Do interbank customer relationships exist? And how did they function over the crisis? Learning from Italy

by Massimiliano Affinito°

This draft: April 2011

Abstract

Using 11 years of monthly Italian bank-by-bank data, this paper matches the bilateral amounts and the identity of each interbank borrower and lender with a large list of explanatory variables. My outcomes show that interbank customer relationships, namely stable and strong relationships between pairs of borrowing and lending banks, exist in Italy, persist over time, and functioned well over the crisis allowing the healthier banks to provide funds and the troubled ones to receive financing.

JEL: G21, G28, C23, C24.
Keywords: interbank market, lending relationship, financial crisis.

Contents

°Bank of Italy, Economics, Research and International Relations. Email address: massimiliano.affinito@bancaditalia.it.
This paper has been written while I was a visiting scholar at the NBER, where I have benefited from invaluable discussions and suggestions from James Poterba and participants at a NBER internal meeting (Boston, May 2010). I would also like to thank for their comments, without implicating, Ugo Albertazzi, Paolo Angelini, Francesco Columba, Riccardo De Bonis, Antonio Di Cesare, Fabio Farabullini, Michele Manna, Gaetano Marseglia, Matteo Piazza, Alberto Franco Pozzolo, participants at the seminar held at the Bank of Italy (Rome, November 2010), and an anonymous referee. The opinions expressed are only mine and do not necessarily reflect those of the Bank of Italy or the NBER.

1. Introduction

Since the interbank market is crucial for the correct functioning of all financial system, for implementing monetary policy, and for successive borrowing conditions of households and firms, its malfunctioning in several systems during the recent crisis has become a cause of concern (e.g. Allen and Carletti, 2008; Brunnermeier, 2009; Heider, Hoerova and Holthausen, 2009). This paper joins in the current debate to empirically figure out: a) which characteristics banks look at in order to assess the creditworthiness of other banks; b) whether and how those characteristics changed during the turmoil.

The focus is on the existence and the functioning of *interbank customer relationships*. The banking literature names "lending relationship" or "relationship banking" or "customer relationship" the stable (over time) and strong (quantitatively relevant) relationship that often arises between a bank (lender) and a non-financial firm (borrower). In my case, customer relationships are "interbank" because both lenders and borrowers are banks. The literature points out that customer relationships have some value for everyone: the lender invests in obtaining borrower-specific, often proprietary, information in order to fulfill its screening and monitoring functions and overcome problems of asymmetric information; the borrower aims at lowering cost and increasing the availability of credit (e.g. Lummer-McConnell, 1989; Diamond, 1991; Rajan, 1992; Berglöf and von Thadden, 1994; Boot and Thakor, 1994; Petersen and Rajan, 1995; Berlin and Mester, 1999; Boot, 2000). In particular, since the long relationship allows for a more accurate prediction of when borrowers bounce back and accommodates an inter-temporal smoothing of lenders' income, a prediction of this literature is that lenders ensure the availability of credit to long lasting borrowers mainly when they are in difficulty (e.g. Chemmanur and Fulghieri, 1994; Petersen and Rajan, 1994; Kashyap et al., 2002) or just during a financial turmoil (De Mitri, Gobbi and Sette, 2010).

My idea is that, as in firm-bank relationships, the interbank market's frequent and repeated interactions can originate a special and steady relationship among some pairs of banks. In turn, these interbank customer relationships might benefit involved banks, especially those troubled during the crisis. My empirical results show that this was indeed the case in Italy.

The hypothesis of interbank customer relationships is not completely new. To my knowledge, at least two papers already use this expression: Ferri and Marullo Reedtz (1989), and Cocco, Gomes and Martins (2009). However, as far as I know, the actual existence of such relationships has never been empirically tested; nor have ever been verified their impact during a crisis. In this respect, Italy

is an interesting case to study for two main reasons. First, it is a bank-based economy so that, if interbank customer relationships exist, they are likely to matter. Second, because of the data requirements of banking supervision, a unique dataset is available for Italy, which includes the bilateral amounts and the identity of each borrower and lender.

My empirical analysis uses nearly 450 thousand monthly observations between June 1998 and April 2009, and is divided into three steps. First, I verify the existence of stable interbank customer relationships through their duration, namely through their length and continuity, running a duration model as in Ongena and Smith (2001). Second, I examine determinants of strong interbank customer relationships, that is, the characteristics of banks that rely more on interbank relationships both as borrowers and lenders. Lastly, I study the functioning of interbank customer relationships during the crisis. My findings have relevant economic and policy implications. They show that interbank customer relationships, when exist and persist over time, allow banks not to lose mutual trust, and enable healthier banks to provide funds and banks more touched by the crisis to receive financing.

My paper is related to different fields of research. First, as mentioned, my paper has to do with the literature on bank-firm relationships. Although the two types of partnerships, between a firm and a bank and between two banks, present evident differences, I apply some concepts and methodologies developed in that context to the interbank market.

Second, my paper is related to the literature on market discipline in banking, which states that, if banks carry out peer monitoring, regulators may use banks' signals to identify which intermediaries are riskier. Although similar concepts were already present in Goodfriend and King (1988), Kaufman (1991), Berger (1991) and Schwartz (1992), who point out that banks are the most well-informed parties to judge the solvency of illiquid banks, the views of this literature are still contrasting. On the one hand, according to Bhattacharya and Gale (1987); Flannery (1996); Allen and Gale (2000); Freixas et al. (2000); Freixas and Jorge (2007), banks should not be able to monitor their peers because interbank markets, as well as other credit markets, are characterized by moral hazard and asymmetric information. Goodfriend (2002) and Martin and McAndrews (2007) claim that banks are not apt to monitor other banks, because the implicit guarantee supplied by central banks, which are expected to intervene in case of crisis, shatters banks' incentives to monitor their peers. On the other hand, Rochet and Tirole (1996) demonstrate that interbank exposures might generate incentives for lending banks to monitor borrowing banks, even if this disciplinary role is poorly effective because interbank exposures can quickly be abandoned owing to their typically

short-term maturity. Calomiris (1998) particularly stresses that banks may be employed as monitors of other banks because similar institutions are best able to identify a peer's risk. DeYoung et al. (1998), Peek et al. (1999), Berger et al. (2000), and Furfine (2002) also admit banks possess knowledge regarding other bank's health, even if they highlight that banks have only a complementary knowledge along with central banks. In the empirical analysis, though still scarce, the hypothesis of peer monitoring prevails. Furfine (2001) documents that interbank interest rates in the U.S. federal funds market reflect in part the credit risk of the borrowing banks. Ashcraft and Beakley (2006) find evidence, though weak, of the existence of market discipline. King (2008) demonstrates that high-risk banks pay more than safe banks for interbank loans. Dinger and Hagen (2009) show that in systems characterized by longer-term interbank exposures the monitoring role performed by lending banks is major. My paper contributes to this literature showing that banks keep up long-term relationships and base these relationships on a mutual monitoring. Moreover, my results suggest that stable interbank customer relationships, and the related peer monitoring, are helpful for macro-regulators because contribute to avoid failures in redistribute liquidity.

