Debts or Credits*	-0.120 ***	-0.320 ***	-0.159 ***	-0.243 ***	-0.405 ***	-0.137 ***	-0.062 ***	-0.194 ***	-0.032	-0.376 ***	-0.270 ***	0.186 ***
		0.007	*0.016*	*0.018*	*0.008*	*0.016*	*0.018*	*0.021*	*0.041*	*0.048*	*0.027*	*0.042*	*0.048*
Cross-Border Extra-Group	*Debts*	-0.077 ***						0.003					
		0.008						*0.009*					
	Credits		-0.159 ***						0.089				
			0.025						*0.055*				
	Net			-0.279 ***						-0.237 ***			
				0.017						*0.033*			
Cross-Border Infra-Group	*Debts*	-0.142 ***						-0.038					
		0.024						*0.060*					
	Credits		-0.146 *						-0.129 **				
			0.090						*0.052*				
	Net			-0.131 **						-0.452 ***			
				0.064						*0.141*			
Central Counterparties	*Debts*	0.494 ***						0.248 ***					
		0.160						*0.045*					
	Credits		-0.400						0.095				
			0.276						*0.154*				
	Net			0.457						0.303 ***			
				0.477						*0.117*			
Size		0.000	0.012 ***	0.014 ***	-0.001	0.013 ***	0.016 ***	0.024 ***	0.005 *	-0.024 ***	0.041 ***	0.007 **	-0.029 ***
		0.000	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.003*	*0.003*	*0.002*	*0.003*	*0.003*
Loans		0.028 ***	-0.178 ***	-0.206 ***	0.034 ***	-0.180 ***	-0.208 ***	0.024 ***	-0.328 ***	-0.331 ***	0.035 ***	-0.334 ***	-0.325 ***
		0.001	*0.003*	*0.003*	*0.001*	*0.003*	*0.003*	*0.003*	*0.007*	*0.008*	*0.004*	*0.007*	*0.008*
Bad Loans		-0.039 ***	-0.118 ***	-0.069 ***	-0.052 ***	-0.123 ***	-0.061 ***	-0.059 ***	-0.205 ***	-0.112 ***	-0.095 ***	-0.202 ***	-0.097 ***
		0.002	*0.006*	*0.006*	*0.003*	*0.006*	*0.007*	*0.007*	*0.014*	*0.016*	*0.009*	*0.014*	*0.017*
Portfolio of Government Debt Securities		-0.003	-0.470 ***	-0.326 ***	0.050 ***	-0.447 ***	-0.326 ***	-0.147 ***	-0.420 ***	-0.230 ***	-0.274 ***	-0.418 ***	-0.574 ***
		0.012	*0.029*	*0.031*	*0.014*	*0.029*	*0.032*	*0.028*	*0.058*	*0.067*	*0.038*	*0.058*	*0.067*
Portfolio of Bank Bonds		-0.166 ***	-0.085 ***	0.154 ***	-0.214 ***	-0.087 ***	0.200 ***	-0.152 ***	-0.237 ***	0.006	-0.181 ***	-0.258 ***	0.025
		0.004	*0.010*	*0.010*	*0.005*	*0.010*	*0.011*	*0.007*	*0.015*	*0.017*	*0.010*	*0.015*	*0.017*
Securitized Loans		-0.013 ***	-0.028 ***	-0.014	-0.052 ***	-0.022 **	0.012	-0.068 ***	-0.111 ***	-0.076 ***	0.004	-0.109 **	-0.128 ***
		0.004	*0.008*	*0.009*	*0.004*	*0.008*	*0.010*	*0.010*	*0.021*	*0.024*	*0.014*	*0.022*	*0.025*
ROE		-0.010 **	0.007	0.004	-0.010 *	-0.004	-0.009	-0.007 **	-0.014 *	-0.009	-0.003	-0.012	-0.012
		0.004	*0.010*	*0.011*	*0.005*	*0.010*	*0.011*	*0.003*	*0.007*	*0.008*	*0.005*	*0.007*	*0.008*
Capital		-0.140 ***	-0.079 ***	0.130 ***	-0.200 ***	-0.088 ***	0.161 ***	-0.122 ***	-0.127 ***	0.069 **	-0.169 ***	-0.117 ***	0.061 **
		0.005	*0.011*	*0.012*	*0.005*	*0.011*	*0.012*	*0.012*	*0.026*	*0.030*	*0.017*	*0.027*	*0.031*
Fundraising		-0.169 ***	0.013 **	0.257 ***	-0.214 ***	0.012 **	0.297 ***	-0.256 ***	0.091 ***	0.423 ***	-0.298 ***	0.085 ***	0.451 ***
		0.002	*0.005*	*0.006*	*0.003*	*0.005*	*0.006*	*0.004*	*0.008*	*0.009*	*0.006*	*0.008*	*0.009*
Rating		0.003 ***	0.002 ***	-0.002	0.005	0.002 **	-0.004 ***	0.007 ***	0.004	-0.010 **	0.000	-0.002	-0.004
		0.000	*0.001*	*0.001*	*0.000*	*0.001*	*0.001*	*0.002*	*0.005*	*0.005*	*0.003*	*0.004*	*0.004*
Banks without Rating		-0.021 ***	0.001 ***	0.021 ***	-0.036 *	0.006	0.038 ***	-0.069 ***	-0.057	0.086 **	-0.058 ***	-0.015	0.059
		0.002	*0.006*	*0.006*	*0.003*	*0.006*	*0.006*	*0.016*	*0.045*	*0.038*	*0.021*	*0.032*	*0.037*
Constant		0.110 ***	0.017	-0.189 ***	0.254 ***	0.048 ***	-0.267 ***	-0.145 ***	0.208 ***	0.309 ***	-0.169 ***	0.277 ***	0.250 ***
		0.006	*0.015*	*0.017*	*0.007*	*0.015*	*0.017*	*0.021*	*0.046*	*0.049*	*0.028*	*0.043*	*0.050*
Bank fixed effects		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effets		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations		44,336	44,145	43,852	44,336	44,145	43,852	16,466	16,417	16,292	16,466	16,417	16,292
Dependent variable in the first stage:		Loans from central bank											

