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

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Abstract

This paper analyses the effect of the crisis on central bank's refinancing and interbank market. It uses monthly banking-group data on all banks operating in Italy from the inception of the single Eurosystem monetary policy to August 2011. It explores the connections among the different segments of the interbank market: domestic and non-domestic; extra-group and intra-group; bilateral and via central counterparties. It adopts two methodological approaches (sample time splitting and difference-in-difference analysis), several estimation methods (IV, SUR, tobit-IV), and a broad range of robustness checks. The outcomes show that, even during the crisis, the Italian interbank market has functioned well and, contrary to some very popular conjectures, the rise in central bank's liquidity has been intermediated among banks and towards the economy.

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Contents

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1. Introduction

The crisis has reminded everyone of the crucial role played by liquidity markets. This paper joins the current debate focusing on the two main wholesale liquidity markets: (i) the central bank refinancing; and (ii) the interbank market. The two liquidity markets have to be analysed jointly.

First, the functioning of the entire financial system, the implementation of monetary policy, the efficiency of payment systems, and the borrowing conditions of households and firms depend both on an adequate amount of liquidity in the economy and on its adequate intermediation through the banking system (Allen and Carletti, 2008; Adrian and Shin, 2009; Brunnermeier, 2009).

Second, the two wholesale liquidity markets are closely linked. Central bank refinancing is the driver of liquidity; interbank market is the main market for liquidity exchange. The central bank is the monopoly supplier of money; the interbank market is the money market. The central bank influences the system through monetary policy operations; the interbank market is the main site of monetary policy transmission. It has been argued that central bank refinancing can be 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.

Third, the two liquidity markets have been both under strain during the crisis, which makes their joint analysis particularly topical. Major central banks have turned repeatedly to extraordinary injections of liquidity. Interbank market have registered some negative developments, notably very high lending rates at longer maturities, that have been widely read as signs of friction.

Other works share the idea that in order to investigate the determinants of banks' demand for central bank liquidity, it is necessary to extend the analysis to the interbank market (e.g. Furfine, 2003; Craig and Fecht, 2007; Bindseil et al., 2009). However, to my knowledge, mine is the first paper to analyse (with micro data and on a very long period that includes the crisis) the mutual relationship between each bank's positions vis-à-vis the central bank and the interbank market. The paper aims at this joint analysis including from a methodological perspective through instrumental variable (IV) estimations, which allow me to reach two goals at the same time: treating the reciprocal interdependence (endogeneity) of the two wholesale liquidity markets; and, being composed of more equations, investigating *all* the determinants of *all* liquidity markets at once.

In particular, the joint analysis of the two liquidity markets allow me to test empirically the validity of two theses become very popular in the crisis: (1) that the large increase in central bank refinancing is evidence of the malfunctioning of interbank market; and (2) that central banks have been ineffective in the crisis. In turn, the second criticism is supposedly demonstrated by two facts: (a) central banks' large liquidity injections increase the excess reserves held by banks, which tend to accumulate liquidity, but do nothing to promote the flow of credit to other banks or to their retail

customers (households and firms); and (b) official liquidity injections cannot restore interbank activity because central banks would become intermediaries and act as the counterparties for all liquidity transactions, thus taking the place of the interbank market.[1] The validity of these criticisms is tested exploring: (i) the effect of the crisis on the determinants, functioning, and interactions between the two liquidity markets; (ii) both the possible directions of the causal nexus between the two liquidity markets; and (iii) the relationships between the two markets and the bank loans to the economy.

The further merit of the paper lies in studying simultaneously and separately the different segments of the interbank market: extra-group and intra-group; domestic and non-domestic; bilateral and via central counterparties. This is done to (i) strengthen the analysis of liquidity redistribution, because only extra-group exposures constitute a real liquidity redistribution through the banking system; (ii) verify if liquidity redistribution takes place domestically and/or cross-border; (iii) investigate the role of the new segment via central counterparties, which increased exponentially in the crisis. My sample period − from January 1999 to August 2011 − covers the entire length of the single euro-area monetary policy, and ends when the euro-area sovereign debts crisis was exacerbating (this allows the analysis to include several phases of the crisis but to focus on the stages emerged inside the banking systems and concerning strictly the banks). My sample country − Italy − is an interesting case for three main reasons. First, it allows studying the effects of the Eurosystem policy on one of the main euro-area banking systems. Second, Italy is a bank-based economy, so interbank market and banking credit are likely to be important. Third, supervisory reporting requirements in Italy make a large set of bank-level characteristics available.

My results have relevant policy implications in view of the need for a better understanding of the markets for liquidity in periods of crisis. My main outcome shows that the banks that rely more on central bank refinancing lend more both to other banks and to the rest of the economy, and thus it contradicts the mentioned popular criticisms widespread during the crisis.

Even if my analysis is new for several aspects, the paper refers to three vast fields of research. First of all, this paper joins the literature on liquidity hoarding. This literature provides two reasons why banks might hoard liquidity and interbank market might freeze: a general increase in the riskiness of the borrowing banks (counterparty credit risk); and a precautionary accumulation of liquidity by lending banks (liquidity risk).[2] However, this literature splits into two conflicting

[1] See, for example, *The Economist* (2007); *Financial Times* (2008); Edlin and Jaffee (2009); Brunetti et al. (2009); Heider et al. (2009). Diamond and Rajan (2008) also examine the limits of central bank influence based on a Ricardian equivalence argument.

[2] Flannery (1996); Freixas et al. (2000); Diamond and Rajan (2005); Acharya et al. (2008); Wu (2008); McAndrews et al. (2008); Michaud and Upper (2008); Taylor and Williams (2008, 2009); Schwarz (2009); Ashcraft et al. (2009);

views when deals with the role of central banks. On the one hand, some scholars assert that central bank intervention cannot solve the problem of liquidity hoarding once occurred. Those aforementioned criticisms on the malfunctioning of interbank market and on central banks' policy ineffectiveness refer just to this part of the literature. On the other hand, the most of the literature stresses that central bank intervention remains warranted even in the case of liquidity hoarding.[3] My outcomes confirm empirically this second view. In particular, my findings complement the analysis of Allen and Carletti (2008), who observe that liquidity hoarding does not pose a threat when banks hold more liquidity and cover their idiosyncratic demands without resorting to the interbank market. That is, it is a threat only if banks' unwillingness to provide liquidity prevents its efficient reallocation of liquidity. Since I show that the central bank's liquidity is not accumulated unproductively by the receiving banks but intermediated in the system and to the economy, liquidity hoarding (in the negative sense clarified by Allen and Carletti) either does not occur in Italy or is solved by the central bank, whose intervention is therefore not only warranted but also effective. My empirical results tally with those of McAndrews et al. (2008), Ashcraft et al. (2009) and Christensen et al. (2009), all of whom find that Fed interventions are effective in the interbank market during the crisis; Afonso et al. (2011), who find that liquidity hoarding is an unimportant factor in US interbank loans; and Ashcraft et al. (2008), who show that, during the first phase of the current crisis, the Federal Home Loan Bank System (a US government-sponsored liquidity provider alternative to the Fed) furnished liquidity to depository institutions, which in turn furnished liquidity more broadly to the rest of the economy. Frame et al (2007) find similar results in a pre-crisis sample period.

Second, this paper draws on and contributes to the literature on central banks' interventions in the interbank market. In short, the literature offers four main reasons why central banks may intervene. (i) In a normally functioning interbank market, when banks with a surplus of liquidity transfer funds to those with a deficit, and even illiquid but solvent banks should be able to obtain

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Allen et al. (2009); Heider et al. (2009); Diamond and Rajan (2009); Ashcraft et al. (2009); Gale and Yorulmazer (2010); Acharya and Merrouche (2010); Acharya and Skeie (2011); Afonso et al. (2011).

[3] Flannery (1996) shows that when banks become reluctant to lend on the interbank market because of uncertainty about counterparties' creditworthiness, the central bank provides public liquidity. In Freixas et al. (2000), the central bank serves as crisis manager, eliminating just the negative incentives to accumulate liquidity either by providing liquidity or by reassuring banks that they will do so in the event of a shortage. Allen et al. (2009) point out that the role of the central bank is to restore efficient liquidity allocation by removing the inefficiency deriving from asset price volatility and to achieve the same allocation as with complete markets. In Acharya et al. (2008), the role of the central bank is to provide liquidity to the system, thus undercutting the market power of the banks with surplus liquidity, which could otherwise extract a surplus from their liquidity-poor counterparts. Keister and McAndrews (2009) argue that the criticism that banks merely accumulate the liquidity provided by central banks is fallacious in the abstract because the high level of bank reserves, even when banks do lend, is determined exclusively by the newly-created liquidity. Freixas et al. (2009) show that the central bank always plays a key role in the interbank market, even during a crisis, either managing interest rates for efficient liquidity reallocation or injecting liquidity to deal with aggregate liquidity shocks. Acharya and Merrouche (2010), though finding liquidity hoarding in the UK, argue that after their sample period the large number of central bank interventions is likely to have helped banks mange their liquidity better.

funding (while if a bank is unable to borrow it is because it is insolvent or failing), central banks step in only to steer liquidity conditions and short-term interest rates smoothly (e.g. Selgin, 1993; Freixas et al. 1999). (ii) When interbank market becomes dysfunctional because of asymmetric information, so that even solvent banks cannot get credit, central banks can step in to solve a market failure.[4] (iii) When liquidity shocks occur, central banks have two unique abilities: to provide liquidity in sufficient amounts in response to abnormal shocks (Bhattacharya and Gale, 1987; Acharya et al. 2008); to diversify risk across a large number of illiquid banks (Flannery, 1996; Rochet and Vives, 2004). (iv) When interbank market has wrongly judged a bank as insolvent, central banks may lend on the basis of their own latest supervisory data (Berger et al., 2000). This paper contributes demonstrating empirically and exploiting the endogenous link between primary and secondary liquidity markets, and showing that central bank's interventions in the interbank market are effective even during the crisis.

Third, this paper is related to the literature on banks' participation in central banks' operations, which numbers both US and euro-area empirical cases.[5] My paper differs and contributes to this literature in several respects. (i) Like this literature, my paper includes bank-specific characteristics to explain the decision to access central bank loans because banks' heterogeneous business activities and risk profiles generate different liquidity needs. (ii) This literature typically focuses on the determinants of banks' participation, prices paid for liquidity, and bid volumes (which have to do also with banks' strategic behaviour at auctions) in *specific types* of central bank operations, while I analyse the determinants of *total banks' borrowing* from central banks more in general. (iii) This literature typically uses high-frequency data spanning a short time horizon, while I use monthly observations on a long sample period. (iv) This literature has a monetary policy implementation perspective, with the partial exception of Craig and Fecht (2007), and Fecht et al. (2011), while I adopt a banking perspective. (v) This literature focuses only on bidders participating in at least one auction, whereas I include all banks operating in Italy, hence also those that never directly access the central bank's liquidity, thus obtaining complementary inferential information and avoiding a biased sample selection. (vi) This literature typically focuses on a few of explanatory factors, while I explore the role played by a large set of bank-specific characteristics in influencing the demand for central bank liquidity. (vii) This literature utilizes individual data, while I use banking-group aggregate data, which are better suited to investigate

[4] Even when the central bank's action is meant to solve a pure distribution problem in the interbank market and not to stabilize or adjust the level of the aggregate money stock, the central bank plays a vital role because of the uniqueness of bank loans. Credit relationships are not easily transferable from one bank to another, particularly for borrowers who do not have access to capital markets as an alternative.

[5] Peristiani (1998), Breitung and Nautz (2001), Nyborg et al. (2002), Furfine (2003), Nautz and Oechssler (2003), 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), and Armantier et al. (2011).

liquidity needs and the decision to access central bank liquidity, which is more likely to be made at banking-group level. (viii) I am able to analyse all interbank transactions, including over-the-counter. (ix) Finally, and notably, I analyse the effects of the current crisis on the banks' liquidity demand, while the other papers study previous sample periods. In this light, an exception is Cassola et al. (2011), who analyse the link between willingness to pay in the Eurosystem repo auctions and alternative sources of funding during the summer of 2007. Their main conclusions are consistent with mine. They find like me that there is not a malfunctioning of the interbank market because the increase in outside funding costs regards only a subset of banks, while for many others increased participation is simply a strategic response to the higher bids of their rivals. They also find that there is heterogeneity in the incidence of the crisis with respect to banks' country of origin. In particular, banks from member countries that relied less on Eurosystem funding before August 2007 appear to have suffered less from the crisis. This conclusion applies perfectly to Italy, whose banks traditionally make relative little recourse to central bank liquidity.

The rest of the paper is organized as follows. Section 2 describes the methodology. Section 3 presents the data. Section 4 reports the results. Section 5 summarizes robustness checks. Section 6 concludes.

2. Empirical strategy

My empirical strategy alternates two approaches, which differ in the way they investigate the impact of the crisis. The first approach simply repeats the same estimations after splitting the sample period into two sub-periods, before and after the onset of the crisis. The second approach is a difference-in-difference estimation, where the crisis is the treatment event of which I study the effects. Both approaches employ IV estimations, which are particularly appropriate with the idea of jointly analysing the primary and secondary liquidity markets, because IV allow to: (i) treat their reciprocal interdependence (endogeneity); and (ii) examine *all* the determinants of *all* liquidity markets at the same time.