Third, my paper is related to the growing literature regarding the impact of the crisis on the functioning of financial markets, and specifically on the interbank market (e.g. Dudley, 2008; Cassola, Holthaussen and Lo Duca, 2008; Gynetelberg and Wooldridge, 2008; Michaud and Upper, 2008; Angelini, Nobili and Picillo, 2009; Taylor and Williams, 2009; Heider, Hoerova and Holthausen, 2009; Porzio, Battaglia, Meles and Starita, 2009). In particular, my analysis complements those of Cassola et al. (2008) and Angelini et al. (2009). Cassola et al. (2008) highlight that the crisis increased cross-country asymmetric information problems and caused a decline in cross-border trades. I show that, unlike cross-country transactions, the Italian domestic interbank market did not experience an increase in asymmetric information problems, and a reason is referable to the presence of interbank customer relationships. Angelini et al. (2009), like me, analyse the Italian interbank market during the period preceding and following the crisis. Although their focus is different, as they study the determinants of the interbank interest rate spread, my findings are consistent with their main conclusion. In fact, they point out that the interbank widening spread over the crisis was determined not by bank-specific characteristics, but by a rise in aggregate risk aversion. Accordingly, my paper shows that, during the crisis, interbank customer relationships seemed to work well and bank-specific characteristics, even when deteriorated, did not hamper interbank transactions.

The rest of the paper is organized as follows. Section 2 describes the three steps of my analysis. Section 3 presents my data on dependent variables and on covariates. Section 4 concerns my results. Section 5 summarizes my robustness checks. Section 6 concludes.

2. Empirical strategy

My empirical analysis is divided into three steps. The first step examines the stability over time; and the second step the quantitative strength of interbank customer relationships. However, both steps mix through estimations and checks the two concepts of stability and strength. Lastly, my third step investigates what happened during the recent financial crisis.

As mentioned in the Introduction, in my first step, I estimate a duration model following Ongena and Smith (2001). Duration models are typically used in labour economics to estimate for example the duration of unemployment; are used by Ongena and Smith (2001) to estimate the duration of firm-bank relationships; and by me to estimate the duration of bank-bank relationships.

These models analyse the duration of time (spell) that passes from a beginning condition (initial state) to the occurrence of a certain random event (switch). In my case, the initial state starts when a bank for the first time lends to − or borrows from − another bank (that is, when an interbank relationship between a pair of banks is established); and the switch occurs when the interbank exposure dries up (that is, when the interbank relationship ends or breaks even only for one period).[1]

In particular, these models allow estimating the presence of positive or negative duration dependence. Duration dependence is said to be positive, when the probability that a switch from the initial state occurs increases as the spell lengthens; while duration dependence is said to be negative, when the probability of switching decreases as spell lengthens, and thus the initial state turns out to be stable. Ongena and Smith (2001) find positive duration dependence in relationships between firms and banks in Norway − namely firms are more likely to leave a bank as the spell increases − and therefore conclude that the value of the firm-bank relationship declines over time. I utilize their same methodology and their same argument, but find negative duration dependence, and thus the probability of ending or breaking an interbank relationship decreases over time. Therefore I can conclude that stable interbank relationships exist.

[1] Relationships which began prior to my sample period are left-censored; relationships continuing after my sample-period are right-censored. Different methods exist to allow for left- and right- censoring. I use them as robustness checks in Section 5.

The presence of positive or negative duration dependence is estimated through a hazard function $\lambda(t)$. The hazard function provides a suitable method for summarising the relation between spell length and the likelihood of switching because determines the probability that a switch occurs conditional on the spell surviving through time t. When $\lambda(t)$ is increasing (decreasing) in t, the hazard function exhibits positive (negative) duration dependence; when $\lambda(t)$ is constant in t, there is constant duration dependence and thus no relation between spell and switch.

In formal terms, I use the following proportional hazard specification to estimate $\lambda(t)$:

$$\lambda(t, K^{L}_{i,t}, K^{B}_{j,t}, K^{LB}_{i,j,t}) = \lim_{\Delta t_s \to 0} \frac{P(t_s \leq T_s < T_s + \Delta t_s | T_s \geq t_s, K^{L}_{i,t}, K^{B}_{j,t}, K^{LB}_{i,j,t}, \alpha, \beta, \gamma)}{\Delta t_s} =$$

$$= \lambda_0(t) \exp(\alpha'^{l}_{k} \mathrm{K}^{\mathrm{L}}_{i,t} + \beta'^{b}_{k} \mathrm{K}^{\mathrm{B}}_{j,t} + \gamma'^{lb}_{k} \mathrm{K}^{\mathrm{LB}}_{i,j,t}) \qquad (1.1)$$

where t_s is the time when a switch from the initial state of interbank relationship occurs; T_s is the spell that passes before the switch occurs; $\lambda_0(t)$ is the baseline hazard function that describes the probability of leaving the initial state of relationship for hypothetical banks with no set of characteristics, which serve as a reference group. The duration model also allows to infer the determinants of the duration, which in my case are captured by the adjustment factor $\exp(\alpha'^{l}_{k}\mathrm{K}^{\mathrm{L}}_{i,t}+\beta'^{b}_{k}\mathrm{K}^{\mathrm{B}}_{j,t}+\gamma'^{lb}_{k}\mathrm{K}^{\mathrm{LB}}_{i,j,t})$, where $K^{L}_{\mathrm{i,t}}$ is a matrix (nt x k^{l}) of lending banks' characteristics; $K^{B}_{\mathrm{i,t}}$ is a matrix (rt x k^{b}) of borrowing banks' characteristics; and $\mathrm{K}^{\mathrm{LB}}_{i,j,t}$ is a matrix (nrt x k^{lb}) of the characteristics capturing interactions between lending and borrowing banks. The logarithm of λ is linear in $\alpha'^{l}_{k}\mathrm{K}^{\mathrm{L}}_{i,t}+\beta'^{b}_{k}\mathrm{K}^{\mathrm{B}}_{j,t}+\gamma'^{lb}_{k}\mathrm{K}^{\mathrm{LB}}_{i,j,t}$, where α, β, and γ are vectors of coefficients. Each coefficient therefore measures the proportional change in the hazard rate that can be attributed to an absolute change in the regressors. Finally, k^{l}, k^{b}, and k^{lb} indicate the different number of regressors in each matrix.