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level.

Table 10. Determinants of interbank market positions

Marginal effects, averaged across estimation models and specifications, of the estimations of Tables 8 and 9.

Dependent variable:		*Domestic Extra-Group* (scaled by total assets)			*Central Counterparties* (scaled by total assets)			*Total interbank market* (scaled by total assets)			*Domestic Extra-Group* (scaled by total assets)			*Central Counterparties* (scaled by total assets)			*Total interbank market* (scaled by total assets)		
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*
Sample period:		**Pre-crisis period**									**Post-crisis period**								
Estimation method:		**IV(2); SUR; IV(5)**			**IV(3); SUR**			**IV(6)**			**IV(2); SUR; IV(5)**			**IV(3); SUR**			**IV(6)**		
Specifications:		1; 7; 16	2; 8; 17	3; 9; 18	4; 7	5; 8	6; 9	19	20	21	1; 7; 16	2; 8; 17	3; 9; 18	4; 7	5; 8	6; 9	19	20	21
Loans from central bank		-0.5	-1.1	3.4	ns	ns	0.0	-2.2	-1.8	2.4	-3.5	1.8	4.6	-0.1	-0.2	-0.4	-4.4	0.6	5.1
Domestic Extra-Group	*Debts*	na			0.0						na			0.1					
	Credits		na			ns						na			ns				
	Net			na			ns						na			0.1			
Domestic Infra-Group	*Debts or Credits*	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	ns	-0.1	0.0	0.1	-0.1	-0.1	0.0
Cross-Border Extra-Group	*Debts*	-0.8			0.1						0.2			-1.5					
	Credits		-0.1			0.1						ns			-0.5				
	Net			0.0			0.1						0.0			0.0			
Cross-Border Infra-Group	*Debts*	-0.1			0.0						ns			-1.5					
	Credits		-0.1			ns						-0.7			ns				
	Net			-0.1			0.0						-0.4			-1.3			
Central Counterparties	*Debts*	1.0			na						1.6			na					
	Credits		ns			na						ns			na				
	Net			ns			na						2.7			na			
Size		1.1	2.5	2.8	-0.2	-0.4	-0.1	ns	2.7	3.1	4.2	2.2	-4.8	2.2	0.3	-2.3	5.4	1.5	-5.9
Loans		4.9	-4.2	-5.0	-0.1	-0.1	ns	0.8	-4.3	-5.0	0.6	-7.8	-7.8	-0.5	ns	0.7	0.8	-8.0	-7.8
Bad Loans		-0.3	-0.8	-0.3	0.0	ns	ns	-0.3	-0.6	-0.3	-0.3	-1.0	-0.5	0.1	0.2	0.2	-0.5	-1.0	-0.5
Portfolio of Government Debt Securities		-0.1	-0.3	-0.2	ns	ns	0.0	0.0	-0.3	-0.2	-0.1	-0.2	-0.9	ns	ns	0.3	-0.2	-0.3	-0.3
Portfolio of Bank Bonds		-0.5	-0.3	0.4	-0.1	ns	0.1	-0.6	-0.3	0.6	-0.5	-0.7	ns	0.2	0.3	-0.2	-0.5	-0.8	ns
Securitized Loans		0.0	0.0	ns	0.0	0.0	0.0	-0.1	0.0	ns	-0.1	-0.1	-0.1	0.2	0.1	-0.1	ns	-0.1	-0.1
ROE		0.0	ns	ns	ns	ns	ns	0.0	ns	ns	0.0	0.0	ns	0.0	ns	0.0	ns	ns	ns
Capital		-0.6	-0.4	0.6	ns	0.0	0.0	-1.0	-0.4	0.8	-0.6	-0.7	0.4	0.2	-0.2	-0.5	-0.8	-0.6	0.3
Fundraising		-3.9	0.2	3.7	-0.2	ns	ns	-3.2	0.2	4.5	-3.7	1.5	6.2	1.4	0.4	-0.9	-4.5	1.3	6.8
Rating		0.6	0.4	ns	-0.2	-0.3	-0.2	ns	0.3	-0.7	1.4	ns	-2.3	1.3	0.8	-0.7	ns	ns	ns
Banks withou Rating		-2.4	ns	2.0	0.8	1.0	0.7	-3.6	ns	3.8	-6.8	ns	8.6	-3.1	ns	1.3	-5.8	ns	ns