More in detail, the first approach (sample time splitting) may be represented by the following simultaneous equations:

$$y_{i,t} = \alpha'_1 x_{i,t-3} + \beta'_1 K^A_{i,t-4} + \eta'_1 b_i + \lambda'_1 p_t + \varepsilon_{i,t} \quad (1.1)$$

$$x_{i,t-3} = \beta'_2 K^A_{i,t-4} + \eta'_2 b_i + \lambda'_2 p_t + \varphi'_2 K^B_{i,t-4} + \xi_{i,t} \quad (1.2)$$

where $y_{i,t}$ − the dependent variable in equation 1.1 − are the total loans granted by the central bank to bank i in month t; $x_{i,t-3}$ is alternatively one of the three interbank market positions (Debts, Credits

or Net Position), measured in the previous quarter. The regressor $x_{i,t-3}$ is the endogenous covariate in equation 1.1 − second stage, in the terms of the IV model − and the dependent variable in equation 1.2 − first stage in the terms of the IV model − where it is instrumented by the matrix of instruments $K^{B}_{i,t-4}$. The two matrixes $K^{A}_{i,t-4}$ and $K^{B}_{i,t-4}$ contain banks' (exogenous) characteristics.[6] α_1, β_1, η_1, λ_1, β_2, η_2, λ_2, φ_2 are vectors of coefficients; $\varepsilon_{i,t}$ and $\xi_{i,t}$ are idiosyncratic errors ~ i.i.d. It is worth noting that I always include bank fixed effects b_i, and month fixed effects p_t, in order to control for bank-level unobservable characteristics, for example to control for 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.

The second approach (difference-in-difference estimation) includes an interaction term between the same regressors as in the first approach and a time-dummy variable c_t capturing the phase of the crisis. The system of equations becomes the following:

$$y_{i,t} = \alpha'_1 x_{i,t-3} + \beta'_1 K^{A}_{i,t-4} + \eta'_1 b_i + \gamma'_1 c_t \times x_{i,t-3} + \delta'_1 c_t \times K^{A}_{i,t-4} + \theta'_1 c_t \times b_i + \lambda'_1 p_t + \varepsilon_{i,t} \quad (2.1)$$

$$x_{i,t-3} = \beta'_2 K^{A}_{i,t-4} + \delta'_2 c_t \times K^{A}_{i,t-4} + \eta'_2 b_i + \theta'_2 c_t \times b_i + \lambda'_2 p_t + \varphi'_2 K^{B}_{i,t-4} + \xi_{i,t} \quad (2.2)$$

where $y_{i,t}$, $x_{i,t-3}$, $K^{A}_{i,t-4}$, $K^{B}_{i,t-4}$, b_i, p_t, and the relative coefficients are defined as in equations 1.1-1.2; and c_t is a dummy variable taking the value of 1 during the crisis and 0 before.[7]

My two approaches serve, on the one hand, as mutual validation; and, on the other hand, as complementary information. The first approach (sample time splitting) explains which banks have more recourse to the central bank in each period or, in other terms, which bank characteristics influence more this recourse in each period. The second approach (difference-in-difference) explains whether and how certain bank characteristics impact in the crisis.

The pairs of equations 1.1-1.2 and 2.1-2.2 may be viewed as systems of equations, and are estimated by: (a) a *tobit*-IV model; (b) a SUR model; and (c) an *ordinary* IV model.[8] (a) Tobit models are well suited to the variable $y_{i,t}$ − central bank refinancing − because it is continuous and has a constrained range, which is zero for a substantial part of the population (my data refer to all banks operating in Italy including those that never directly access the central bank's liquidity, which provides complementary inferential information and avoids a biased sample selection). It is worth

[6] The variable $x_{i,t-3}$ is lagged by a quarter in order to avoid further possible endogeneity problems. The regressors in the matrixes $K^{A}_{i,t-4}$ and $K^{B}_{i,t-4}$ are lagged by four months to avoid new endogeneity in estimating the interbank market's determinants (equation 1.2), and to replicate the publication delay needed for mutual assessment by banks.

[7] The dummy c_t is not separately estimated thanks to the presence of the month fixed effects p_t, which in addition allow a better identification. In some specifications, $x_{i,t-3}$ is the only endogenous regressor and is accordingly instrumented in equation 2.2. However, this choice and the instruments change in different specifications and robustness checks. In some checks, the interaction-term $c_t \times x_{i,t-3}$ is instrumented as well adding a further equation. See Section 5.

[8] Both the *tobit* and the *ordinary* IV estimations may include single or multiple endogenous regressors.

emphasizing that, when running the tobit model as well I employ a version with continuous endogenous regressors. (b) The SUR model allows for contemporaneous correlation across the different innovations, and allows estimation of the mutual effect of the different endogenous variables. This occurs both (i) including the variable $y_{i,t-3}$ in the second equation of the system; and (ii) splitting the variable $x_{i,t-3}$, and then adding new equations. In this sense, the two systems of equations 1.1-1.2 and 2.1-2.2 are only representative of the many specifications I run. In fact, since I estimate the effects and the determinants of five different interbank market segments separately, $x_{i,t-3}$ may refer alternatively either to one interbank market segment (and thus the system is composed of two equations as exemplified), or to more than one segment (and the system of equations gets composed of more than two equations). For example, when I analyse simultaneously two interbank segments, the system is composed of three equations: the first equations − both 1.1 and 2.1 − contain two endogenous regressors, and the matrix of instruments $K^{B}_{i,t-4}$ includes instruments for two segments of the interbank market.[9] (c) The ordinary IV regression is run just because, compared with the tobit-IV method, obtains results more immediately comparable with those of the SUR model.

The split of $x_{i,t-3}$ in five segments of the interbank market is necessary in my analysis. I first detail the five segments, and then explain why they are distinguished. The five segments are the following.

(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) Non-Domestic Extra-Group.

(iv) Non-Domestic Intra-Group.

(v) Central Counterparties, embracing the *trilateral* interbank transactions via domestic central counterparties. The central counterparties are third parties that mediate the lending operations between two banks, for the purpose of reducing counterparty risk for the lender.[10] Like the exposures of point (i), the interbank transactions via domestic central counterparties are extra-group

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

[10] The lending operations realized via a central counterparty typically take the form of tripartite repos, instead of the ordinary bilateral repo operation. Tripartite repos are structured as follows: i) the borrowing bank enters into a repurchase agreement with the central counterparty, borrowing the required amount and providing collateral; ii) the lending bank enters into a reverse repo with the central counterparty; iii) the central counterparty administers the transaction and the collateral, acting as the direct counterparty to the seller and to the buyer, thus assuming the risk of borrower default. In addition, collateral management is highly standardised in terms of profiling and margining, which enhance transparency, and the administrative burden for borrower and lender is significantly lower than in a bilateral repo.

(namely among banks not belonging to any banking group or belonging to different banking groups). On the other hand, unlike those exposures, the ultimate counterparty of transactions via domestic central counterparties can be a non-domestic bank or another non-domestic central counterparty.

The distinction between Extra-Group and Intra-Group exposures is essential because only Extra-Group exposures constitute a real liquidity redistribution through the banking system.[11] The distinction between Domestic and Non-Domestic exposures allows to investigate both if the liquidity redistribution occurs and if it occurs domestically and/or cross-border. The distinction between bilateral and trilateral exposures allows to explore the role played by the new segment of Central Counterparties, which increased notably during the crisis and is purely neither domestic nor non-domestic.

In turn, for each segment of the interbank market, $x_{i,t-3}$ captures alternatively the borrowing side (Debts), the lending side (Credits), and the Net Position (Credits minus Debts). In order to verify the hypothesis of liquidity hoarding, the concurrent analysis of *gross* and *net* interbank positions provides complementary information. The aim of the variable Net Position is plain. It reveals whether banks borrowing from the central bank have the characteristic of being interbank net-borrowers or net-lenders, and therefore whether the central bank liquidity is obtained by liquidity requiring or liquidity redistributing banks. The variables Debts and Credits are useful as well. Even for the same size of Net Position, Debts and Credits indicate if banks are using, and how much, the interbank market.[12] Moreover, their concurrent analysis furnishes a complete picture of liquidity markets enabling to estimate the determinants of all interbank positions in equations 1.2 and 2.2 and to check the stability of control regressors. In short, $x_{i,t-3}$ represents alternatively 13 different variables: 3 positions (Debts, Credits, and Net Position) for four segments (Domestic Extra-Group, Central Counterparties; Non-Domestic Extra; and Non-Domestic Intra); and 1 position for the Domestic Intra-Group segment.[13]

As a further means of checking my results, the interbank positions $x_{i,t-3}$ are alternatively expressed either as ratios to total assets or as growth rates. I start making use of the variables $x_{i,t-3}$ as ratios to total assets for three reasons. First, in analogy with $y_{i,t}$, which is always scaled by total

[11] To exemplify, if banks paradoxically lent only within their own banking groups, the total interbank market apparently would work, but liquidity hoarding actually would occur at banking groups level.

[12] To exemplify, let us assume a banking system composed of two banks (*A* and *B*) and two months (t_1 and t_2). Let us assume that during t_1, *A* and *B* do not mutually exchange their liquidity at all; while, during t_2, *A* lends to and borrows from *B* an amount equal to 100. At the end of both months, the Net Position of the two banks is zero. Nevertheless, in the first month the interbank market is frozen, while in the second month it is fully operational (*A* and *B* can have mutually financed their temporary liquidity needs in different moments of the same month).

[13] In fact, as for the Domestic Intra-Group 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 or not the banking groups with a larger exchange of internal liquidity increase the recourse to the central bank refinancing and to the other segments.

assets. Second, the panel estimation context enables the ratios to capture at least in part also the developments' effect. Third, to the purposes of my analysis, it is not crucial to verify whether the growth rates of interbank activity increase, while it is indispensable to verify whether banks obtaining the central bank liquidity have the characteristic of being hoarding or redistributing institutions. In any case, for completeness and check, I run also the version with the growth rates.

So far, in order not to strain the exposition and the following estimations, I have explained that my empirical strategy treats (and exploits) the endogeneity between primary and secondary liquidity markets, but I have still described it as if implicitly assumed one only possible direction of the casual nexus (from interbank positions to central bank refinancing). In other words, as the literature typically does (e.g. Furfine, 2003; Craig and Fecht, 2007; Bindseil et al., 2009; Afonso et al., 2011), I start estimating the banks' demand for central bank liquidity (which is therefore the main dependent variable), and I use banks' characteristics as explanatory variables (crucially the interbank positions, which are the endogenous regressors). However, I have already mentioned that the SUR model enables to include the lagged variables $y_{i,t-3}$ $y_{i,t-6}$ as regressors of $x_{i,t-3}$ to double-check if central bank liquidity injections have a reversed direct impact on interbank positions. Nevertheless, one could still argue that the causal effect between the primary and secondary liquidity markets could be completely inverted, and the liquidity hoarding hypothesis should be tested by a reversed experiment. In this light, I run also a new IV regression, instrumenting central bank refinancing in the first stage, and using it as the endogenous regressor to estimate the interbank positions in the second stage. In spite of the reversed econometric framework, all the features of my empirical strategy (sample time splitting and dif-in-dif; IV models; interbank segments' split; the use of the three interbank positions; their alternative expression as ratios to total assets or growth rates) remain unchanged when I carry out these checks.

3. Data

I have two kinds of key variables: the central bank refinancing ($y_{i,t}$ in equations 1.1 and 2.1), and the positions in the different interbank market segments (the set of variables $x_{i,t-3}$). The source of data are the Bank of Italy's prudential supervisory reports.

My first key variable $y_{i,t}$ is the ratio between total exposures of each bank towards the central bank in each period (gross- or alternatively 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, NCBs, carry out the transactions), my dataset includes all loans that the Eurosystem grants to banks operating in Italy, both domestic and foreign, through the Bank of Italy. Under the Eurosystem operational

framework, banks that have establishments (a head office or branches) in more than one member state may access the Eurosystem liquidity through different NCBs. Therefore, my dataset, on the one hand, may exclude the liquidity obtained by an Italian bank through the NCB of another country where it owns a branch; but it includes the liquidity obtained through the Bank of Italy by, say, a French or a German bank that owns a branch in Italy. The variable $y_{i,t}$ comprises the total amount of liquidity provided by the Bank of Italy to each bank and banking group. This total amount covers standing facilities, open market operations, and loans granted through the non-standard measures taken by the Eurosystem during the crisis.[14] The distinction by type of central bank loan is irrelevant for my purposes because I analyse the determinants of the overall demand for central bank liquidity regardless of the substitute role of different instruments.[15] The variables $y_{i,t}$. is employed in the estimations as *gross* loans and as a robustness check as *net* loans, i.e. after subtracting from the gross loans granted by the central bank to each bank the amounts that each bank re-deposits at the central bank.

As explained in Section 2, the second set of key variables $x_{i,t-3}$ measures alternately the three positions (Debts, Credits, and the Net Position) in five segments of the interbank market. My data cover all interbank exposures, including over-the-counter.

All the variables are computed aggregating at banking group level monthly bank-by-bank data (and leaving at bank level the data of independent banks). The aggregation at banking group level is explained just by the focus on the central bank refinancing and interbank markets. First, the

[14] The Eurosystem uses two types of operations: standing facilities and open market operations. Open market operations, the more important, include main refinancing; longer-term refinancing; fine tuning; and structural operations. Open market lending normally takes place in the form of reverse transactions: the central bank buys assets under a repurchase agreement or grants a loan against assets pledged as collateral. Reverse transactions are therefore temporary open market operations, which provide funds for a limited, pre-determined period. The standing facilities include two types of operations: the marginal lending facility and the deposit facility. Both have an overnight maturity and are available to counterparties at their own initiative. Since August 2007, the Eurosystem has undertaken several temporary unconventional monetary policy measures, targeted mainly at the banking sector, with the aim of supporting financing conditions and the flow of credit beyond what could be achieved through reductions in key ECB interest rates alone. 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) and Eser et al. (2012).