Computationally, it is standard to adopt the Weibull model as a functional form of the baseline hazard $\lambda_0(t)$.[2] It states that:

$$\lambda_0(t) = \theta \varphi t^{\varphi-1} \qquad (1.2)$$

[2] I also use other baseline hazard functions as robustness checks. See Section 5.

where $\theta > 0$ and $\varphi > 0$ are unknown parameters. On the basis of estimations: when $\varphi = 1$, the distribution exhibits constant duration dependence; when $\varphi > 1$, positive duration dependence; and when $\varphi < 1$, negative duration dependence.

Once investigated the existence of stable relationships, my second step analyses the determinants of strong relationships. To this end, preliminarily, I measure the strength of each lending and borrowing relationship through two indexes.

The first index is computed as the ratio between the total funds that *i* lends to *j* ($L^{i\rightarrow j}$) and the total funds that *i* lends in the interbank market ($\sum L^{i\rightarrow N_t}$), and measures if *j* is a relevant interbank borrower of *i* (relevant borrower index, hereafter RBI):

$$\text{RBI}_{i,j,t} = \left[\frac{L^{i\rightarrow j}}{\sum L^{i\rightarrow N_t}}\right]_t, \qquad (2.1)$$

where $i, j = 1, 2, \ldots, N_t$ indicate all pairs of banks $i \neq j$; and $t = 1, 2, \ldots, T$ are the time periods. The subscript t in N_t indicates that the number of banks operating in the interbank market and the number of counterparties change over time and across banks.

The second index is computed as the ratio between the total funds that *i* borrows from *j* ($B^{i\leftarrow j}$) and the total funds that *i* borrows in the interbank market ($\sum B^{i\leftarrow N_t}$), and displays if *j* is a relevant interbank lender of *i* (relevant lender index, hereafter RLI):

$$\text{RLI}_{i,j,t} = \left[\frac{B^{i\leftarrow j}}{\sum B^{i\leftarrow N_t}}\right]_t. \qquad (2.2)$$

The higher the two indexes are, the closer each interbank customer relationship is. As a check, I also construct alternative measures of the two indexes based on the number of interbank relationships rather than on transacted quantities.[3]

Then, I analyse the determinants of these indexes, that is I try to detect the banking characteristics that strengthen interbank relationships. Again, as in equation (1.1), I investigate the

[3] Thus, I calculate the relationship between *i* and *j* as one to the number of banks that *i* lent to (or borrowed from) during each period. My indexes are similar to those computed by Furfine (2001); Cocco et al. (2009); and in general to those extensively utilized in the literature on bank-firm customer relationships (e.g. Elsas, 2005).

determinants of my indexes using as regressors both lender side and borrower side characteristics along with variables measuring the interactions between lenders and borrowers. In formal terms, I estimate the following equation:

$$I_{i,j,t} = \alpha'^{l}_{k} K^{L}_{i,t} + \beta'^{b}_{k} K^{B}_{j,t} + \gamma'^{lb}_{k} K^{LB}_{i,j,t} + \eta_{i,t} \qquad (2.3)$$

where $I_{i,j,t}$ is equal alternatively to either $RBI_{i,j,t}$ or $RLI_{i,j,t}$, defined in equations (2.1) and (2.2); α'^{l}_{k}, $K^{L}_{i,t}$, β'^{b}_{k}, $K^{B}_{j,t}$, γ'^{lb}_{k}, $K^{LB}_{i,j,t}$ are defined as in equation (1.1), and $\eta_{i,t}$ is the idiosyncratic error ~ i.i.d. $(0, \sigma_{\eta}^{2})$. Since my indexes capture the cross-sectional and the time dimension of interbank customer relationships, the second step uses the panel estimation as a basic regression model.

The third step of my analysis investigates both the effects of the crisis on interbank customer relationships and the consequences of interbank customer relationships on the effects of the crisis. To this purpose, I repeat the same exercises of the two previous steps after splitting the entire sample period into two spans, before and after the crisis.

3. Data

3.1 Key variables: duration and strength of interbank relationships

In the first step, the key variable is the duration of each interbank relationship. In the second step, the dependent variables are the indexes RBI and RLI, alternatively computed on the quantities of interbank exposures in the basic estimations, and on the number of counterparties as a check. In the third step, all kinds of my key variables are used. Table 1 reports their summary statistics. Table 2 shows the relations among them, when computed as averages, first by each bank, and then across banks and over time.

All my key variables are computed on monthly Italian bank-by-bank data, drawn from the Bank of Italy's accounting supervisory reports. The Bank of Italy collects information on the gross bilateral interbank exposures, borrowed and lent by each bank, and the identity of every counterpart. My sample covers monthly data from June 1998 to April 2009, thus the number of time periods is: $t_i = 1, 2, \ldots, T_i$, where $T_i = 131$ if the bank is always present in the interbank market. Since in Italy all banks, including branches of foreign banks, must report to the Bank of Italy, my data refer to all banks operating in Italy. The number of banks $i = 1, 2, \ldots, N_t$ varies in each t from 833 in June 1998

to 771 in April 2009. The number of counterparties $c_{i,t} = 1, 2, \ldots, C_{i,t}$ varies across banks and over time. The final number of my observations is $T_i N_t C_{i,t} = 460{,}964$.

Three aspects deserve to be emphasized. First, I focus on quantity measures of interbank customer relationships. My choice is not unusual. Emphasis on the quantity dimension has been growing in the literature on interbank markets (e.g. Furfine, 2001; King, 2008; Dinger and Hagen, 2009; Cocco et al., 2009), and is widespread in the related literature on firm-bank relationships. Moreover, it allows me to analyse all Italian interbank exposures, even the over-the-counter ones, for which data on interbank interest rates are not available.

Second, although interbank activity is usually at very short maturities, I use end-of-month stocks for my dependent variables, because data on quantities are not available on a more frequent basis. For example, Cocco et al. (2009) and Angelini et al. (2009) utilize daily data for interest rates, but quarterly or yearly data for their regressors; King (2008) uses only quarterly data; and Dinger and von Hagen (2009) only yearly data.