Table reports marginal effects, averaged across estimation models and specifications, of the estimations shown in Tables 8 and 9. The marginal effects quantify the estimated economic impact of each regressor on the dependent variable, other things being equal. The estimated effect of each determinant is computed as the change in the percentage share of interbank positions to total assets between the 25th to the 75th percentile of each variable. ns denotes statistically non-significant regressors; na non-applicable regressors.

Table 11. Determinants of interbank market positions

Results of equation 1. Sample time splitting: each specification is identically repeated before and after the crisis. Estimation method: *ordinary*-IV. Dependent variable $y_{i,t}$: Specifications (22)-(24): Domestic-Extra-Group positions; Specifications (25)-(27): Total interbank positions (i.e. sum of Domestic-Extra-Group + CCPs + Cross-Border Extra-Group + Cross-Border Infra-Group positions). Compared to Table 9, dependent variables are computed as month growth rates. Endogenous and instrumented regressor $x_{i,t}$: ratio of total gross loans from central bank to total assets. Corresponding IV first stage results are not reported because equivalent to those of Table 5.

Dependent variable:		*Domestic Extra-Group* (growth rates)			*Total interbank market* (growth rates)			*Domestic Extra-Group* (growth rates)			*Total interbank market* (growth rates)		
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*
Sample period:		**Pre-crisis period**						**Post-crisis period**					
Estimation method:		**IV (7)**			**IV (8)**			**IV (7)**			**IV (8)**		
Specifications:		**(22)**	**(23)**	**(24)**	**(25)**	**(26)**	**(27)**	**(22)**	**(23)**	**(24)**	**(25)**	**(26)**	**(27)**
Loans from central bank		-0.537 ***	-0.511	-6.288	-0.312	-0.420	-2.562	-2.519	4.610 ***	4.361 *	-5.677 **	6.040 ***	2.911
		0.097	*3.357*	*7.092*	*1.063*	*0.904*	*2.550*	*2.439*	*1.030*	*2.553*	*2.447*	*1.174*	*1.963*
Domestic Infra-Group	*Debts or Credits*	-1.225 **	-4.425 ***	-1.466	-1.217 *	-1.385 **	9.698 ***	-2.405	-2.229 *	-1.353	-3.978	-3.399 **	4.572 **
		0.613	*0.656*	*1.980*	*0.705*	*0.591*	*1.666*	*2.717*	*1.199*	*4.277*	*2.735*	*1.324*	*2.019*
Cross-Border Extra-Group	*Debts*	-3.699 ***						-0.737					
		0.721						*1.173*					
	Credits		0.422						1.444				
			1.065						*1.596*				
	Net			-2.068						-16.35 ***			
				1.937						*2.898*			
Cross-Border Infra-Group	*Debts*	-1.306						2.717					
		1.982						*7.825*					
	Credits		-2.493						2.483				
			3.612						*14.962*				
	Net			-18.74 **						-27.02 **			
				7.096						*12.447*			
Central Counterparties	*Debts*	7.796						3.263					
		13.46						*5.886*					
	Credits		3.571						0.088 *				
			11.097						*0.046*				