[15] There are different fields of the literature that deal with the types of central bank loan. First, a part of the literature on central bank actions analyses single types of central bank liquidity provision because they may be informative about a bank's ability to use a specific refinancing option or about which specific type of central bank operation satisfies the liquidity needs of certain banks. Second, the literature is not unanimous on whether stabilization can be achieved by open market operations (Goodfriend and King, 1988; Kaufman, 1991) or lending to individual banks (Flannery, 1996; Goodhart, 1999). Market operations are preferred when the central bank is believed to have no informational advantage over the interbank market. Individual operations when interbank market inefficiencies are expected to result in some solvent banks becoming illiquid because unable to borrow. Third, the literature also questions whether or not a distinction can be made between monetary-policy and lender-of-last-resort operations (Freixas et al., 1999). To my purposes, these distinctions would be misleading. For example, in the hypothesis of preference for market operations (since under the Eurosystem's liquidity-neutral policy, injections are intended to meet aggregate and not individual requirements), 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.

only proper way to investigate the decision and determinants of access to central bank liquidity is to refer to banking groups. A banking group comprising various banks may decide to resort to central bank liquidity through one, several or all of them. In any case, these transactions are likely to be decided by the parent bank, to fit into a group-specific scheme, and to be affected by group task-sharing.[16] Second, the aggregation enables to distinguish the Intra-Group exposures, which (as argued in Section 2) must be removed from the interbank market in order to properly analyse the hypothesis of liquidity hoarding.[17]

My sample period covers monthly data from January 1999, when the single Euro-area monetary policy was instituted, to August 2011, when the sovereign debts crisis was exacerbating. The number of time periods is therefore $t = 1, 2, \ldots, 152$. In order to verify the effect of the crisis, my first approach (equations 1.1.-1.2) splits the sample period into two sub-periods: before and after August 2007, the consensus date for the onset of the crisis (even if I experiment with alternative dates). In the pre-crisis sample, T is equal to 103; in the post-crisis, to 49. My second approach (equations 2.1.-2.2) assigns the value of 1 to the variable c_t from August 2007 onwards. The total number of observations is about 43,500 in the pre-crisis sample and 16,000 in the post-crisis sample. These numbers reflect: (i) the variation in the total number of banking groups and independent banks $i = 1, 2, \ldots, N_t$ in each t, from 720 in January 1999 to 644 in August 2011; (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 intensify during the crisis. Figure 2 shows that also the share of central bank's loans in total assets and the number of banks borrowing from the central bank raise during the crisis.[18] With regard to interbank market segments, Figures 3 and 4 document that during the crisis: (i) Domestic Extra-Group interbank market exposures are stable; (ii) Non-Domestic Extra-Group interbank exposures decrease; and (iii) exposures via Central Counterparties increase. Table 1 reports the summary statistics of the key variables. Table 2 shows the correlations. The central bank's loans tend to be

[16] Bruno et al. (2005) find that the membership in a banking group is a factor in the decision to take part in a Eurosystem auction. Likewise, Fecht et al. (2011) find that the participation of banks in "formal liquidity networks" influences their auction behaviour.

[17] 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 variables in the matrixes $K^A_{i,t-4}$ and $K^B_{i,t-4}$.

[18] Counterparties in Eurosystem monetary policy operations must satisfy eligibility criteria, defined to ensure equal treatment for institutions throughout the area. To be eligible, a counterparty must (i) be a credit institution; (ii) be subject to the Eurosystem's minimum reserve system; (iii) be subject to at least one form of supervision by national authorities and be financially sound; and (iv) satisfy specified operational criteria. The number of counterparties actually participating in open market operations is normally much lower than the number of eligible counterparties.

correlated positively with interbank Debts and negatively with interbank Net Positions. However, there is no lack of non-linear effects, which indirectly confirms the need for more sophisticated statistical tools.

Table 3 lists my explanatory variables (again aggregated for banking groups for group-banks) included in the matrixes $K^{A}_{i,t-4}$ and $K^{B}_{i,t-4}$; tells how they are calculated; and gives their summary statistics. All regressors are natural logarithms, ratios or dummy variables. Most of the explanatory variables are again drawn from the Bank of Italy's prudential supervisory reports. The exceptions are two variables taken from Fitch, which capture the role of rating agencies and are included in the matrix of instruments $K^{B}_{i,t-4}$. The variable Rating is coded so as to take values from 1 to 11, where 1 corresponds to the best rating class and 10 to the worst (11 designates banks with no rating). My 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.[19]

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, emphasis on quantitative aspects has been increasing in the literature on interbank market (e.g. Furfine, 2004 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 ones for which interest rate data are not available.[20]

Second, while liquidity needs are usually at very short maturities, 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 (e.g. Craig and Fecht, 2007, Fecht et al. 2011). 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 it accordingly has a stable maturity.

[19] Angelini *et al.* (2011) find that Fitch ratings are more informative in the assessment of banks and financial firms. I use four different kinds of credit scores taken from the Fitch agency through the database of Bloomberg. All the credit ratings are obtained as a monthly average of daily ratings. My first choice is the overall individual rating; the other three types are: support, long-term and short-term issuer default rating. In the case of banking groups, I use the rating of the parent company.

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

4. Results

As described in Section 2, the set of variables $x_{i,t-3}$ is treated as endogenous and instrumented. Potentially, the endogeneity regards the positions in all the five different interbank market segments. However, on the basis of my estimations, in two cases (Domestic Extra-Group and Central Counterparties) $x_{i,t-3}$ turns out to be indeed endogenous, and results do differ depending on whether or not it is instrumented. But, in three cases (Domestic Intra-Group, Non-Domestic Extra- and Non-Domestic Intra-Group) $x_{i,t-3}$ turns out to be exogenous and results do not change if it is instrumented or not.[21] This different endogeneity of the various interbank market segments is a first interesting outcome. It shows that the interbank exposures effectively codetermined with the central bank refinancing concern only some market segments.[22] Accordingly, the Tables present the instrumented results as for the positions of the Domestic Extra-Group and Central Counterparties segments, while include the other three interbank market segments as exogenous regressors (i.e. placing them in the matrix $K^{A}_{i,t-4}$).

As a general comment, it is to note that regressors across all specifications are not always statistically significant, but they do provide clear indications because (i) they never change the statistical significance of their sign, though tested by a broad range of empirical approaches, estimation models, specifications and robustness checks; and (ii) the magnitude of marginal effects furnishes univocal economic interpretations.[23] The following Sub-Section 4.1 concerns the results of the determinants of the variable $y_{i,t}$; while Sub-Section 4.2 summarizes those of the variable $x_{i,t-3}$.

[21] More technically, in equation 1.1, as for Domestic Intra-Group, Non-Domestic Extra- and Non-Domestic Intra-Group positions, both the Durbin-Wu-Hausman test (ordinary IV) and the Wald test (tobit-IV) cannot reject the null hypothesis of no endogeneity. On the contrary, as far as Domestic Extra-Group and Central Counterparties are concerned, the two tests do reject the null. In equation 2.1 of the difference-in-difference approach, the results of all the interbank market segment variables (once interacted with the dummy variable c_t capturing the crisis phase) remain stable irrespective of the instrumented variable. Things are more highly differentiated for the variables that are not interacted with the dummy, which however are not the focus of the difference-in-difference approach. With regard to validity and strength of instruments, the results of the standard tests corroborate my choices. 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 $x_{i,t-6}$ as an alternative, and results hold.

[22] Even if I have not yet described my results in detail, for completeness on this issue, it is useful to highlight that the two interbank segments resulting indeed endogenous (Domestic Extra-Group and Central Counterparties) are also those with a larger economic impact.

[23] For all the 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.

4.1 Determinants of $y_{i,t}$ (total loans from the central bank)

The results of the variable $y_{i,t}$ are presented in Tables 4-6. Table 4 displays the results of equation 1.1 (sample time splitting). Each specification is identically repeated before and after the crisis. In detail:

- Specifications (1)-(3) show the results of a IV estimation, where the endogenous (instrumented) regressor $x_{i,t-3}$ coincides, alternately, with the three positions in the Domestic Extra-Group segment. Specification (1) focuses on and instruments for the Domestic Extra-Group *Debts*; specification (2) for the Domestic Extra-Group *Credits*; and specification (3) for the Domestic Extra-Group *Net Position*.[24]
- Specifications (4)-(6) show again the results of a IV estimation. However, in this case, the endogenous (instrumented) regressor $x_{i,t-3}$ coincides, alternately, with the three positions in the Central Counterparties segment.
- Specifications (7)-(9) show the results of a SUR estimation with three equations, where the first equation estimates $y_{i,t}$, and the other two equations refer to Domestic Extra-Group and Central Counterparties positions. Therefore, specification (7) focuses on and "instruments" for both Domestic Extra-Group and Central Counterparties *Debts*; specification (8) for both Domestic Extra-Group and Central Counterparties *Credits*; and specification (9) for both Domestic Extra-Group and Central Counterparties *Net Position*.

Since the reliable results are obviously those that are instrumented, specifications (1)-(3) present the relevant outcomes of the Domestic Extra-Group positions (while black out the results of Central Counterparties). Vice-versa, specifications (4)-(6) present the relevant outcomes of Central Counterparties (and black out the Domestic Extra-Group). In specifications (7)-(9), the two interbank market segments are contemporaneously "instrumented", and indeed the results are consistent (and hence mutually validated) with those of specifications (1)-(3) as for the Domestic Extra-Group, and with those of specifications (4)-(6) as for Central Counterparties.

Table 5 reports the results of equation 2.1 (difference-in-difference approach).[25] Each specification presents two columns: column (*a*) shows the results of the variables interacted with the

[24] 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. In this case, in order not to weaken my instruments, I employed $x_{i,t-6}$ as an additional instrument in the matrix $K^B_{i,t-4}$. Results are equivalent.

[25] To improve comparability between IV and SUR outcomes, Table 4 reports the results of an *ordinary*-IV estimation; while Table 5 reports the *tobit*-IV results for the difference-in-difference approach. In both cases, however, the two IV estimations provide outcomes substantially equivalent. As noted earlier, in equation 2.1, the results of the regressor $x_{i,t-3}$, once interacted with the dummy c_t, remain stable, and then I can be more parsimonious in using different specifications. In Table 5, the instrumented variables are, alternatively, the three Domestic Extra-Group positions.

crisis dummy c_t (representing the real focus of the difference-in-difference approach); column (*b*) refers to the non-interacted regressors and serves basically as a control.[26]

Table 6 reports marginal effects, averaged across the specifications, of all the previous estimations. The marginal effects quantify the estimated economic impact of each regressor on the variable $y_{i,t}$, other things being equal, passing from the 25th to the 75th percentile of each determinant.

The following subparagraphs describe the results of the different determinants of $y_{i,t}$ referring to all the mentioned Tables at once. I start illustrating the results of my key determinants (the interbank market segment positions), and then discuss the results of the control regressors, which also provide interesting outcomes.

Domestic Extra-Group interbank market segment

In the estimation of equation 1.1, the variable Domestic Extra-Group Debts is significantly negative before the crisis, and not significantly after (Tables 4, specifications 1 and 7). Domestic Extra-Group Credits and Net Position are significantly negative before and significantly positive after the crisis. That is, before the crisis banks borrowing from the central bank had lower interbank Debts, lower interbank Credits, and were interbank net-borrowers; but after the onset of the crisis (recursively since in a panel estimation context) the banks more involved in central bank refinancing have higher interbank Credits and are net-lenders. The same outcomes are found in the estimation of equation 2.1: interacted with the dummy variable c_t capturing the crisis phase, Domestic Extra-Group Credits and Net Position are significantly positive (Table 5). The effect is also economically relevant: moving from the 25th to the 75th percentile of Domestic Extra-Group Credits and Net Position, loans from the central bank rise by between 1.8 and 3.6 percentage points in proportion to total assets, depending on the estimation method (Table 6). Therefore, the central bank liquidity is obtained (not by hoarding banks, but) by banks characterized by a higher weight of loans to other domestic banks.[27] This outcome is far removed from some very popular theses widespread in the crisis, and instead is consistent with the Eurosystem's liquidity-neutral policy, by which liquidity injections are intended to serve aggregate and not individual needs.

Central Counterparties interbank market segment

[26] By analogy with the first approach, 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.

[27] It worthwhile stressing here and now that, as aforementioned in Section 2, and as detailed in Section 5, the results do not change when both (i) the variables $x_{i,t-3}$ are employed as annual growth rates rather than as ratios to total assets; and (ii) the econometric framework is reversed and $x_{i,t}$ becomes the main dependent variable.

During the crisis, banks with more Central Counterparties Credits and those that are net-lenders in the Central Counterparties segment resort less to central bank liquidity (Tables 4, specifications 4-9). This is opposite to the previous result on the Domestic Extra-Group segment. However, the signal of redistribution effect found in the Domestic Extra-Group segment prevails in quantitative terms (Table 6).[28] Therefore, the transactions via Central Counterparties appear to be not a channel for the redistribution of central bank liquidity, but an alternative funding source (as is suggested by the marked prevalence of borrowing positions presented in Figures 2-3). This is also confirmed by the significant and negative sign of Central Counterparties Debts in equation 2.1 (Table 5).[29]

Domestic Intra-Group interbank market segment

From here onwards, the results of regressors are consistent across the specifications. The variable measuring the size of the Domestic Intra-Group liquidity market is negative in the estimation of equation 1.1, both before and after the crisis (Table 4), and is negative as well in the estimation of equation 2.1, once interacted with the crisis dummy (Table 5). Therefore, a larger volume of Domestic Intra-Group liquidity exchange means less recourse to central bank liquidity. However, the marginal size of this effect is negligible according to all estimation methods (Table 6).

Non-Domestic Extra-Group and Intra-Group interbank market segments

Banks with more Non-Domestic Extra-Group Debts and Credits borrow less from the central bank (Table 4). For Net Position, the effect differs between before and after the crisis: No-Domestic Extra-Group interbank net-lenders have lesser recourse to central bank refinancing before the crisis and greater recourse after it. Even more, banks borrow from the central bank when lend to foreign banks belonging to the same group. These outcomes confirm a cross-border redistribution of the Eurosystem liquidity. Since this is particularly true for Non-Domestic *Intra-Group* Credits, it confirms that international banking groups raise funds in a decentralised manner, even if they have

[28] As detailed in Section 5, the redistribution effect prevails also when the positions in the two interbank segments are added up.