Third, my key variables are computed on the component of interbank transactions carried out domestically by banks belonging to different banking groups (between-group exposures). In other words, I dropped data on non-domestic and within-group transactions. The non-domestic exposures are simply removed because, even if the Bank of Italy's database allows me to obtain the stock of interbank exposures from and to abroad, I could not account for the characteristics of foreign counterparties as regressors. By contrast, the within-group (or internal capital market) exposures are removed because this kind of transactions fits into a group-specific scheme, is likely to be decided by group-parents, and is affected by a group task sharing (e.g. Houston, James and Marcus, 1997; de Haas and van Lelyveld, 2010). In any case, although I eliminated from my key variables the within-group and abroad transactions, I retained them as two explanatory variables.

In particular, in order to eliminate the within-group exposures, I used information on the identity of each counterpart and on its group of affiliation. For the banks, which changed group during my sample period, I traced the current group of affiliation in each t_i, and analyzed their effective between-group relationships in each period. To exemplify how I computed the spell T_s in these cases, let us assume to have three banks initially belonging to two banking groups: *a* is affiliated to group *A*; *b* and *c* to *B*. Let us assume also that the three banks maintain always mutual interbank exposures, and in t_s *c* is acquired by the group *A*. Before t_s, I exclude the transactions between *b* and *c* because carried out within the same group. After t_s, my counting: (i) continues as for the relationships between *a* and *b* because the two banks were and remain in different groups; (ii)

ends as for *a* and *c* because their mutual exposures become within-group; (iii) starts for the first time as for the transactions between *b* and *c* because their relationship becomes between-group.

My approach works well even when an interbank relationship ends because one of the two involved banks leaves the market as a consequence of a merger. In fact, in such a circumstance in the abstract there may be a (disputable) measurement error, but in practice in my sample it is unimportant. To clarify this point, let assume to have three banks: *x* and *y* have an interbank relationship before t_s, and *x* leaves in t_s because merges with *z*. In t_s, my counting of duration of the relationship between *x* and *y* obviously ceases. Always in t_s, as for *y* and *z*, there are four hypothetical cases: (i) *y* and *z* continue to have no relationship; (ii) continue a previous relationship; (iii) cease their relationship; (iv) establish a relationship. In the first three cases, my counting of duration does not present problems. Only in the last case, it is arguable that (perhaps) the relationship between *y* and *z* derives from the ceased relationship between *x* and *y*, while I start a new counting. However, in practice such situations are negligible in my sample.[4]

Figures 1 and 2 plot outstanding amounts and percentage shares on total assets of four kinds of interbank exposures: total, non-domestic, within-group and between-group transactions. The figures show that, apart from non-domestic exposures (Cassola et al., 2008; Heider et al., 2009), the amounts of Italian interbank domestic exposures have not fallen since the outset of the crisis. The figures also show that the between-group activity accounts for only a portion of total transactions among banks, while the most and increasing part is made up by the internal capital market. Therefore, my approach serves to remove a large quantity of misleading and noisy information.

An exam of my descriptive statistics serves mainly to confirm the need of more sophisticated statistical tools. The average duration of an interbank relationship is 28 consecutive months, when the average is computed on the *ongoing* duration in each period; it increases to 47 consecutive months, when the average is computed on the *final* duration of all relationships; and to 96, when the average is computed on the *final* duration of the *longest* relationships of each bank (Table 1). The average number of borrowers is about 5; while the average number of lenders is higher, about 8. The more intense concentration of the borrowing side is confirmed by the average value of RBI, equal to

[4] There is a second − not less relevant − reason why my approach works well even in the case exemplified in the point (iv). For completeness on this issue, it is useful to deal with this second reason here, even if I have not yet described my estimations in detail. The case in the point (iv) represents a (potential) measurement error. The only possible effect of this error would be underestimating the length of spell T_s. However, since in my estimations I find that relationships are long and stable, my outcomes would have been even stronger without this error. Furthermore, I checked this issue also empirically in my regressions, adding a dummy variable assuming value one when a bank merger occurs. The dummy variable had no impact on the likelihood of terminating an interbank relationship nor on the other regressors.

0.19, which is higher than the average value of RLI, 0.13. In general, longer relationships are associated with stronger relationships and less counterparties (Table 2). However, there is no lack of non-liner effects. The hypothesis of the existence and strengthening over time of interbank customer relationships seems to be supported by the fact that the average values of RLI and RBI are increasing (Figures 3), and the number of counterparties is decreasing (Figures 4). On the other hand, these average developments may simply derive from the general process of banking concentration. Figure 5 plots different specifications of the final duration of interbank relationships, in terms both of the number of months and as a percentage of the effective presence in the interbank market. If one refers to the longest interbank relationship of each bank, about the 70 per cent of banks and 80 per cent of interbank market maintain at last one very long-lasting relationship (at last 81 consecutive months or more than 80 per cent of periods of interbank activity). On the other hand, if one refers to the average duration of all relationships, the distribution is much more uniform.

3.2. Explanatory variables and expected signs

Table 3 lists my explanatory variables, how they are calculated, and their summary statistics. All regressors are dummy variables, ratios or natural logarithms.[5] My regressors belong to the matrixes $K^{B}_{j,t}$, $K^{L}_{i,t}$, and $K^{LB}_{i,j,t}$ of equations (1.1) and (2.3) depending on whether they refer to borrowers, lenders or both. Moreover, my covariates may be classified in six groups on the basis of the effect they proxy (Table 4).

The first variable is named Relationship Duration, which is similar to the key variable T_s in equation (1.1), and is used as a regressor in the second and third step of my analysis.[6] In fact, in addition to being the object of the analysis in the first step, the duration of a relationship may affect its strength. In particular, its expected sign is positive if interbank customer relationships persist over

[5] Estimations of the three steps of my analysis are carried out using banks' prior quarter balance sheet items to resolve possible endogeneity problems and to replicate the publication delay needed to banks in order to assess each other.