	Net			-3.829 ***						-3.055			
				0.526						*10.323*			
Size		0.021	0.108 **	-0.031	0.077	0.218 ***	0.002	0.140	0.180 **	-0.688 **	0.344	0.316 ***	0.435
		0.051	*0.045*	*0.141*	*0.060*	*0.041*	*0.118*	*0.259*	*0.087*	*0.309*	*0.262*	*0.093*	*1.427*
Loans		-0.197	-0.614 ***	0.577	-0.142	-0.888 ***	-0.493	-0.467	-1.572 ***	0.512	0.062	-1.266 ***	1.279
		0.136	*0.119*	*0.367*	*0.158*	*0.107*	*0.301*	*0.592*	*0.202*	*0.714*	*0.579*	*0.211*	*3.227*
Bad Loans		-0.666 *	-0.230	0.308	0.569	-0.376 *	0.212	-0.311	-1.043 **	-1.002	-0.309	-1.456 ***	-0.435
		0.376	*0.238*	*0.735*	*0.437*	*0.217*	*0.620*	*1.244*	*0.417*	*1.484*	*1.265*	*0.444*	*6.828*
Portfolio of Government Debt Securities		0.517	-0.864	-4.484	-4.044 **	-4.100 ***	-2.737	-7.445	-5.829 ***	9.840 *	-10.952 **	-2.984 *	-0.773
		1.270	*1.175*	*3.561*	*1.477*	*1.062*	*3.016*	*4.707*	*1.685*	*6.003*	*4.778*	*1.826*	*27.901*
Portfolio of Bank Bonds		-1.415 ***	0.213	0.245	-1.539 ***	-1.699 ***	-1.725 *	-1.721	-0.651	-1.985	-1.882	-1.096 **	-0.824 *
		0.442	*0.390*	*1.191*	*0.501*	*0.348*	*0.997*	*1.183*	*0.429*	*1.501*	*1.191*	*0.466*	*7.120*
Securitized Loans		-1.353 ***	-0.625 *	2.024 *	0.274	0.427	-1.414	-1.313	0.451	7.380 ***	2.057 ***	1.458 **	3.777 ***
		0.348	*0.343*	*1.060*	*0.411*	*0.313*	*0.879*	*1.423*	*0.618*	*2.152*	*1.462*	*0.682*	*1.040*
ROE		-1.117 **	0.409	2.849 **	0.131	-0.315	0.313	0.188	0.063	0.083	-0.432	-0.284	0.892
		0.434	*0.403*	*1.233*	*0.506*	*0.366*	*1.036*	*0.596*	*0.208*	*0.729*	*0.618*	*0.229*	*3.517*
Capital		0.309	0.269	-1.670	-1.784 ***	-1.590 ***	-1.624 ***	4.343 *	0.886	0.472	4.909 **	-1.162	10.840
		0.524	*0.450*	*1.396*	*0.598*	*0.397*	*1.134*	*2.394*	*0.783*	*2.736*	*2.259*	*0.803*	*12.189*
Fundraising		-1.011 ***	0.037	-0.285	-1.997 ***	-0.593	-1.203	-2.576 ***	0.227	1.851 **	-3.009 ***	-0.513	-0.666
		0.243	*0.209*	*0.644*	*0.264*	*0.825*	*0.916*	*0.667*	*0.236*	*0.840*	*0.619*	*0.350*	*3.825*
Rating		0.036	-0.103 ***	0.359 ***	-0.038	-0.005	-0.113	0.026	-0.071	-0.360	0.043	-0.061	-0.849
		0.032	*0.035*	*0.107*	*0.038*	*0.032*	*0.091*	*0.243*	*0.157*	*0.400*	*0.256*	*0.124*	*1.898*
Banks without Rating		-0.237	0.413 **	-2.913 ***	0.390	0.084	0.577	-0.127	0.276	2.576	-0.452	0.321	6.790
		0.207	*0.229*	*0.693*	*0.243*	*0.209*	*0.582*	*2.053*	*1.290*	*3.311*	*2.120*	*1.031*	*15.713*
Constant		0.565	-0.203	-2.608	0.554	-1.416 **	1.345 **	3.479	-1.053	-7.868 *	-2.592	-2.377 *	-9.399
		0.676	*0.610*	*1.885*	*0.784*	*0.546*	*1.561*	*-0.110*	*1.350*	*4.415*	*3.542*	*1.339*	*20.455*
Bank fixed effects		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effets		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations		42,115	41,767	40,472	42,115	41,767	40,472	15,653	15,588	15,451	15,653	15,588	15,451
Dependent variable in the first stage:		Loans from central bank											