[29] The Central Counterparties segment is to some extent non-domestic. It is certainly domestic in the sense that banks interact with a domestic agent (the domestic central counterparty). But, as clarified above, the ultimate counterparty can be a non-domestic bank or another non-domestic central counterparty. In this sense, when the Central Counterparties segment is a funding source in aggregated terms (i.e. for the entire banking system of a country), the financial resources are coming from abroad.

centralised liquidity management (Freixas and Holthausen, 2005; ECB, 2011). However, the marginal effect of these variables is not great (Table 6).[30]

Loans

Notably, my results signal that banks obtaining resources from the central bank are those with a higher weight of loans not only to other banks but also to the economy. In the estimation of equation 1.1, the variable Loans is negative before the crisis and positive after (Table 4). Accordingly, in the estimation of equation 2.1, Loans interacted with c_t is positive (Table 5). This effect of Loans may be partially explained 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 relevant: 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).[31]

Size

In the estimation of equation 1.1, the variable Size tends to be negative before and positive after the crisis. Accordingly, in the estimation of equation 2.1, the variable Size is positive. These results confirm that in the pre-crisis period larger banks receive 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, being a larger bank corresponds to greater recourse to central bank refinancing (as in Ashcraft et al., 2008; Fecht et al., 2011). The marginal effect is economically relevant. Moving from the 25th to the 75th percentile of the variable Size, the ratio of total loans from the central bank to total assets increases by about 1.5 percentage points in the crisis (Table 6). This outcome is in line with the standard analyses on larger banks, which are more affected by tough conditions in funding markets (Bank of Italy, 2011a).

Bad Loans

In the estimation of equation 1.1, the variable Bad Loans tends to be negative in the pre-crisis period (as in Fecht et al., 2011), and positive in the post-crisis period. Consistently, in the estimation of equation 2.1, Bad Loans interacted with c_t is positive. This may corroborate the liquidity hoarding theory prediction that the post-crisis liquidity requirement mainly involves the banks performing worse (Allen et al., 2009; Acharya et al., 2009; Heider et al., 2009; Acharya and

[30] Although the presence of foreign banks impacts on all the variables of my estimations, it is more likely to matter for the covariates that capture 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 5.

[31] 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 the absence of liquidity hoarding.

Merrouche, 2010; Acharya and Skeie, 2011). It could also signal a risk of moral hazard and/or a risk-taking channel effect.[32] In any case, during my sample period, the economic impact of Bad Loans on central bank refinancing is modest (Table 6). Gilbert (1995) and Stojanovic et al. (2008) also find a statistically significant yet economically negligible effect of refinancing on banks' risk-taking. What my results could suggest is therefore a simple early warning to prevent possible perverse incentives during phases of extensive liquidity injection.

Securities holdings and Securitized Loans

Unlike interbank loans, borrowing from central banks is typically collateralized. However, the Eurosystem accepts a broad range of assets as collateral, and extended the eligibility range in the course of the crisis, so collateral is unlikely to be a limiting factor.[33] Moreover, during the crisis, collateralized interbank lending have increased (Cappelletti et al., 2011). In any case, what is interesting is to verify which eligible assets are actually most commonly posted as collateral by banks. In the estimation of equation 1.1, the variable Portfolio of Government Debt Securities tends to be positive before the crisis and negative after; and coherently, in the estimation of equation 2.1 the variable is negative when interacted with the crisis dummy. This suggests that the use of government bonds as collateral decreases in the crisis, in part just because the Eurosystem broadened the other securities eligible (typically, in operations with the central bank, bad collateral drives out good; see Ewerhart and Tapking, 2008). Conversely, the variable Portfolio of Bank Bonds tends to be negative before the crisis and positive after, and positive when interacted with the crisis dummy. Likewise, the variable Securitized Loans is negative before the crisis and positive after it in the estimation of equation 1.1, and is positive in the estimation of equation 2.1. Again, this confirms the use in the crisis of new eligible collateral in the operations with the central bank in place of government debt securities.[34]

[32] A large part of the literature stresses that central bank lending inevitably creates moral hazard because its provision of liquidity reduces the private cost of risk-taking and undermines market discipline (e.g. Goodfriend and King, 1988; Kaufman, 1991 Schwartz, 1992; Flannery, 1996; Goodhart, 1999). But this view is not unanimous. Repullo (2005) shows that when the central bank charges penalty rates, banks are pushed towards higher-risk, higher-return strategies; while without penalty rates (as during the current crisis), central bank lending does not alter the level of risk chosen by banks. The "risk-taking channel" is a newly theorized transmission mechanism of monetary policy, according to which the risk tolerance of banks increases when policy interest rates are kept low for too long (Adrian and Shin, 2009; Borio and Zhu, 2008).

[33] Eligible collateral for Eurosystem refinancing includes government bonds, bank bonds (both uncovered and covered), corporate bonds, asset backed securities, other marketable securities, and some credit claims.

[34] In extreme cases, the increase in sovereign risk may reduce the value of the collateral, provoke large haircuts and lead to the ineligibility of the securities of certain governments (see Bank of Italy, 2011b). In the abstract, this is an alternative explanation for the negative effect of Portfolio of Government Debt Securities on central bank lending. However, the euro-area sovereign debt crisis in my sample period does not appear to reach such an implication. Moreover, the Eurosystem adapted the criteria for defining eligible collateral in its refinancing operations to the evolving conditions of the market. Finally, the sign of the variable Portfolio of Government Debt Securities does not change before and after the crisis in the interbank transactions, and its effect on the interbank Net Position is negative

ROE and Capital

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 indication of dysfunction in the interbank market. My results show that this is not the case. In the estimation of equation 1.1, 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. In the estimation of equation 2.1, both ROE and Capital are negative when interacted with the crisis dummy. These outcomes indicate that healthy banks are not forced to turn to the central bank refinancing, the same result found by Afonso et al. (2011) for the US.

Fundraising

In the estimation of equation 1.1 and 2.1, the variable Fundraising is always negative, and has a relevant economic impact (Tables 4-6). Banks with substantial deposits and retail bond issues have less need for central bank liquidity, even in the crisis, and thus do not accumulate further liquidity. This result is in line with the predictions of Nyborg and Strebulaev (2004), and with the findings of Fecht et al. (2011), who show that liquidity positions and financial health affect the price of liquidity and amounts bid for, and in particular contradicts the hypothesis of liquidity accumulation.

4.2 Determinants of $x_{i,t-3}$ (Domestic Extra-Group and Central Counterparties segments)

As is typical in the IV framework, Domestic Extra-Group and Central Counterparties positions are explanatory (empirically endogenous) variables in equation 1.1 and 2.1, and at the same time are the dependent variables in the equations 1.2 and 2.2. In order not to overload the exposition, Tables 7-8 report the results of equation 1.2 only.[35] In particular, Table 7 couples with Table 4, namely contains the corresponding results of equation 1.2. The specifications of Table 7, repeated before and after the crisis, correspond to the specifications of Table 4: specifications (1)-(3) refer to Domestic Extra-Group positions; specifications (4)-(6) to Central Counterparties positions; and specifications (7)-(9) to both Domestic Extra-Group and Central Counterparties positions (i.e. the SUR results of a system of three equations). Table 8 reports marginal effects.

Summing up, six main findings emerge. (i) The sign of the determinants of Domestic Extra-Group and Central Counterparties segments seldom changes with the crisis, another outcome that

(Table 7), suggesting that there is no collateral value-loss effect. If this is true for secondary funds, it is true *a fortiori* in the Eurosystem operations.

[35] Results of equation 2.2 are analogous and unreported. As usual, all unreported results are available upon request.

contradicts the hypothesis of malfunctioning of the interbank market. (ii) Banks that are net-lenders externally are net-borrowers domestically. (iii) The effect of a larger Domestic Intra-Group segment is negligible on the presence in other segments. (iv) The relationship between the traditional bilateral Domestic Extra-Group and the tripartite Central Counterparties segments is positive. (v) As noted, in spite of this mutual positive relationship, the effect of the two interbank segments on central bank refinancing differs. (vi) The determinants of the positions in the two interbank market segments do not always coincide, which helps to explain why the mutual relationship is positive but the impact on central bank refinancing conflicts. The rest of this section delves into this issue.

The effect is common for four kinds of determinants. (a) The results of Size confirm that larger banks have greater liquidity needs in the crisis: both bilateral and tripartite Debts are increasing in Size, and Net Position is decreasing in Size (Table 7). The economic effect is relevant: in the crisis, moving from the 25th to the 75th percentile of the variable Size, the percentage share of Domestic Extra-Group Debts on total assets rise by 4 points, that of those via Central Counterparties by 2 points (Table 8). (b) The results of the variables Rating and Banks without Rating corroborate the hypothesis of peer monitoring among banks, as lower-rated banks receive both less bilateral funds and less funds thorough central counterparties.[36] (c) The negative effect of Non-Domestic (Extra- and Intra-Group) Net Position on interbank (both Domestic Extra-Group and Central Counterparties) Net Position confirms that banks that are net-lenders externally (in particular Intra-Group) are net-borrowers domestically. (d) As to Credits only, Capital and Fundraising have an identical effect in the two segments of the interbank market. Highly capitalized banks lend less in both segments, probably because they have greater capability of locating profitable investment opportunities outside the interbank market. Banks with more funds from their retail customers lend more in both segments, another result showing that liquid banks do not hoard their liquidity.

For three determinants, however, the effect is different. (a) The effect of Fundraising is positive for Domestic Extra-Group Net Position (i.e. more liquid banks are interbank net-lenders); but it is negative, though less substantial, for Central Counterparties. This confirms that the Domestic Extra-Group segment is used to redistribute liquidity among banks, while the Central Counterparties segment is not. (b) Banks with more Loans (to customers) conceivably borrow more (and lend less) in the traditional bilateral interbank segment, but they borrow less via Central Counterparties and are net-lenders in this interbank segment. (c) The variable Bad Loans suggests

[36] The results of the variables Rating and Banks without Rating have to be considered together. According to the theory of peer monitoring among banks, banks are the best informed parties to judge the solvency of other banks because kindred institutions are best able to identify a peer's risk (e.g. Furfine, 2001; Ashcraft and Bleakley, 2006; King, 2008; Dinger and von Hagen, 2009).

that the peer monitoring hypothesis is more valid in the traditional bilateral segment that via central counterparties, which in fact were created precisely in order to attenuate counterparty risk.

5. Robustness checks

I verified the robustness of my results in several ways.[37]

5.1 Additional checks on the Domestic Extra-Group and Central Counterparties segments

Since these two secondary liquidity segments present opposite results, I further verified the outcomes adding their figures, and then running a IV method instrumenting for this sum. The results are given in Tables 9-10. Three findings stand out. (i) The results of all other determinants of central bank refinancing are confirmed. (ii) When the figures of the two interbank market segments are summed, their combined effect on $y_{i,t}$ matches the results of the Domestic Extra-Group segment, which therefore again (as for marginal effects) prevail. (iii) Likewise, the determinants of the sum replicate the determinants of the Domestic Extra-Group segment.

5.2 Total secondary liquidity market

As a further check, I also added up four segments of the secondary liquidity market, excluding the Domestic Intra-Group exposures. This was done in two steps: first, I added all the variables measuring the external exposures (Domestic Extra-Group; Central Counterparties; and Non-Domestic Extra-Group variables), and then also the Non-Domestic Intra-Group variables. Again, in both cases, the results of the Domestic Extra-Group segment drive all the others.

5.3 Reverse causality between the primary and secondary liquidity markets

As clarified in Section 2, in addition to the use of IV estimations, I have double-checked the reverse causality between primary and secondary liquidity markets in two ways. First, I included in some specifications of the SUR model either the variable $y_{i,t-3}$ or $y_{i,t-6}$ in equation 1.2, and its effect is again positive on Domestic Extra-Group Credits and Net Position. Second, I ran a new IV regression, instrumenting central bank refinancing in the first stage by its lagged figures, and using it as the endogenous regressor to estimate in the second stage either the Domestic Extra-Group or Central Counterparties positions. The sense of results remain unchanged: in particular, borrowing from the central bank has a positive effect on Domestic Extra-Group Credits and Net Position, negative on Central Counterparties. Therefore, also the reversed econometric framework confirms

[37] Since results always remained very similar to those reported in Tables 4-8, for brevity I limit the use of additional tables, but all the robustness checks are available from the author upon request.

that the Domestic Extra-Group segment is used to redistribute central bank liquidity among domestic banks, while the Central Counterparties segment is used as an alternative source of funds.

5.4 Running different estimation methods: Tobit and panel methods

In order to estimate equations 1.1 and 2.1, I also employed other tobit models: standard, tobit II, and random effects. These models confirm the bulk of my results, and in some cases (Loans, Capital, Fundraising) even strengthen them. However, these models do not allow instrumenting the endogenous variables.

As for equations 1.2 and 2.2, I employed other estimation methods to verify the determinants of Domestic Extra-Group and Central Counterparties positions. First, I ran both fixed-effects and random-effects panel estimations. The results remain unaltered, even because *T* is large. Second, since interbank market positions tend to be persistent, I included the lagged dependent variables in the estimation of the variable $x_{i,t-3}$, and used both the two-step Arellano and Bond GMM estimator and the one-step system GMM estimator.[38] The results are again confirmed, including the expected persistence of interbank positions.

5.5 Cooperative banks and branches of foreign banks

A set of checks was performed on cooperative banks and branches of foreign banks, because these institutions are often regarded as unlike other banks. In particular, since I analyse the Eurosystem's liquidity provision, which is decentralized as explained in Section 3, foreign banks could influence my results if they massively exploit the option to refinance at a specific central bank. By contrast, my results remain unchanged when both types of bank are dropped either in turn or jointly. Since my basic results hold even when foreign banks are excluded, this means that the liquidity redistribution towards Non-Domestic interbank segments is carried out in part by Italian banks as well. 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 my basic specifications adding the impact of two dummies, for cooperative and foreign banks (renouncing on the other hand the fixed effects b_i). This check suggests some preliminary observations on the role played by foreign banks, which deserves however to be the subject of specific research. In equation 1.1, the dummy related to foreign banks tends to be positive, both before and after the crisis. The marginal effects indicate that the economic impact is negligible before but relevant after. This confirms once more that international banking groups raise funds in a decentralised manner (Freixas and Holthausen, 2005; Buiter, 2008; ECB, 2011).

[38] The two GMM estimators take into account both autocorrelation, due to the presence of the lagged dependent variable among the covariates, and individual effects characterizing the heterogeneity among banks.