[6] As a robustness check, the variable Relationship Duration is computed in three alternative ways. First, in the basic estimations, it counts in each period the integer number of consecutive months elapsed in my sample since the start of an interbank relationship between each pair of banks. Equivalently to T_s, the counting restarts whenever a relationship resumes after a break of any length, even one month. Second, to control for the size of the exposures, I recalculated the variable removing the smallest relationships, i.e. those under either the 10^{th} or 25^{th} distribution percentile of RBI and RLI. Third, to control for the effective period of activity of each bank, I computed the variable as a ratio between the number of consecutive months and the total number of months in which the bank is operative in the interbank market, such that the variable continues to assume increasing values but weighted for the effective period of activity. In the first definition of the variable, the values and number of observations of Relationship Duration and the spells T_s, computed in equation 1.1 are partially different (Tables 1-3). This is because equation 1.1 excludes one-period relations, while Relationship Duration considers those as relations lasted one month.

time and their length positively affects their strength (e.g., with regard to bank-firm relationship, Petersan and Rajan, 1994; Berger and Udell, 1995).[7]

The second group of regressors includes seven borrower-specific variables, which are related to agency problems (Table 4, second column, upper panel): Size, Capital, Bad Loans, Structure of Income or Opacity, ROE, Rating, and Banks without Rating. The expected sign of these variables is *ex-ante* ambiguous. On the one hand, if a regressor signals higher asymmetric information, the expected effect on my dependent variables is negative. On the other hand, as argued in the literature on relationships between banks and non-financial corporations, customer relationships can overcome agency problems, borrowers may be financed mainly when troubled in the short-term, and thus the effect of testable indicators may turn out to be inverted (e.g. Chemmanur and Fulghieri, 1994; Petersen and Rajan, 1994, 1995; Berlin and Mester, 1999; Kashyap et al., 2002).[8]

Two regressors of this group measure the role of rating agencies. The variable named Rating is coded so as to take values from 1 to 11, where 1 corresponds to the best rating class, 10 corresponds to the worst rating class and 11 is assigned to banks with no rating. At the same time, following Angelini et al. (2009), I use a dummy variable, named Banks without Rating, which assumes the value of 1 for banks with no rating and 0 otherwise. In the estimations, I use four different kinds of banks' credit scores taken from the agency Fitch through the database of Bloomberg.[9] Being an inverse measure, the expected sign of borrowers' Rating is negative if lending banks trust credit rating agencies and use them to value the creditworthiness of borrowing banks; while it is positive (or possibly insignificant) if lending banks distrust rating agencies or interbank customer relationships render their judgement pointless. The prediction of the dummy Banks without Rating is equally uncertain (see Morgan, 2002; Flannery, Kwan, and Nimalendran, 2004).

---

[7] As detailed in Section 4, the signs of coefficients have an opposite interpretation in the first and second step of my analysis. In particular, in a partially counterintuitive way, the hazard rate estimation predicts that negative coefficients of covariates indicate a longer duration. In this section, I comment on the expected signs in the "intuitive" way.

[8] Two variables of this group deserve some more details. The variable Size is particularly interesting in this field of research because of the classical "too big to fail" argument, according to which, larger banks are more likely to obtain interbank loans because should not go bankrupt. Moreover, larger firms are typically considered less opaque and thus more creditworthy. On the other hand, the effect might be opposite, at least after the turmoil, had the Lehman Brothers failure reversed the traditional "too big to fail" argument or rendered less plain to detect who is "too big", and because larger banks might demand less interbank funds, as they can count upon other sources. The name of the variable Structure of Income or Opacity derives from the fact that it is often used as a proxy of asymmetric information because fee-generating activities are considered less easy-to-read by other agents compared to interest-generating activities.

[9] Angelini et al. (2009) find that Fitch ratings are more informative in the assessment of banks and financial firms. All the credit ratings are obtained as a monthly average of ratings available at a daily frequency. My first choice is the overall individual rating; the other three types of credit rating are: support, long-term and short-term issuer default rating. Again following Angelini et al. (2009), I assign the rating of the controlling company to banks that do not have their own rating, but belong to groups with rated banks. However, as a check I remove this hypothesis.

The seven regressors of the third group of variables are equivalent to the previous ones, but are referred to lenders instead of borrowers. In this case, they do not measure agency problems, but the lending capacity of banks. Their predictions are equally open. For example, lenders' Capital and ROE are positive if only well-capitalized and profitable banks are lenders in the interbank market; while they are negative if well-capitalized and profitable banks are more active outside the interbank market than inside.

The fourth group of regressors concerns three variables related to borrowers' and lenders' liquidity situation. Fund Raising measures the level of liquidity of each bank; Volatility of Liquidity measures the related degree of volatility; and, following Cocco et al. (2009), Liquidity Shocks Correlation measures the correlation between the liquidity shocks of each pair of banks. The predictions are again open. For example, the higher Fund Raising is, the less likely a bank should be to request funds from other banks, and the more likely it should be to offer funds. However, the sign might be opposite if, for example, highly-liquid banks choose more remunerative investments rather than lending in the interbank market.

The fifth group of variables includes five covariates that proxy the use banks make of their liquidity. Three regressors refer to both borrowers and lenders: Total Loans; Non-Domestic Assets; and Total Shares. Two additional regressors are calculated only for borrowers: Within-Group Interbank Net-Position measures the net-position of each bank inside its banking group (the internal capital market); Non-Domestic Interbank Net-Position measures the external net-position of each bank. The expected sign of these variables depends on the relevance of each kind of business.

The last category of regressors comprises two variables named Securities' Interaction, which are the securities issued by the borrower and held by the lender (or vice-versa). These are proxies of the interactions between borrowers and lenders outside the interbank market, the idea being that, such as in bank-firm relationships, the information that banks obtain by offering multiple services may be of value in lending (e.g. Degryse and Van Cayseele, 2000). The expected sign is therefore positive.

4. Results

4.1. First step: stability and existence

The results of the first step of my analysis are reported in Table 5, where I present seven specifications, variously mixing my explanatory variables. Specification (1) is empty of regressors,

and the focus is only on the value of the parameter φ of equation (1.2); Specification (6) includes bank-by-bank dummies and the full range of my regressors presented in Table 4; Specification (7) includes as regressors also the number of bank counterparties.

The first relevant outcome is that the parameter φ is always significantly less than one, even when, as expected, it slightly increases owing to the addition of the explanatory variables.[10] Therefore, interbank customer relationships exhibit negative duration dependence, and thus they exist and are stable because the probability that they end or break decreases over time.

The second lesson of this first step concerns the factors driving the probability of ending an interbank relationship. On the borrowers' side, the duration of interbank relationships is longer if borrowers are: first, well-capitalized and profitable (borrowers' variables Capital and ROE are significantly negative); second, if their business is focused more on fee-generating services than on interest-generating activities (Structure of Income/Opacity is significantly negative); third, if they are either non-rated or well-rated; fourth, if they are net-lenders inside their domestic banking group or abroad (Within-Group Interbank Net-Position and Non-Domestic Interbank Net-Position are significantly negative); and finally if their lending activity is florid (Total Loans is significantly negative). On the contrary, the probability of ending an interbank relationship earlier increases if borrowers are large banks (Size is significantly positive) and if their liquidity is high in amount and volatility.