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level.

Table 12. Reverse causality between central bank refinancing and Loans (to bank customers)

Sample time splitting: only post-crisis results are reported. Estimation method: *ordinary*-IV. Dependent variable: Specification (28): Loans as ratios to total assets; Specification (29): Loans as year growth rate. Endogenous and instrumented regressor: ratio of total gross loans from central bank to total assets. Corresponding IV first stage results are not reported because equivalent to those of Table 5.

Dependent variable		*Loans*			
		scaled by total assets		*growth rate*	
Sample period:		**Post-crisis period**			
Estimation method:		**IV(9)**		**IV(10)**	
Specifications:		**(28)**		**(29)**	
Loans form central bank		0.204	***	0.598	*
		0.038		*0.351*	
Domestic Extra-Group	*Net*	-0.294	***	-0.118	
		0.007		*0.141*	
Domestic Infra-Group	*Debts or Credits*	-0.429	***	-4.652	***
		0.046		*0.920*	
Cross-Border Extra-Group	*Net*	-0.034		4.139	***
		0.031		*0.591*	
Cross-Border Infra-Group	*Net*	-0.433	***	7.722	***
		0.133		*2.604*	
Central Counterparties	*Net*	0.613	***	50.269	***
		0.110		*2.114*	
Size		-0.063	***	0.514	***
		0.003		*0.064*	
Bad Loans		-0.799	***	-0.950	***
		0.014		*0.290*	
Portfolio of Government Debt Securities		-0.475	***	3.086	**
		0.063		*1.257*	
Portfolio of Bank Bonds		0.036	**	0.211	
		0.016		*0.307*	
Securitized Loans		-0.242	***	-1.386	***
		0.023		*0.415*	
ROE		-0.006		-0.154	
		0.008		*0.149*	
Capital		0.419	***	2.906	***
		0.029		*0.577*	
Fundraising		0.319	***	-0.499	***
		0.009		*0.181*	
Rating		-0.021	***	0.238	*
		0.004		*0.126*	
Banks without Rating		0.147	***	-2.079	**
		0.035		*1.022*	
Constant		0.135	***	-6.295	***
		0.005		*1.018*	
Bank fixed effects		yes		yes	
Time fixed effets		yes		yes	
Number of observations		16,103		15,794	
Dependent variable in the first stage:		*Loans from central bank*			

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level.

Table 13. Robustness check: Determinants of central bank refinancing

Results of equation 1. Difference-in-difference estimations. Dependent variable $y_{i,t}$: ratio of total gross loans from central bank to total assets. Estimation method: *tobit*-IV. Endogenous and instrumented set of lagged regressors $x_{i,t-3}$: Domestic-Extra-Group positions. Corresponding IV first stage results are not reported because equivalent to those of Tables 8 and 9. Each specification contains two columns: (*a*) shows the results of the variables interacted with the crisis dummy c_t (representing the real focus of the diff-in-diff); (*b*) refers to the non-interacted regressors.