5.6 Controlling for the endogeneity of other covariates: discarding explanatory variables and further IV estimations

In the estimations presented in the Tables, I control for endogeneity of the key covariates, but in theory endogeneity may involve other covariates of the matrix $K^A_{i,t-4}$ as well. To verify the stability of each explanatory variable 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.

5.7 Reverse causality between central bank loans and Loans

Although I controlled for endogeneity also between Loans and central bank liquidity, one could still argue that my outcomes do not show that central bank' injections are effective because Loans should follow and not precede central bank refinancing. In this vein, I ran an inverse regression to verify whether central bank refinancing spurs bank Loans to the economy. It does: (i) using both the time-sample splitting and the difference-in-difference approaches; (ii) instrumenting for the central bank loans or not; (iii) instrumenting with one or more of the interbank market segments; (iv) replacing the variable Loans (which is the ratio of loans to total assets) with its growth rate.

5.8 Changing starting dates and periods

In addition to time fixed effects, in order to test the sensitivity of my results to different dates and periods, I employed two kinds of check. First, I experimented with dates other than August 2007 as the starting point of the crisis (both bringing it by one or two months, and postponing it by one to four months); another date used was September 2008 (with the Lehman Brothers failure).[39] Second, I tested the stability of the results of the pre-crisis period, which is much longer in my sample, juxtaposing two periods of the same length (that is, comparing the last 49 months prior to the critical point with my 49-month-long post-crisis period). In all cases, the results remain stable.

5.9 Changing definitions of some explanatory variables

I defined some variables in a different way. First of all, I focused on my key variables $y_{i,t}$ and $x_{i,t-3}$. As aforementioned, in my basic estimations presented in the Tables, $y_{i,t}$ is measured as *gross* loans. In several checks, I re-measured $y_{i,t}$ as *net* loans, subtracting (from the gross loans that

[39] 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.

the central bank grants to each bank) the amounts that each bank re-deposits at the central bank. Results do not change. However, I preferred using the gross $y_{i,t}$ 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 ECB system of reserve requirement, their inclusion is inconsistent with the variable Fundraising, which is worth keeping because provides useful information. As for the set of variables $x_{i,t-3}$, I have already stressed that they have been employed as ratios to total assets or as growth rates, and results do no change. In this case, I preferred using the ratios to total assets because (i) they suffice for my purposes; and (ii) present minor measurement problems.[40]

Then, 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 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 Loans or Bad Loans. Second, I split the variable Securitized Loans between derecognized and non-derecognized loans; and then I attributed the former to Loans (and to Bad Loans), and left the latter to Securitized Loans.[41] Third, vice versa 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, both in equation 1.1 and 2.1. The great merit of my basic approach is to show that the variable Loans, even net of securitizations, positively affects the decision to apply to the central bank for liquidity.

Finally, to assess the effect of capital adequacy I adopted different proxies as checks. I alternatively 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 are confirmed.

[40] The ratios to total assets could potentially mislead the role of interbank positions only if data exhibited significant cases of (de)leveraging. This is not the case in my sample for banks operating in Italy.

[41] Securitization is the pooling and repackaging of loans into securities, which are then sold. 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 to the purchaser. They are "non-derecognized" when they are not so deleted. 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.

6. Conclusions

Since the outbreak of the crisis the issue of liquidity and the (mal)functioning of liquidity markets have been causes of concern, and have been at the centre of the academic and institutional debate. This paper contributes investigating the determinants, the functioning and the interrelations, before and during the crisis, of banks' two main wholesale sources of liquidity: central bank refinancing (the primary liquidity market) and the various segments of the interbank market (the secondary liquidity market).

The paper features a number of distinctive characteristics. a) It jointly studies the effects of the crisis on central bank refinancing and interbank market. b) It investigates both the casual directions between primary and secondary liquidity markets. c) It concerns a major central bank. d) It bears on one of the main euro-area banking systems. e) It distinguishes the different interbank market segments. f) It covers a long sample period from January 1999 to August 2011. g) It covers all the banks operating in Italy, including those that never directly accessed central bank liquidity, in order to avoid sample selection bias. h) It explores the effect of a large set of individual bank characteristics. i) It uses banking group data, reflecting the fact that the decision to access central bank liquidity is likely to be made at group level. l) It utilizes two methodological approaches (sample time splitting and difference-in-difference analysis), several estimation methods (IV, SUR, tobit-IV), and a broad range of robustness checks.

My empirical findings reject for Italy a hypothesis that has been very popular in the crisis, namely that the interbank market malfunctions and central bank injections of liquidity are pointless because banks build up liquidity reserves but do not intermediate flows of credit to their wholesale customers (other banks) or retail customers (households and firms). This view relates to a part of the literature on banks' liquidity hoarding. The theory of liquidity hoarding postulates that banks may decide to hoard liquidity and interbank market may freeze up, but, while a part of the literature claims that central banks interventions are ineffective, the prevailing literature recognizes that central banks can resolve the problem. My paper tests empirically these conflicting predictions and shows that in Italy interbank markets have worked even during the crisis, and however that the central bank's intervention allowed the liquidity to flow among banks and the economy. In particular: (a) in the crisis banks relying more heavily on central bank refinancing are those that lend more both to other banks and to the economy; (b) the main determinants of interbank market positions do not change between the pre- and post- crisis periods; (c) banks that raise more funds from their retail customers do not apply for additional unproductive central bank liquidity and indeed lend more to other banks; (d) more capitalized and profitable banks are not forced to turn to the central bank refinancing.

Finally, the paper investigates the relationships between the different components of the liquidity markets. The main findings can be summarized as follows. (a) The central bank and the main segments of the interbank market are endogenous, and their estimation requires specific econometric tools to achieve well-founded results. (b) The most relevant relations between central bank and interbank market liquidity occur in two segments of the interbank market: the domestic traditional bilateral segment and the trilateral segment via central counterparties. (c) The two secondary liquidity segments have opposite effects on central bank refinancing; and the effects of the domestic traditional bilateral extra-group segment prevail. (d) Banks use the traditional bilateral segment of the interbank market to redistribute the central bank's liquidity to other domestic banks. (e) This preference of the domestic traditional bilateral extra-group segment as a redistribution channel could derive from the peer monitoring among banks, which is here stronger. (f) Accordingly, banks do not use transactions via central counterparties to redistribute the liquidity of the central bank, but essentially as an auxiliary funding source. (g) Also banks redistributing abroad, mainly to banks belonging to the same banking group, access the central bank's liquidity. (h) Banks that are net-lenders externally tend to be net-borrowers domestically. (i) The magnitude of the domestic internal capital market has negligible effects on resort to central bank liquidity and on banks' presence in the other secondary liquidity market segments.

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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)

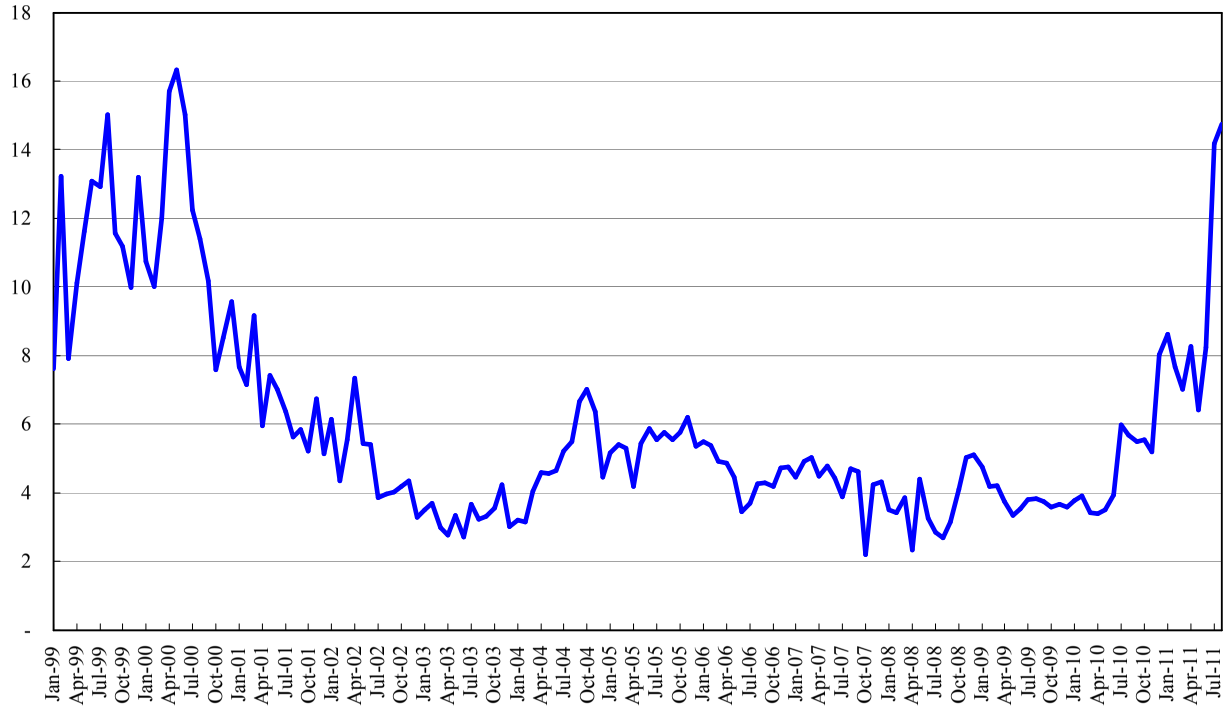

Figure 2. Central bank refinancing and borrowing banks operating in Italy

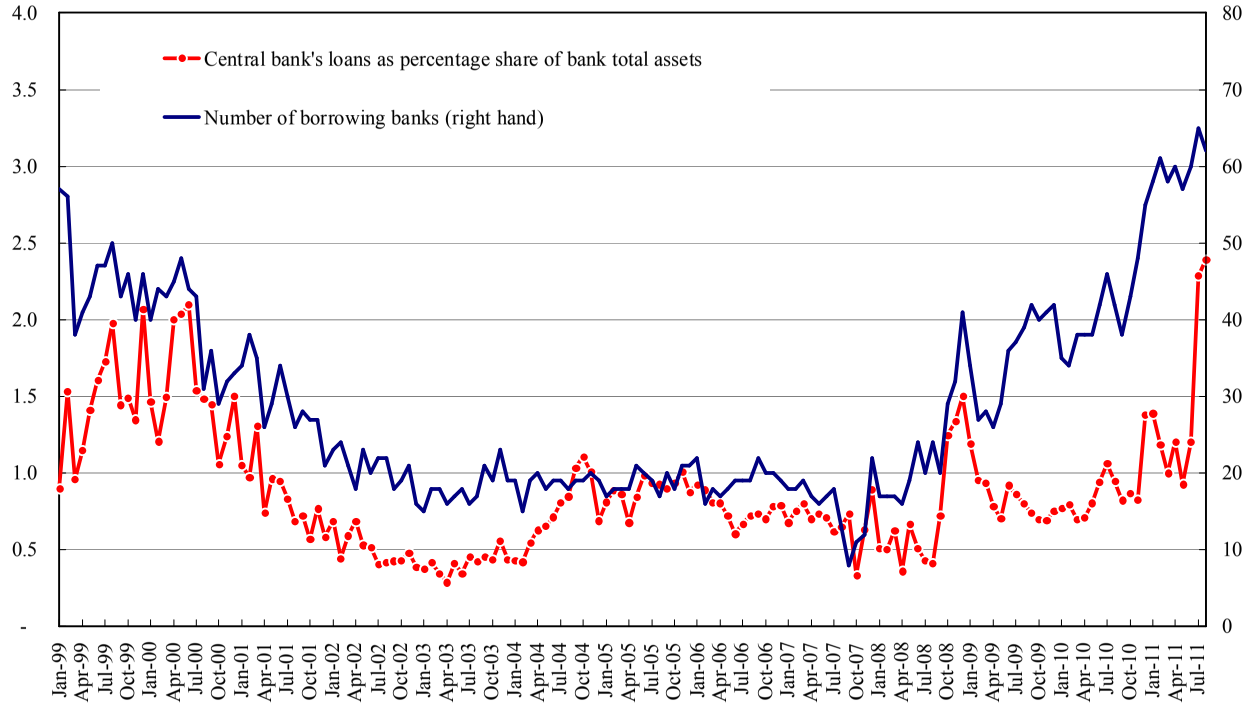

Figure 3. Italian interbank market segments: Debts as percentage shares of bank total assets

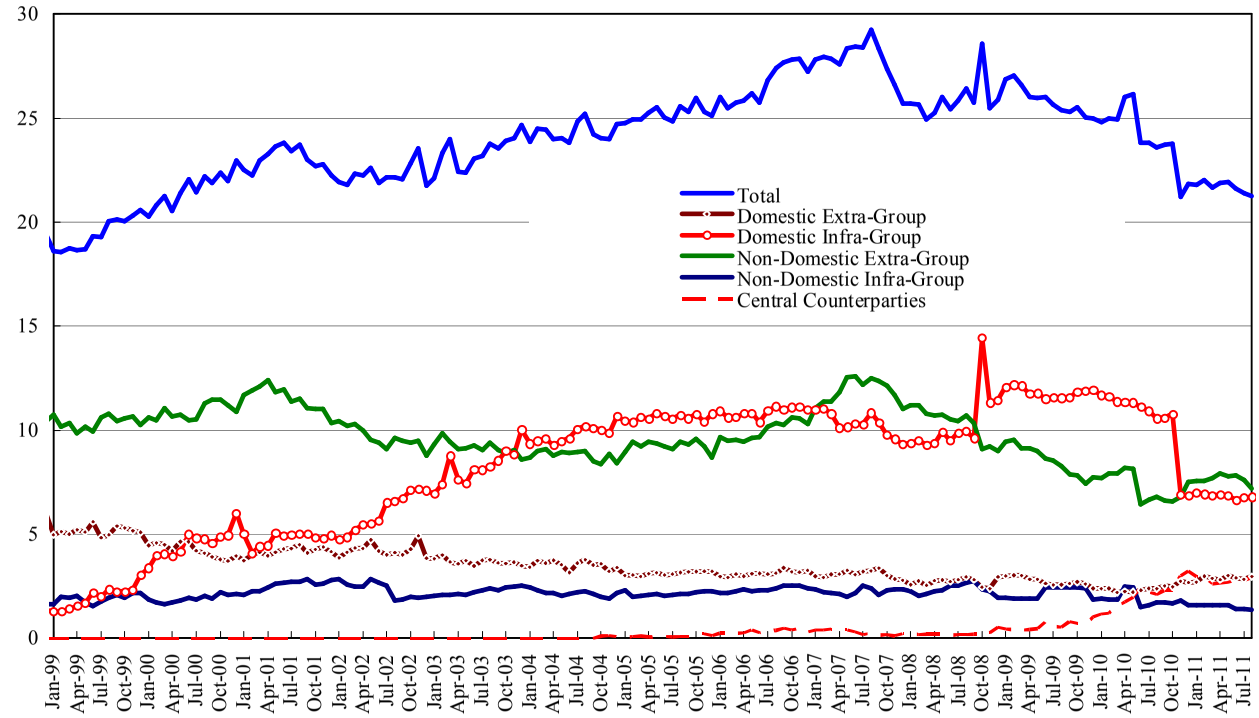

Figure 4. Italian interbank market segments: Credits as percentage shares of bank total assets