On the lenders' side, the duration of interbank relationships is longer if lenders are well-capitalized, profitable, and liquid. In contrast, the duration shortens if lenders are large; burdened with non-performing loans; non-rated; if their liquidity is volatile; and their investment opportunities are devoted to other businesses (Total Loans and Total Shares are significantly positive).

On the interaction's side, the duration of interbank relationships increases if borrowers and lenders interact outside the interbank market. In Specification (7), I included as regressors the number of lenders (lending to borrowers) as well as the number of borrowers (borrowing from lenders). The sign of both regressors is significantly negative. This means that the probability of ending later one's own interbank relationships increases in the number of counterparties.

[10] Besides permitting the estimation of duration's determinants, indeed, the inclusion of regressors serves to control for heterogeneity across observations, and, according to Heckman and Singer (1984) and Ongena and Smith (2001), eliminates possible biases in the outcomes of the parameter φ. In this light, I also ran regressions including or not a time dummy to allow for macroeconomic trends and in particular for the monetary policy stance (e.g. Affinito and Farabullini, 2009).

All specifications indicate that interbank relationships are long. During my sample period of 131 months, they last on average between 108 and 70 consecutive months, respectively, using Specification (1) and (7), and the average values of the explanatory variables. The duration of relationships among banks is particularly extensive if one considers the typically very short maturities of interbank exposures. To verify the robustness of such a long estimated duration, I repeated the first step after removing the small relationships. In fact, one may conjecture that the duration dependence might change with regard to the size of exposures. In an extreme case, banks might maintain some stable relationships but based on small quantities, while exchange the main part of transactions with changing counterparties. To control for this, I removed alternatively the exposures under the 10^{th}, 25^{th} and 50^{th} distribution percentile of RBI and RLI defined in equations (2.1) and (2.2). In all cases, φ always remained significantly less than one. The estimation of the duration reduced, but it never fell below 60 consecutive months.

Using Specifications (6) and (7), I also quantified the estimated effect of the different regressors on the expected duration of interbank relationships, all other things being equal. The last columns of Table 5 report the change of duration expressed in number of months passing from the 25^{th} to the 75^{th} distribution percentile of each regressor. For example, moving from the 25^{th} to the 75^{th} distribution percentile of borrowers' Fund Raising, namely comparing two borrowers, one illiquid and the other liquid, the duration of interbank relationships decreases by 97 periods according to Specification (6) and by 66 according to (7). The other economically relevant factors in lengthening the duration are: both lenders' and borrowers' Total Loans; lenders' Fund Raising; and borrowers' rating and credit scores. Interestingly, a crucial lengthening role is also played by borrowers' Non-Domestic Interbank Net-Position: transferring funds abroad does not hamper, but even extends the duration of interbank customer relationships.

4.2. Second step: strength and determinants

Table 6 reports the results of the second step of my analysis for eight specifications, containing the same covariates for both the indexes RLI and RBI.[11] Other estimations are described

[11] As mentioned, in the second step I use panel estimation as a basic regressor model. It is worthwhile clarifying three aspects. First, I ran both fixed effects and random effects models. Results remained stable, even because my T is large enough. I present results of the fixed effects because the individual effects and the explanatory variables are likely to be correlated, as signalled by the Hausman test. Second, I attempted to cluster both at the borrower and lender level. In the displayed specifications, the fixed effects capture the borrowers in the RBI and the lenders in the RLI, as they are the object of the selection process in each respective equation. However, results were stable after switching the individual effects, because I added counterparty dummies in coherence with the related literature and in line with the presence of the counterparty's characteristics among regressors. Third, as in the first step, I ran regressions including or not a time

in the next Section as robustness checks. As evident in Table 6, and as I explain in this and in the next Section, results are robust.[12]

The same variables, both on the borrowers' and lenders' side, often have different signs in the estimations of the RLI and RBI. This derives from the different role played by banks, on the one hand, as "relevant lenders" or "relevant borrowers", and, on the other hand, as "lenders of relevant borrowers" and "borrowers of relevant lenders".[13]

The first variable, Relationship Duration, which is always significantly positive, confirms the persistence of interbank relationships found in the first step and signals that the longer a relationship is, the more likely it is to be strong.

Taken together, the regressors associated with borrowers' agency problems show that, although interbank customer relationships exist and persist, monitoring activity on borrowing banks seems to remain necessary. As mentioned, *ex-ante*, one might reasonably argue that repeated interbank transactions would allow banks to assess each other and create mutual trust regardless of the short-term conditions. By contrast, my outcomes show that interbank customer relationships are based on the observable characteristics of borrowers. In fact, according to the RBI estimation, relevant borrowers tend to be chosen if they have larger Size, greater Capital and less Bad Loans.[14]

The regressors proxying lending capacity show that relevant lenders have larger Size, lower Capital and a higher burden of Bad Loans. This seems to suggest that poorly-capitalized banks are more likely to be relevant interbank lenders because they are less likely to invest outside the interbank market. As a consequence, they have more bad loans, because they are less accustomed or less skilled to monitor the creditworthiness of their non-bank customers; yet they are non-rated or

---

dummy. Fourth, I adopted the fixed effects adjusting the standard errors for general forms of heteroskedasticity and autocorrelation (Arellano, 1987).

[12] Only very few regressors appear less stable: 5 out of 68 total regressors. In Section 5, I dwell on the reasons of this minor stability. Coherently with the first step, I also ran regressions including as regressors the numbers of counterparties. Even if results were confirmed, I decided not to use those estimations in the second step because (i) my dependent variables already discount the number of counterparties; and (ii) the inverses of the number of counterparties are used as alternative dependent variables in not reported but consistent estimations.

[13] The different effect determined by the same variables in the asset and in the liability side is typical of the literature on interbank markets. The use of the same regressors in the estimations of the two indexes allows me to detect some interesting, sometimes uneven and sometimes mirrored, results. For example, the variable Size presents uneven results. In the RLI, relevant lenders of small borrowers tend to be large banks (the signs of variable Size are negative for borrowers and positive for lenders). In the RBI, relevant borrowers of small lenders tend to be large banks. This result is typical and is also due to the fact that larger banks weight more on the balance sheets of their counterparties. An example of mirrored result is represented by the variable Bad Loans. When relevant lenders have high Bad Loans, so have borrowers (RLI estimation); when the value of the ratio is small, it is small for both of them (RBI).

[14] The outcomes of the two borrowers' variables linked to rating agencies are described in the next Sub-Section because the results of these two variables seem to depend on a different attitude of banks before and after the financial crisis.

have good ratings (lenders' Banks without Rating is positive and Rating is negative), because they are likely to assume a lower amount of risks outside the interbank market.