Dependent variable:		*Loans from central bank*							
Sample period:		All: diff-indiff model							
Estimation method:		Tobit-IV							
Specifications:		**(30)**		**(31)**		**(32)**		Marginal effects	
		(a)	**(b)**	**(a)**	**(b)**	**(a)**	**(b)**	(a)	(b)
Domestic Extra-Group	*Debts*	0.219 *0.314*	-0.234 *0.303*					ns	ns
	Credits			0.826 *** *0.291*	-0.289 *0.244*			1.8	ns
	Net					0.728 * *0.443*	-0.462 *0.434*	2.3	ns
Domestic Infra-Group	*Debts or Credits*	-0.089 *** *0.022*	-0.056 *** *0.009*	-0.096 *** *0.021*	-0.068 *** *0.009*	-0.058 ** *0.024*	-0.069 *** *0.009*	0.0	0.0
Cross-Border Extra-Group	*Debts*	-0.176 *** *0.025*	-0.011 *0.013*					-2.2	ns
	Credits			-0.196 *** *0.064*	0.002 *0.022*			-0.2	ns
	Net					0.247 *** *0.034*	-0.001 *0.016*	0.0	ns
Cross-Border Infra-Group	*Debts*	-0.059 *0.064*	-0.104 *** *0.028*					ns	-0.1
	Credits			0.159 * *0.096*	-0.223 *** *0.053*			0.1	-0.1
	Net					0.107 * *0.056*	0.172 *** *0.034*	0.1	0.2
Central Counterparties	*Debts*	-0.162 *** *0.031*	0.133 *** *0.016*					-0.3	0.2
	Credits			-0.092 *** *0.024*	0.035 *** *0.010*			-0.5	0.2
	Net					-0.068 *** *0.018*	-0.003 *0.009*	-0.4	ns
Size		-0.001 *0.001*	0.011 *** *0.000*	0.001 * *0.001*	0.012 *** *0.000*	0.002 *** *0.001*	0.009 *** *0.000*	0.4	2.3
Loans		0.095 *** *0.011*	-0.024 *** *0.004*	0.116 *** *0.010*	-0.022 *** *0.005*	0.125 *** *0.012*	-0.022 *** *0.005*	2.8	-0.6
Bad Loans		0.058 ** *0.023*	-0.014 *0.009*	0.094 *** *0.022*	-0.018 * *0.010*	0.088 *** *0.025*	-0.030 *** *0.011*	0.5	-0.2
Portfolio of Government Debt Securities		-0.409 *** *0.113*	0.001 *0.057*	-0.284 *** *0.112*	0.034 *0.055*	-0.106 *0.124*	-0.006 *0.066*	-0.2	ns
Portfolio of Bank Bonds		0.139 *** *0.021*	0.101 *** *0.015*	0.118 *** *0.021*	0.123 *** *0.014*	0.193 *** *0.022*	0.064 *** *0.013*	0.5	0.4
Securitized Loans		0.248 *** *0.017*	-0.097 *** *0.013*	0.252 *** *0.016*	-0.108 *** *0.014*	0.242 *** *0.018*	-0.094 *** *0.015*	0.3	-0.2
ROE		-0.043 * *0.025*	0.016 *0.015*	-0.062 ** *0.025*	0.005 *0.017*	-0.060 ** *0.028*	0.013 *0.019*	-0.2	ns
Capital		-0.154 *** *0.029*	-0.059 *** *0.014*	-0.168 *** *0.029*	-0.079 *** *0.015*	-0.109 *** *0.031*	-0.130 *** *0.014*	-0.8	-0.5
Fundraising		-0.058 *** *0.008*	-0.017 ** *0.008*	-0.078 *** *0.011*	-0.013 ** *0.005*	-0.029 *** *0.010*	-0.075 *** *0.005*	-0.9	-0.7
Constant		-0.109 *** *0.010*		-0.103 *** *0.007*		-0.057 *** *0.007*			
Bank fixed effects		yes		yes		yes			
Time fixed effets		yes		yes		yes			
Number of observations		59,499		59,191		58,778			
Dependent variable in the first stage:		*Domestic Extra-Group:*							
		Debts		*Credits*		*Net*			
Corresponding first stage results (eqaution 2) are not reported because analogous to those of Table 7									

Table reports regression coefficients and associated standard errors in italics. ***, **, and * denote statistical significance at 1, 5 and 10 % level. The dummy c_t (taking the value of 1 during the crisis and 0 before) is not separately estimated thanks to the presence of the month fixed effects p_t, which in addition allow a better identification. By analogy with Table 4, one could read column (*a*) as the post-crisis outcomes, and column (*b*) as the pre-crisis outcomes. However, the interpretation of interaction-term components' coefficients cannot be the same as if they were ordinary coefficients in a strictly additive model. Table also reports marginal effects, averaged across specifications. The marginal effects quantify the estimated economic impact of each regressor on the dependent variable, other things being equal. The estimated effect of each determinant is computed as the change in the percentage share of interbank positions to total assets between the 25th to the 75th percentile of each variable. ns denotes statistically non-significant regressors.