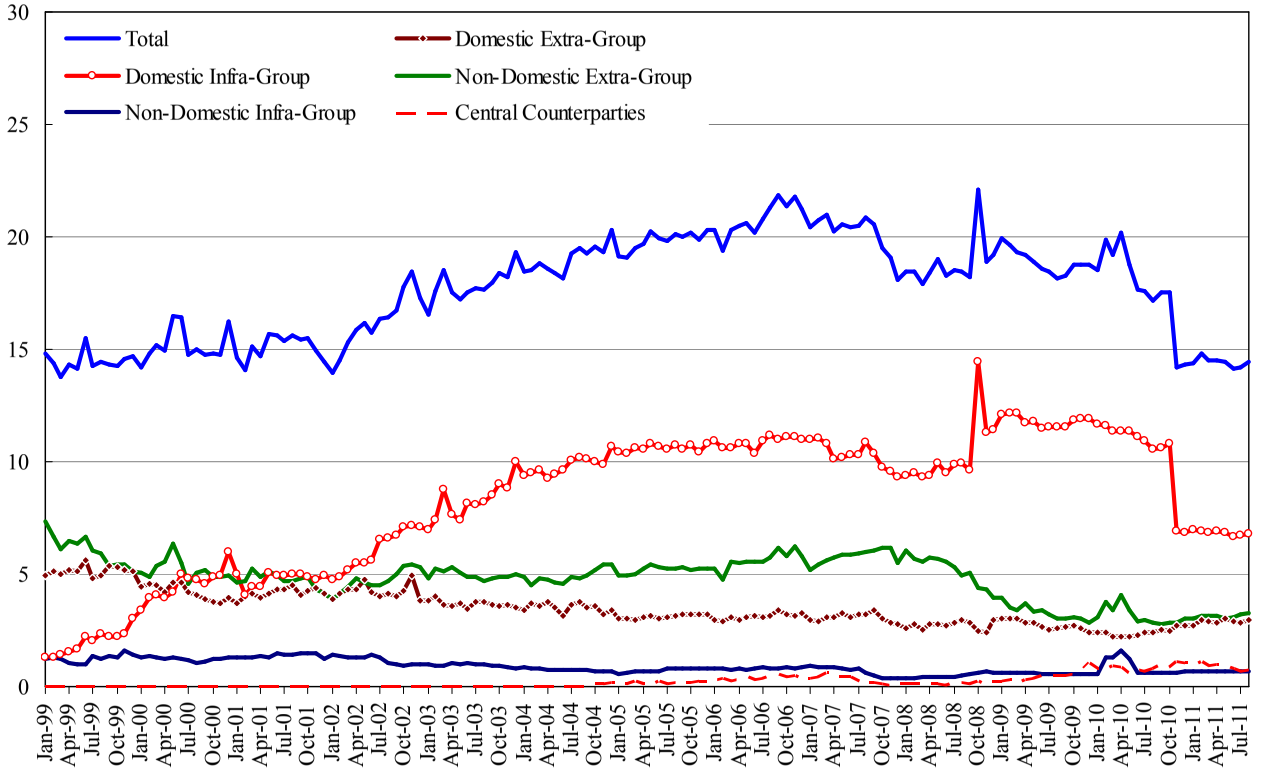

Table 1. Summary statistics of key variables

Key variables (scaled by total assets)			Obs	Mean	Sd. Dev.	Min	Max
Total loans form central bank			59,499	0.009	0.005	0.000	0.132
Interbank market sections	Domestic Extra-Group	*Debts*	59,499	0.029	0.021	0.000	0.110
		Credits	58,405	0.036	0.041	0.000	0.220
		Net	58,086	0.003	0.048	-0.110	0.200
	Central Counterparties	*Debts*	59,499	0.0040	0.001	0.000	0.074
		Credits	59,499	0.0038	0.001	0.000	0.051
		Net	59,499	-0.0002	0.001	-0.068	0.051
	Domestic Infra-Group		59,499	0.037	0.022	0.000	0.389
	Non-Domestic Extra-Group	*Debts*	59,499	0.058	0.034	0.000	0.756
		Credits	59,313	0.049	0.010	0.000	0.149
		Net	59,253	-0.015	0.013	-0.190	0.199
	Non-Domestic Infra-Group	*Debts*	59,499	0.001	0.005	0.000	0.146
		Credits	59,499	0.002	0.003	0.000	0.065
		Net	59,499	-0.001	0.004	-0.134	0.031

Table 2. Relations among key variables

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

Table 3. Summary statistics of explanatory variables

Name	Definition	Obs	Mean	Sd. Dev.	Min	Max
Size	Log (Total assets)	59,499	5.675	1.659	1.386	13.662
Loans	Total performing (non-securitized) loans to the domestic private sector/ Total assets	59,499	0.560	0.136	0.003	0.790
Bad Loans	Total non-performing (non-securitized) loans (private sector) / Total performing (non-securitized) loans (private sector)	59,499	0.046	0.049	0.000	0.300
Portfolio of Government Debt Securities	Holdings of Euro-area Government bonds / Total assets	59,499	0.022	0.006	0.000	0.150
Portfolio of Bank Bonds	Holdings of their own bonds and of other banks' bonds / Total assets	59,499	0.025	0.028	0.000	0.160
Securitized Loans	Total (dereconized and non-dereconized) securitized loans / Total assets	59,499	0.010	0.030	0.000	0.220
ROE	Net profits / (Capital and reserves)	59,499	0.007	0.021	-0.048	0.140
Capital	Regulatory capital / Total risk weighted assets	59,499	0.122	0.037	0.068	0.339
Fundsraising	(Total deposits and bonds) / Total assets	59,499	0.733	0.090	0.000	0.961
Rating	Rating agency scores	59,499	7.732	1.309	2	11
Banks without rating (0-1)	Banks without rating (0-1)	59,499	0.587	0.199	0	1

Table 4. First approach (sample time splitting) results of equation 1.1.

Dependent variable y_{i,t_3}: ratio of total gross loans from central bank to total assets.

Estimation method: ordinary IV and SUR.

Endogenous and instrumented regressor $x_{i,t-3}$ as ratios to total assets: in Specifications (1)-(3): Domestic-Extra-Group positions; in Specifications (4)-(6): Central Couterparties positions; in Specifications (7)-(9): both Domestic-Extra-Group and Central Counterparties positions. IV first stage results are reported in Table 7.

		Pre-crisis period									**Post-crisis period**								
		IV (1)			**IV (2)**			**SUR**			**IV (1)**			**IV (2)**			**SUR**		
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
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*
Domestic Extra-Group	*Debts*	-0.0626*** *0.023*			0.000 *0.001*			-0.002 *0.113*			-0.018 *0.121*			-0.065*** *0.004*			0.280 *-0.423*		
	Credits		-0.0612*** *0.012*			0.000 *0.000*			-0.034*** *0.009*			0.615*** *0.236*			0.002 *0.004*			0.193 *0.184*	
	Net			-0.0568*** *0.019*			0.002*** *0.001*			-0.045*** *0.017*			0.269* *0.141*			0.0206*** *0.002*			0.541*** *0.189*
Central Counterparties	*Debts*	-0.142*** *0.032*			0.380 *0.241*			0.374 *1.039*			0.215*** *0.037*			0.173 *0.219*			-0.466 *0.841*		
	Credits		-0.136*** *0.030*			0.443** *0.164*			0.282 *0.171*			0.222** *0.108*			-0.735*** *0.188*			-0.596** *0.235*	
	Net			0.022 *0.059*			0.130** *0.050*			0.125** *0.051*			-0.189*** *0.065*			-0.323 *0.385*			-0.259** *0.131*
Domestic Infra-Group		-0.0170*** *0.003*	-0.0315*** *0.004*	-0.0201*** *0.004*	-0.012*** *0.002*	-0.016*** *0.002*	-0.014*** *0.002*	-0.013 *0.009*	-0.026*** *0.004*	-0.022*** *0.004*	-0.012 *0.014*	-0.117** *0.059*	-0.013 *0.016*	-0.020 *0.022*	-0.112 *0.030*	-0.003 *0.032*	-0.045 *0.042*	-0.054 *0.066*	-0.173* *0.104*
Non-Domestic Extra-Group	*Debts*	-0.002 *0.002*			0.002 *0.001*			0.002 *0.007*			-0.0293*** *0.004*			-0.0293*** *0.005*			-0.039** *0.017*		
	Credits		-0.00873*** *0.003*			-0.004 *0.003*			-0.008*** *0.003*			-0.123*** *0.040*			-0.562*** *0.121*			-0.496*** *0.144*	
	Net			-0.0312*** *0.006*			-0.0154*** *0.002*			-0.028*** *0.005*			0.127*** *0.032*			0.0714*** *0.008*			0.160*** *0.039*
Non-Domestic Infra-Group	*Debts*	-0.0168*** *0.005*			-0.006 *0.004*			-0.007 *0.020*			-0.006 *0.029*			-0.015 *0.044*			-0.090 *0.112*		
	Credits		0.0195** *0.010*			0.0250** *0.008*			0.022** *0.009*			0.801** *0.356*			0.364* *0.177*			0.529** *0.230*	
	Net			0.0196** *0.008*			0.0243*** *0.007*			0.021*** *0.007*			0.187** *0.083*			0.034 *0.061*			0.000 *0.150*

(to be continued)

Table 4. First approach (sample time splitting) results of equation 1.1. (*continued*)

	Pre-crisis period									Post-crisis period								
	IV (1)			IV (2)			SUR			IV (1)			IV (2)			SUR		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
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*
Size	-0.0006***	0.000	0.000	-0.001***	-0.001***	-0.001***	-0.0005***	-0.0003**	0.000	0.002	0.000	0.00797**	0.003***	0.002	0.002**	-0.003	0.003*	0.013***
	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*	*0.004*
Loans	-0.003***	-0.01***	-0.0103***	0.001	0.002	0.002	0.001	-0.005***	-0.008**	0.000	0.201***	0.0925**	0.001	0.003	0.011***	-0.009	0.064	0.187***
	0.001	*0.002*	*0.004*	*0.000*	*0.000*	*0.000*	*0.003*	*0.002*	*0.004*	*0.003*	*0.076*	*0.046*	*0.002*	*0.003*	*0.002*	*0.013*	*0.059*	*0.065*
Bad Loans	0.000	-0.00489***	-0.002	0.002	0.002	0.002	0.002	-0.001	-0.001	0.012	0.133***	0.0439***	0.009*	0.050***	0.021***	0.025	0.077**	0.082***
	0.001	*0.002*	*0.002*	*0.000*	*0.001*	*0.001*	*0.005*	*0.001*	*0.001*	*0.008*	*0.046*	*0.015*	*0.003*	*0.011*	*0.004*	*0.025*	*0.031*	*0.026*
Portfolio of Government Debt Securities	0.0137***	-0.011	-0.008	0.014***	0.018***	0.012***	0.014***	0.002	-0.003	-0.0615***	0.157	0.026	-0.067***	-0.073**	-0.034*	-0.026	0.002	0.106
	0.002	*0.006*	*0.007*	*0.002*	*0.003*	*0.003*	*0.002*	*0.005*	*0.007*	*0.019*	*0.098*	*0.042*	*0.014*	*0.027*	*0.015*	*0.050*	*0.074*	*0.063*
Portfolio of Bank Bonds	-0.00986***	-0.002	-0.004	0.000	0.003	-0.012	0.000	0.000	-0.005*	-0.003	0.151***	0.007	-0.009	0.037	0.004	0.048	0.078**	0.002
	0.004	*0.001*	*0.003*	*0.001*	*0.001*	*0.001*	*0.019*	*0.001*	*0.003*	*0.018*	*0.058*	*0.006*	*0.004*	*0.011*	*0.004*	*0.069*	*0.039*	*0.010*
Securitized Loans	-0.0023***	-0.004***	0.000	-0.002**	-0.003***	0.000	-0.002*	-0.003***	0.000	0.106***	0.175***	0.121***	0.103***	0.165***	0.110***	0.149***	0.176***	0.101***
	-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*	*0.057*	*0.019*	*0.018*
ROE	0.000	0.000	0.000	0.001	0.000	0.000	0.000	-0.001	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***	-0.009	-0.012***	-0.012***	-0.0306**	0.056	-0.0456**	-0.036***	-0.057***	-0.028***	0.009	-0.027	-0.091***
	0.003	*0.002*	*0.003*	*0.001*	*0.001*	*0.001*	*0.016*	*0.001*	*0.002*	*0.015*	*0.034*	*0.015*	*0.006*	*0.015*	*0.008*	*0.056*	*0.034*	*0.031*
Funds Raising	-0.0122***	-0.000973*	0.006	-0.002***	-0.002***	-0.009***	-0.002	-0.001**	0.003	-0.028	-0.0705***	-0.124**	-0.039***	0.004	-0.024***	0.049	-0.016	-0.245***
	0.004	*0.001*	*0.005*	*0.000*	*0.000*	*0.001*	*0.019*	*0.000*	*0.004*	*0.029*	*0.022*	*0.058*	*0.003*	*0.006*	*0.003*	*0.108*	*0.021*	*0.081*
Constant	0.0214***	0.0157***	0.005	0.0114***	0.0121***	0.0153***	0.012	0.014***	0.006	-0.019	-0.176**	-0.0926***	-0.0235*	-0.026	-0.0335**	-0.015	-0.086	0.008
	0.003	*0.001*	*0.004*	*0.001*	*0.001*	*0.002*	*0.019*	*0.001*	*0.004*	*0.013*	*0.061*	*0.035*	*0.009*	*0.017*	*0.011*	*0.026*	*0.048*	*0.005*
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	43,544	43,323	43,027	43,544	43,323	43,027	43,362	43,186	42,907	15,945	15,859	15,743	15,945	15,859	15,743	15,880	15,812	15,698