As far as liquidity is concerned, relevant borrowers tend to be those with sizeable liquidity needs due to both low Fund Raising and high Volatility of Liquidity. On the other hand, banks with high Fund Raising are not relevant lenders, as one might expect, confirming that these banks are more likely to search for more profitable investments outside the interbank market. However, relevant lenders tend to have low Volatility of Liquidity. The picture remains consistent with regard also to Liquidity Shocks Correlation. Borrowers tend to rely on relevant lenders with low Volatility of Liquidity and hence are not concerned about Liquidity Shocks Correlation, which turns out to be positive (RLI estimation). In contrast, lenders tend to select relevant borrowers with high Volatility of Liquidity, provided that Liquidity Shocks Correlation is negative (RBI estimation).

The regressors linked to liquidity motivations confirm that, when banks are relevant lenders, they are less involved in other kinds of businesses (in RLI, lenders' Total Loans, Non-domestic Assets, and Total Shares are negative). At the same time, relevant borrowers rely on interbank relationships to finance all their activities (in RBI, the three borrowers' variables are positive). Moreover, the odds of being relevant borrowers increase when banks are net-lenders inside a domestic group or abroad, because in such circumstances banks demand a comparatively large amount of funds from every lender in order to set up a stable financing source for themselves, the whole group, and their abroad counterparties.[15]

Finally, the two symmetrical variables Securities' Interaction usually have a positive and significant coefficient showing that interactions undertaken by banks outside the interbank market strengthen their relationship.[16]

4.3. Third step: Over the crisis

As explained in Section 2, in order to verify whether interbank customer relationships have continued to exist, and how they functioned over the crisis, I split my entire sample period into two spans, before and after August 2007, when it is customary to date the onset of the crisis, and then I repeated the exercises of the previous two steps.

[15] On the other hand, both regressors are negative in the RLI. This means that, when a bank is a net-lender inside a domestic group or abroad, it does not select one particular lender because it is likely to request funds from many banks.
[16] Interestingly, however, the sign is negative in the RBI for securities held by borrowers and issued by lenders. This seems to corroborate the idea that relevant borrowers do not choose, but are chosen by their lenders.

It must first be stressed that interbank customer relationships have survived the crisis. The parameter φ is always significantly less than one running equations (1.1) and (1.2) only over the months following the onset of the crisis (not reported). Nevertheless, banking practices have changed and adapted to the crisis, as is shown by the reshaping of coefficients in the estimation of equations (2.1)-(2.3). Table 7 reports the results of the only Specification (8), chosen because it contains the full range of my explanatory variables. The effect of Relationship Duration remains remarkably unmodified after the meltdown, signalling that the length of the relationship remains a crucial factor in explaining when a bank is a relevant lender or borrower. By contrast, the sign or the statistical significance of some relevant determinants are different before and after the crisis.

First, after the crisis, relevant lenders are rated (in RLI, lenders' dummy Banks without Rating is positive before the crisis and becomes negative after the crisis), and have worse rating scores (the variable Rating becomes positive). However, they have higher capital, a higher level of liquidity, a larger amount of loans, and are less opaque. At the same time, borrowers of relevant lenders are financed even if, or mainly because, they are in trouble, having less capital, worse ratings, lower ROE, and fewer loans. Moreover, they are financed regardless of bad loans, and being rated or not.

Second, after the crisis, relevant borrowers are picked out if they have easy-to-read balance sheets (in RBI, Structure of income/Opacity is insignificant before the crisis but becomes significant and negative after the crisis); higher profits; and with no regard for their rating, liquidity volatility and correlation. Moreover, the financing of relevant borrowers is unrelated or inversely related to the interactions outside the interbank market (in RBI, after the crisis, the two variables Securities' Interaction become, respectively, insignificant and negative). At the same time, lenders of relevant borrowers provide liquidity even if they have less capital, and regardless of their bad loans, structure of income, rating score, amount of loans and shares (these variables become insignificant).

As mentioned in the previous Section, the results of borrowers' rating and credit scores before and after the crisis are particularly interesting, and clarify the role of rating agencies in the selection of relevant borrowers. In fact, before the crisis, relevant borrowers were chosen if they either were non-rated or, if rated, had good scores. On the contrary, after the crisis the presence of rating and credit scores become unimportant and relevant borrowers seem to be selected on the basis of a pure lenders' assessment.

The marginal effects of the explanatory variables confirm this picture. Table 8 displays the percentage change that both indexes, RLI and RBI, undergo passing from the 25^{th} to the 75^{th}

distribution percentile of each regressor, before and after the crisis. In general, the main determinants are very similar to those concerning the duration of interbank relationships: Size, Fund Raising, Total Loans, rating, and credit scores. Like Furfine (2001), King (2008), and Angelini et al. (2009), I find that Capital and Bad Loans play a statistically significant yet economically modest role. Mainly, my results show that the length of relationships positively and heavily affects both RLI and RBI, both before and after the crisis.

Furthermore, marginal effects confirm even as economic impact that, after the crisis, healthier banks appear willing to be relevant lenders and troubled banks are not deprived of interbank financing. These outcomes seem to contradict the hypothesis of Acharya, Gromb and Yorulmazer (2008), who conjecture that banks with a liquidity surplus may rationally not provide liquidity to needy banks in the hope to purchase their assets at fire-sale prices, while corroborate the general predictions of the literature on customer relationships.

5. Robustness checks

In addition to the checks described in the previous Sections[17], I tested the robustness of my results in further several ways.[18]

5.1 Left and right censoring

Typical of the kind of analysis, my first step suffers from both left and right censoring, which may cause biased and inconsistent estimations (Heckman and Singer, 1984; Kiefer, 1988). Censoring arises because it is necessary to know the complete history of every relationship in order to identify exactly when it starts (relationships which began prior to the dataset are left-censored) and ends (relationships continuing after the dataset are right-censored). In this regard, it is worth stressing that: the advantage of my dataset is its length and frequency; my results are confirmed when I carry out estimations over different sub-sample periods; and right-censoring should not jeopardize my findings

[17] I refer to: (i) the inclusion of a dummy variable assuming value one when a bank merger occurs, in order to control for relationships terminated because of a merger; (ii) the estimation of φ removing the small relationships, i.e. those under the 10th, 25th and 50th distribution percentile of RBI and RLI; (iii) the alternative measure of RBI and RLI based on the number of interbank relationships rather than on transacted quantities; (iv) the two alternative computations of the variable Relationship Duration (the former obtained removing the smallest exposures; the latter calculated as a ratio between the number of consecutive months and the total number of operative months of each bank); (v) the adoption of fixed and random effects in the second and third step; (vi) the clustering at the borrower and lender level; (vii) the inclusion of a time dummy; (viii) the use of the other three types of credit ratings taken by Fitch; (ix) the removing of the hypothesis that the same rating applies to non-rated banks of the same group. My outcomes are robust to all these checks.