Table 5. Second approach (difference-in-difference) results of equation 2.1.
Dependent variable $y_{i,t}$,: ratio of total gross loans from central bank to total assets
Estimation method: tobit-IV
Endogenous and instrumented regressor $x_{i,t-3}$ as ratios to total assets: Domestic Extra-Group positions

Dependent variable in the second stage (equation 2.1):		*Loans from central bank*					
		(10)		**(11)**		**(12)**	
		(a)	**(b)**	**(a)**	**(b)**	**(a)**	**(b)**
Domestic Extra-Group	*Debts*	0.219 *0.314*	-0.234 *0.303*				
	Credits			0.826 *** *0.291*	-0.289 *0.244*		
	Net					0.728 * *0.443*	-0.462 *0.434*
Central Counterparties	*Debts*	-0.162 *** *0.031*	0.133 *** *0.016*				
	Credits			-0.092 *** *0.024*	0.035 *** *0.010*		
	Net					-0.068 *** *0.018*	-0.003 *0.009*
Domestic Infra-Group		-0.089 *** *0.022*	-0.056 *** *0.009*	-0.096 *** *0.021*	-0.068 *** *0.009*	-0.058 ** *0.024*	-0.069 *** *0.009*
Non-Domestic Extra-Group	*Debts*	-0.176 *** *0.025*	-0.011 *0.013*				
	Credits			-0.196 *** *0.064*	0.002 *0.022*		
	Net					0.247 *** *0.034*	-0.001 *0.016*
Non-Domestic Infra-Group	*Debts*	-0.059 *0.064*	-0.104 *** *0.028*				
	Credits			0.159 * *0.096*	-0.223 *** *0.053*		
	Net					0.107 * *0.056*	0.172 *** *0.034*
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*
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*
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*
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*
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*
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*
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*
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*
Funds Raising		-0.058 *** *0.008*	-0.017 ** *0.008*	-0.078 *** *0.011*	-0.013 ** *0.005*	-0.029 *** *0.010*	-0.075 *** *0.005*
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 2.2) are not reported because analogous to those of Table 7							

Table 6. Marginal effects, averaged across the specifications, of the estimations of Tables 4-5

		Pre-crisis period			Post-crisis period			Difference-in-difference	
Estimation method:		**IV (1)**	**IV (2)**	**SUR**	**IV (1)**	**IV (2)**	**SUR**	*column (a)*	*column (b)*
Domestic Extra-Group	*Debts*	-0.2	ns	ns	ns	-0.2	ns	ns	ns
	Credits	-0.5	ns	-0.3	3.6	ns	2.9	1.8	ns
	Net	-0.4	0.0	-0.4	2.1	1.9	2.0	2.3	ns
Central Counterparties	*Debts*	-0.5	ns	ns	2.2	ns	ns	-0.3	0.2
	Credits	-0.5	0.5	ns	0.1	-1.0	-1.1	-0.5	0.2
	Net	ns	1.0	0.2	-1.3	ns	-1.4	-0.4	ns
Domestic Infra-Group		-0.1	-0.1	-0.1	-0.1	ns	-0.1	0.0	0.0
Non-Domestic Extra-Group	*Debts*	ns	ns	ns	-0.4	-0.4	-0.5	-2.2	ns
	Credits	-0.1	ns	-0.1	-0.1	-0.6	-0.5	-0.2	ns
	Net	0.0	-0.1	-0.1	0.1	0.1	0.1	0.0	ns
Non-Domestic Infra-Group	*Debts*	-0.1	ns	ns	ns	ns	ns	ns	-0.1
	Credits	0.1	0.1	0.1	0.4	0.2	0.3	0.1	-0.1
	Net	0.1	0.1	0.1	0.2	ns	ns	0.1	0.2
Size		-0.2	-0.2	-0.2	1.7	1.2	1.6	0.4	2.3
Loans		-0.3	ns	-0.2	3.6	3.1	4.6	2.8	-0.6
Bad Loans		-0.1	ns	ns	0.4	0.2	0.5	0.5	-0.2
Portfolio of Government Debt Securities		0.1	0.1	0.1	-0.1	-0.1	ns	-0.2	ns
Portfolio of Bank Bonds		-0.1	ns	-0.1	0.5	ns	0.3	0.5	0.4
Securitized Loans		-0.1	-0.1	-0.1	0.1	0.2	0.2	0.3	-0.2
ROE		ns	ns	ns	ns	ns	ns	-0.2	ns
Capital		-0.1	-0.2	-0.2	-0.3	-0.3	-0.5	-0.8	-0.5
Funds Raising		-0.2	-0.2	-0.1	-1.6	-1.3	-2.1	-0.9	-0.7

Table 7. First approach (sample time splitting) results of equation 1.2.

Table 7 couples with Table 4 (i.e. it contains the corresponding IV first stage results).

Dependent variable $x_{i,t-3}$ as ratios to total assets: Specifications (1)-(3): Domestic-Extra-Group positions; Specifications (4)-(6): Central Couterparties positions; Specifications (7)-(9): both Domestic-Extra-Group and Central Counterparties positions.

		Pre-crisis period												**Post-crisis period**											
		IV (1)			**IV (2)**			**SUR**						**IV (1)**			**IV (2)**			**SUR**					
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**		**(8)**		**(9)**		**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**		**(8)**		**(9)**	
Dependent variable in the first stage (equation 1.2):		*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*	
Domestic Extra-Group	*Debts*				0.0004***				-0.011								0.0061***				0.563				
					0.000				-0.018								*0.001*				-1.278				
	Credits					0.000				-0.012***								0.000					0.031		
						0.000				-0.004								*0.000*					-0.029		
	Net						0.000					-0.010							0.0014***						0.102***	
							0.000					-0.011							*0.001*						-0.040	
Central Counterparties	*Debts*	0.497***												0.218***											
		0.163												*0.048*											
	Credits		-0.413												0.087										
			0.280												*0.163*										
	Net			0.446												0.340***									
				0.484												*0.125*									
Domestic Infra-Group		-0.116***	-0.312***	-0.162***	0.0049***	0.0068***	0.002***	-0.116***	0.004*	-0.317***	0.003**	-0.162***	0.000	-0.062***	-0.209***	-0.058	-0.0797***	-0.0116***	0.0696***	-0.079***	-0.035	-0.208***	-0.005	-0.040	0.074***
		0.007	*0.016*	*0.018*	*0.000*	*0.000*	*0.000*	-0.007	-0.002	-0.016	-0.001	-0.018	-0.002	*0.021*	*0.042*	*0.049*	*0.003*	*0.002*	*0.003*	-0.020	-0.102	-0.041	-0.007	-0.048	-0.004
Non-Domestic Extra-Group	*Debts*	-0.072***			0.0010***			-0.073***	0.000					0.014*			-0.0106***			0.015*	-0.019				
		0.008			*0.000*			-0.008	-0.001					*0.009*			*0.001*			-0.009	-0.020				
	Credits		-0.147***			0.0067***				-0.151***	0.005***				0.064			-0.0621***					0.068	-0.0653***		
			0.025			*0.000*				-0.025	-0.001				*0.056*			*0.003*					-0.055	-0.003		
	Net			-0.281***			0.000					-0.279***	-0.003			-0.207***			-0.0066***						-0.202***	0.014
				0.017			*0.000*					-0.017	-0.003			*0.034*			*0.002*						-0.033	-0.009
Non-Domestic Infra-Group	*Debts*	-0.141***			-0.0030***			-0.146***	-0.005					-0.034			-0.1475***			-0.068	-0.113				
		0.023			*0.001*			-0.023	-0.003					*0.061*			*0.010*			-0.060	-0.082				
	Credits		-0.164*			0.002				-0.182**	0.000				-1.330**			-0.013					-1.398***	0.034		
			0.090			*0.002*				-0.089	-0.002				*0.528*			*0.026*					-0.514	-0.040		
	Net			-0.111*			-0.001					-0.117*	-0.002			-0.396***			-0.1178***						-0.372***	-0.079***
				0.064			*0.001*					-0.063	-0.001			*0.145*			*0.009*						-0.139	-0.021

(to be continued)

Table 7. First approach (sample time splitting) results of equation 1.2. (*continued*)

	Pre-crisis period												Post-crisis period											
	IV (1)			IV (2)			SUR						IV (1)			IV (2)			SUR					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		(8)		(9)		(1)	(2)	(3)	(4)	(5)	(6)	(7)		(8)		(9)	
Dependent variable in the first stage (equation 1.2):	*Domestic Extra-Group:*			*Central Counterparties*			*Domestic Extra-Group*	*Central Counterparties*	*Domestic Extra-Group*	*Central Counterparties*	*Domestic Extra-Group*	*Central Counterparties*	*Domestic Extra-Group:*			*Central Counterparties*			*Domestic Extra-Group*	*Central Counterparties*	*Domestic Extra-Group*	*Central Counterparties*	*Domestic Extra-Group*	*Central Counterparties*
	Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*		*Credits*		*Net*		*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*		*Credits*		*Net*	
Size	0.000	0.011***	0.014***	-0.0001***	-0.0002***	-0.000***	0.000	-0.0001***	0.012***	0.000	0.014***	0.000	0.020***	0.004	-0.022***	0.0009***	0.000	-0.0010***	0.021***	-0.011	0.003	0.000	-0.022***	0.001
	0.000	*0.001*	*0.001*	*0.000*	*0.000*	*0.000*	0.000	0.000	-0.001	0.000	-0.001	0.000	*0.001*	*0.003*	*0.004*	*0.000*	*0.000*	*0.000*	-0.001	-0.026	-0.003	0.000	-0.003	-0.001
Loans	0.028***	-0.178***	-0.205***	-0.0003***	-0.0004***	0.000	0.028***	0.000	-0.178***	-0.002***	-0.204***	-0.002	0.025***	-0.322***	-0.329***	-0.0022***	0.000	0.0032***	0.026***	-0.017	-0.322***	0.010	-0.328***	0.036***
	0.001	*0.003*	*0.003*	*0.000*	*0.000*	*0.000*	-0.001	-0.001	-0.003	-0.001	-0.003	-0.002	*0.003*	*0.007*	*0.008*	*0.001*	*0.000*	*0.001*	-0.003	-0.033	-0.007	-0.009	-0.008	-0.013
Bad Loans	-0.039***	-0.116***	-0.066***	-0.0002**	0.000	0.000	-0.040***	-0.001	-0.114***	-0.002***	-0.062***	-0.001	-0.060***	-0.190***	-0.096***	-0.001	0.0043***	0.0055***	-0.059***	0.033	-0.192***	0.0104*	-0.100***	0.016***
	0.003	*0.006*	*0.007*	*0.000*	*0.000*	*0.000*	-0.003	-0.001	-0.006	0.000	-0.007	-0.001	*0.007*	*0.015*	*0.017*	*0.001*	*0.001*	*0.001*	-0.007	-0.077	-0.015	-0.006	-0.017	-0.004
Portfolio of Government Debt Securities	-0.009	-0.470***	-0.319***	0.000	-0.001	-0.001**	-0.009	0.000	-0.471***	-0.006***	-0.315***	-0.004	-0.112***	-0.380***	-0.245***	-0.004	0.000	0.006	-0.116***	0.062	-0.377***	0.012	-0.233***	0.030***
	0.012	*0.029*	*0.032*	*0.000*	*0.001*	*0.000*	-0.012	0.000	-0.029	-0.002	-0.032	-0.003	*0.028*	*0.059*	*0.069*	*0.005*	*0.003*	*0.004*	-0.028	-0.150	-0.058	-0.011	-0.068	-0.011
Portfolio of Bank Bonds	-0.163***	-0.088***	0.144***	0.000	0.000	0.000	-0.167***	-0.002	-0.086***	-0.001**	0.146***	0.002	-0.146***	-0.242***	-0.004	0.010	0.004	-0.0028**	-0.146***	0.091	-0.244***	0.0118*	-0.003	-0.003*
	0.004	*0.010*	*0.010*	*0.000*	*0.000*	*0.000*	-0.004	-0.003	-0.009	0.000	-0.010	-0.002	*0.007*	*0.015*	*0.017*	*0.001*	*0.001*	*0.001*	-0.007	-0.186	-0.015	-0.007	-0.017	-0.002
Securitized Loans	-0.014***	-0.027***	-0.011	0.0010***	0.0015***	0.001***	-0.014***	0.001***	-0.026***	0.002***	-0.007	0.001***	-0.102***	-0.109***	-0.023	0.0191***	0.0070***	-0.0104***	-0.097***	0.073	-0.108***	0.010***	-0.022	-0.008***
	0.004	*0.008*	*0.010*	*0.000*	*0.000*	*0.000*	-0.004	0.000	-0.008	0.000	-0.009	0.000	*0.010*	*0.022*	*0.025*	*0.002*	*0.001*	*0.002*	-0.010	-0.125	-0.021	-0.003	-0.024	-0.002
ROE	0.011**	0.007	0.004	0.000	0.000	0.000	0.003***	0.000	0.009***	0.000	0.004	0.000	-0.007**	-0.014*	-0.010	0.0011*	0.000	-0.0010*	0.002	0.006	0.002	0.000	-0.011	0.000
	0.004	*0.010*	*0.011*	*0.000*	*0.000*	*0.000*	-0.001	0.000	-0.003	0.000	-0.011	0.000	*0.004*	*0.007*	*0.008*	*0.001*	*0.000*	*0.001*	-0.002	-0.009	-0.005	-0.001	-0.008	0.000
Capital	-0.137***	-0.078***	0.120***	0.000	-0.0004**	-0.000*	-0.139***	-0.002	-0.072***	-0.001***	0.116***	0.001	-0.117***	-0.122***	0.080***	0.0043**	-0.0050***	-0.0101***	-0.123***	0.073	-0.125***	-0.001	0.077**	-0.018***
	0.005	*0.011*	*0.012*	*0.000*	*0.000*	*0.000*	-0.005	-0.003	-0.011	0.000	-0.012	-0.001	*0.012*	*0.027*	*0.031*	*0.002*	*0.001*	*0.002*	-0.013	-0.157	-0.027	-0.004	-0.031	-0.004
Funds Raising	-0.166***	0.012**	0.248***	0.000	0.000	0.000	-0.169***	-0.002	0.012**	0.000	0.247***	0.002	-0.240***	0.092***	0.409***	0.0089***	0.0024***	-0.0052***	-0.240***	0.143	0.090***	0.000	0.407***	-0.046***
	0.002	*0.005*	*0.006*	*0.000*	*0.000*	*0.000*	-0.002	-0.003	-0.005	0.000	-0.006	-0.003	*0.004*	*0.008*	*0.010*	*0.001*	*0.000*	*0.001*	-0.004	-0.307	-0.008	-0.003	-0.009	-0.016
Rating	0.003***	0.002**	-0.001	-0.0003***	-0.0005***	-0.000***	0.003***	-0.001***	0.003**	-0.001***	-0.001	-0.000***	0.006***	0.003	-0.011**	0.0041***	0.0006**	-0.0025***	0.0075***	0.000	0.004	0.000**	-0.014***	-0.002**
	0.000	*0.001*	*0.001*	*0.000*	*0.000*	*0.000*	0.000	0.000	-0.001	0.000	-0.001	0.000	*0.002*	*0.006*	*0.005*	*0.000*	*0.000*	*0.000*	-0.002	-0.010	-0.005	0.000	-0.004	-0.001
Banks without Rating	-0.020***	0.002	0.020***	0.0019***	0.0030***	0.001***	-0.018***	0.002***	-0.001	0.003***	0.0180***	0.00157***	-0.062***	-0.057	0.079**	-0.0331***	-0.003	0.0219***	-0.070***	0.006	-0.064	0.000	0.085**	0.013***
	0.002	*0.006*	*0.006*	*0.000*	*0.000*	*0.000*	-0.003	0.000	-0.006	0.000	-0.007	0.000	*0.016*	*0.046*	*0.039*	*0.003*	*0.002*	*0.003*	-0.016	-0.090	-0.044	-0.002	-0.038	-0.005
Constant	0.117***	-0.003	-0.201***	0.004	0.007	0.002***	0.124***	0.006**	-0.009	0.007***	-0.205***	0.000	-0.110***	0.214***	0.280***	-0.033	-0.002	0.026	0.000	0.033	0.236***	-0.009	0.336***	-0.007
	0.006	*0.014*	*0.016*	*0.000*	*0.000*	*0.000*	-0.006	-0.002	-0.014	0.000	-0.015	-0.002	*0.021*	*0.047*	*0.050*	*0.003*	*0.002*	*0.003*	0.000	-0.152	-0.046	-0.008	-0.049	-0.014
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	43,544	43,323	43,027	43,544	43,323	43,027	43,362		43,186		42,907		15,945	15,859	15,743	15,945	15,859	15,743	15,880		15,812		15,698	

Table 8. Marginal effects of the estimations of equation 1.2.
Dependent variable $x_{i,t-3}$ as ratios to total assets: Domestic-Extra-Group positions; and Central Counterparties positions.

		Pre-crisis period						Post-crisis period					
		Domestic Extra-Group			*Central Counterparties*			*Domestic Extra-Group*			*Central Counterparties*		
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*	*Debts*	*Credits*	*Net*
Domestic Extra-Group	*Debts*	na			0.0			na			0.1		
	Credits		na			ns			na			ns	
	Net			na			ns			na			0.1
Central Counterparties	*Debts*	0.9			na			1.6			na		
	Credits		ns			na			ns			na	
	Net			ns			na			2.6			na
Domestic Infra-Group		0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	ns	-0.1	0.0	0.1
Non-Domestic Extra-Group	*Debts*	-0.9			0.1			0.2			-1.4		
	Credits		-0.1			0.1			ns			-0.6	
	Net			0.0			ns			0.0			0.0
Non-Domestic Infra-Group	*Debts*	-0.1			0.0			ns			-1.6		
	Credits		-0.1			ns			-0.7			ns	
	Net			-0.1			ns			-0.4			-1.2
Size		ns	2.5	2.8	-0.2	-0.4	-0.1	4.3	ns	-4.7	2.2	ns	-2.3
Loans		4.9	-4.3	-4.9	-0.1	-0.1	ns	0.6	-7.9	-7.9	-0.5	ns	0.7
Bad Loans		-0.3	-0.6	-0.3	0.0	ns	ns	-0.3	-1.0	-0.5	ns	0.2	0.2
Portfolio of Governments Debt Securities		ns	-0.3	-0.2	ns	ns	0.0	-0.1	-0.2	-0.8	ns	ns	ns
Portfolio of Bank Bonds		-0.5	-0.3	0.4	ns	ns	ns	-0.5	-0.7	ns	ns	ns	-0.2
Securitized Loans		0.0	0.0	ns	0.0	0.0	0.0	-0.1	-0.1	ns	0.2	0.1	-0.1
ROE		0.0	ns	ns	ns	ns	ns	0.0	0.0	ns	0.0	ns	0.0
Capital		-0.6	-0.4	0.6	ns	0.0	0.0	-0.6	-0.7	0.4	0.2	-0.2	-0.5
Funds Raising		-3.7	0.2	3.7	ns	ns	ns	-3.7	1.4	6.3	1.4	0.4	-0.9
Rating		0.6	0.4	ns	-0.2	-0.3	-0.2	1.4	ns	-2.3	1.3	0.8	-0.7
Banks withou Rating		-2.0	ns	2.0	0.8	1.0	0.7	-6.6	ns	8.4	-3.5	ns	1.1

Table 9. First approach (sample time splitting) results of equation 1.1.
Dependent variable $y_{i,t}$,: ratio of total gross loans from central bank to total assets
Estimation method: ordinary IV
Endogenous and instrumented regressor $x_{i,t-3}$ as ratios to total assets: sum of (Domestic-Extra-Group + Central counterparties) positions

		Pre-crisis period			Post-crisis period		
		(13)	(14)	(15)	(13)	(14)	(15)
Dependent variable in the second stage (equation 1.1):		*Loans from central bank*			*Loans from central bank*		
Domestic Extra-Group + Central Counterparties	*Debts*	-0.057**			0.040		
		0.026			*0.075*		
	Credits		-0.060***			0.619**	
			0.012			*0.254*	
	Net			-0.054***			0.133*
				0.019			*0.081*
Domestic Infra-Group		-0.017***	-0.032***	-0.020***	-0.022	0.123	-0.040
		0.003	*0.004*	*0.004*	*0.017*	*0.065*	*0.013*
Non-Domestic Extra-Group	*Debts*	-0.001			-0.032***		
		0.002			*0.004*		
	Credits		-0.010***			-0.100***	
			0.003			*0.036*	
	Net			-0.030***			0.099***
				0.006			*0.020*
Non-Domestic Infra-Group	*Debts*	-0.015***			-0.029		
		0.006			*0.033*		
	Credits		0.0196**			0.792**	
			0.010			*0.365*	
	Net			0.019**			0.157**
				0.008			*0.064*
Size		-0.001***	0.000	0.000	0.001	0.000	0.005***
		0.000	*0.000*	*0.000*	*0.002*	*0.002*	*0.002*
Loans		-0.003***	-0.010***	-0.010**	-0.001	0.202**	0.047*
		0.001	*0.002*	*0.004*	*0.002*	*0.082*	*0.026*
Bad Loans		0.000	-0.005***	-0.002	0.015**	0.132***	0.029***
		0.001	*0.002*	*0.001*	*0.006*	*0.048*	*0.008*
Portfolio of Government Debt Securities		0.014***	-0.010	-0.007	-0.056***	0.158	-0.009
		0.002	*0.006*	*0.007*	*0.017*	*0.104*	*0.026*
Portfolio of Bank Bonds		-0.009**	-0.002	-0.004	0.007	0.150**	0.007
		0.004	*0.001*	*0.003*	*0.010*	*0.061*	*0.004*
Securitized Loans		-0.002***	-0.004***	0.000	0.115***	0.173***	0.120***
		0.001	*0.001*	*0.001*	*0.007*	*0.029*	*0.007*
ROE		0.000	0.000	0.000	0.000	0.008	0.002
		0.001	*0.001*	*0.001*	*0.002*	*0.006*	*0.002*
Capital		-0.016***	-0.015***	-0.010***	-0.023**	0.058	-0.032***
		0.004	*0.002*	*0.003*	*0.011*	*0.037*	*0.009*
Funds Raising		-0.011***	-0.001*	0.005	-0.013	-0.072***	-0.067**
		0.004	*0.001*	*0.005*	*0.017*	*0.025*	*0.032*
Constant		0.020***	0.015***	0.006	-0.017	-0.177**	-0.065**
		0.004	*0.001*	*0.004*	*0.011*	*0.065*	*0.023*
Bank fixed effects		yes	yes	yes	yes	yes	yes
Time fixed effets		yes	yes	yes	yes	yes	yes
Number of observations		43,544	43,323	43,027	15,945	15,859	15,743
Dependent variable in the first stage:		*Domestic Extra-Group + Central Counterparties*					
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*
Corresponding first stage results (equation 1.2) are reported in Table 10							

Table 10. First approach (sample time splitting) results of equation 1.2.
Table 10 couples with Table 9 (i.e. it contains the corresponding IV first stage results).
Dependent variable $x_{i,t-3}$ as ratios to total assets: sum of (Domestic-Extra-Group + Central counterparties) positions

		Pre-crisis period			Post-crisis period		
		(13)	(14)	(15)	(13)	(14)	(15)
Dependent variable in the first stage (equation 1.2):		*Domestic Extra-Group + Central Counterparties*					
		Debts	*Credits*	*Net*	*Debts*	*Credits*	*Net*
Domestic Infra-Group		-0.109***	-0.308***	-0.160***	-0.161***	-0.222***	0.035
		0.007	*0.016*	*0.018*	*0.021*	*0.042*	*0.049*
Non-Domestic Extra-Group	*Debts*	-0.071***			0.001		
		0.008			*0.009*		
	Credits		-0.144***			-0.004	
			0.025			*0.056*	
	Net			-0.281***			-0.217***
				0.017			*0.034*
Non-Domestic Infra-Group	*Debts*	-0.146***			-0.214***		
		0.023			*0.062*		
	Credits		-0.163*			-1.344**	
			0.090			*0.529*	
	Net			-0.112*			-0.555***
				0.064			*0.144*
Size		0.000	0.012***	0.014***	0.022***	0.004	-0.0230***
		0.000	*0.001*	*0.001*	*0.001*	*0.003*	*0.004*
Loans		0.027***	-0.178***	-0.205***	0.023***	-0.322***	-0.326***
		0.001	*0.003*	*0.003*	*0.003*	*0.007*	*0.008*
Bad Loans		-0.039***	-0.117***	-0.066***	-0.062***	-0.186***	-0.089***
		0.003	*0.006*	*0.007*	*0.007*	*0.015*	*0.017*
Portfolio of Government Debt Securities		-0.008	-0.471***	-0.319***	-0.118***	-0.381***	-0.236***
		0.012	*0.029*	*0.032*	*0.029*	*0.059*	*0.070*
Portfolio of Bank Bonds		-0.163***	-0.088***	0.144***	-0.136***	-0.238***	-0.007
		0.004	*0.010*	*0.010*	*0.007*	*0.015*	*0.017*
Securitized Loans		-0.013***	-0.027***	-0.010	-0.079***	-0.102***	-0.037
		0.004	*0.008*	*0.010*	*0.011*	*0.022*	*0.025*
ROE		-0.011**	0.007	0.004	-0.006*	-0.014*	-0.012
		0.004	*0.010*	*0.011*	*0.004*	*0.007*	*0.008*
Capital		-0.138***	-0.079***	0.119***	-0.113***	-0.127***	0.067**
		0.005	*0.011*	*0.012*	*0.013*	*0.027*	*0.031*
Funds Raising		-0.167***	0.012**	0.248***	-0.231***	0.094***	0.403***
		0.002	*0.005*	*0.006*	*0.004*	*0.008*	*0.010*
Rating		0.003***	0.002*	-0.002*	0.012***	0.004	-0.014***
		0.000	*0.001*	*0.001*	*0.002*	*0.006*	*0.005*
Banks without Rating		-0.018***	0.004	0.021***	-0.103***	-0.060	0.109***
		0.002	*0.006*	*0.006*	*0.016*	*0.046*	*0.039*
Constant		0.124***	0.001	-0.198***	-0.151***	0.212***	0.316***
		0.006	*0.014*	*-0.015*	*0.021*	*0.047*	*0.050*
Bank fixed effects		yes	yes	yes	yes	yes	yes
Time fixed effets		yes	yes	yes	yes	yes	yes
Number of observations		43,544	43,323	43,027	15,945	15,859	15,743
Dependent variable in the second stage:		*Loans from central bank*			*Loans from central bank*		
Corresponding second stage results (equation 1.1) are reported in Table 9							