[18] Since results always remained very similar to those reported in Tables 5-8, for brevity, I limit the use of additional tables. However, all robustness checks are available upon request.

because, on the contrary, it should have increased rather than decreased φ in equation (1.2). Nonetheless, I again followed the strategy adopted by Ongena and Smith (2001), and added further checks, in order to assess the sensitivity of my outcomes to the presence of censoring. As for left-censoring, I used two methods: (i) I reran regressions on a wide number of hypothetical new start dates; and (ii) eliminated the left-censored observations. As for right-censoring, I implemented three methods: (i) I expressed the log-likelihood function as a weighted average of the sample density of completed duration spells and the survivor function of uncompleted spells; (ii) I eliminated the right-censored observations; and (iii) I calculated the duration of each relationship by considering it either as ended or not, after one, two, or three months of interruption. In all cases, φ remained smaller than one both on my entire sample period and after the crisis.

5.2 Different baseline hazard functions

In addition to Weibull hazard function, I estimated equations (1.1)-(1.2) using as an alternative baseline hazard function for $\lambda_0(t)$ the log-logistic, which allows non-monotonic duration dependence. Consistently with my main results, this regression showed that interbank relationships are more likely to end in the very early part, but continue to exhibit later negative duration dependence. In any case, both the larger log likelihood and the smaller AIC values confirmed the preference for the Weibull model.

5.3 Controlling for endogeneity: discarding explanatory variables and IV estimations

One concern with the fixed effects estimator used in the second step of my analysis is that the covariates should be strictly exogenous and thus should not depend upon the history of $I_{i,j,t}$ in equation (2.3). To verify the stability of each explanatory variable, and in general to test for possible collinearity, I discarded, in turn, all regressors of the matrixes $K^{L}_{i,t}$, $K^{B}_{j,t}$, and $K^{LB}_{i,j,t}$. Results of this check can be summarized as follows. First, only few regressors exhibit minor stability: there are only three in the RBI (borrowers' variables Size, Capital, and Volatility of Liquidity); and there are only two in the RLI (borrowers' Rating and lenders' Fund Raising).[19] Second, these regressors never switch the statistical significance of their sign. Third, neither their inclusion nor exclusion is apt to affect the other regressors. Fourth, the impression is that the lack of stability of these five variables is not due to an intrinsic weakness, but their different roles before and after the crisis. As a further

[19] In particular, although they were expected to be more liable to endogeneity problems, results were always confirmed for the following variables: Relationship Duration; Liquidity Shocks Correlation; Securities Interaction; borrowers' Rating; Within-Group, and Non-Domestic Net Interbank Position.

robustness check, I employed the IV estimator for several variables. I adopted either a single IV estimator for each variable or a multiple endogenous regression, where for each potential endogenous regressor an instrumental variable is included. As a vector of instruments, I used either the other regressors or the same regressors computed with two-quarter lags. The outcomes were always confirmed.

5.4 Banking group consolidated data

One feature of the Italian banking system is the widespread presence of banking groups. I have already taken this fact into account because: first, my key variables in all steps of my analysis are constructed after eliminating interbank transactions involving banks belonging to the same group; second, I used the Within-Group net-position of each borrower as a control variable. Nevertheless, in order to verify that the composition and the needs of groups do not invalidate my outcomes, I used another, more radical, methodology. I consolidated all the data of banks affiliated in the same groups, thus transforming my bank-by-bank data into group-by-group data. In this way, I reran regressions not for each bank *i* on each other bank *j*, but for each group on each other group. Remarkably, in spite of a drastic reduction of observations and minor changes in coefficients and their significance levels, all outcomes remained stable.

5.5 Changing start dates and spans

In addition to the inclusion of a time dummy, in order to test the sensitivity of my results on different dates and periods, I employed many checks, in particular in the third step. First, I experimented with alternative dates substituting August 2007 as the turning point of the meltdown (e.g. Taylor and Williamson, 2009). I brought forward the outset of the crisis by either one or two months (the idea being that some indicators might have changed earlier); or, in the opposite direction, I postponed the crisis by one, two, three, or four months (the idea being that some indicators might have changed later); moreover, I considered the crisis beginning September 2008 (when the Lehman failure occurred and the financial crisis worsened). Second, in a similar way, I tested the stability of the results of my pre-crisis period, which is much longer in my sample, repeating the exercises on different and shorter pre-crisis sub-sample periods. In particular, I tested the results of my pre- and post-crisis comparison by juxtaposing two periods of the same length, that

is, comparing the last 21 months prior to the critical point with my 21 months long post-crisis period.[20] In all cases, results remained stable.

5.6 Adding explanatory variables

Data at my disposal comprise four extra explanatory variables, which I chose not to display in the tables of all steps of my analysis because their time-series are shorter or available for a much smaller sub-set of banks. The first additional regressor is the month percentage change of the unit price of the quoted banking shares, taken from the Italian Stock Exchange. Its effect turned out to be insignificant; and, on average, there were but 30 listed banks in Italy during my sample period. The second additional regressor is the 5-year-credit default swap obtained from Datastream. Though interesting, this regressor conflicts with the credit rating and is available only for a handful of banks. The third supplementary regressor is made up of interbank interest rates, calculated as monthly averages of daily information drawn from the *e*-MID, a multilateral screen-based trading facility on which banks electronically exchange interbank deposits and loans. Like for my key variables, I am able to know the identity of each borrower and lender, and how much each intermediary pays or receives. Results indicate that borrowing banks, which pay a lower interest rate, rely more on interbank customer relationships. Nonetheless, while my data on quantities cover the whole Italian interbank market, including the over-the counter operations, the data sourced from the *e*-MID regard a small market share. The fourth additional regressor is the ratio between securitized loans and total assets, the idea being that securitizing banks have an additional channel to satisfy their liquidity needs (e.g. Affinito and Tagliaferri, 2010). However, the variable turns out to be not significant.[21] In any case, it must be stressed that the inclusion of these additional variables left unaltered the other results.

5.7 Secured interbank loans

An alternative hypothesis to explain the persistence of interbank relationships after the crisis lies in the possible increase of collateralized interbank transactions.[22] Moreover, the use of collateral

[20] Furthermore, since new Bank of Italy's accounting supervisory reports went into effect as of December 2008, and this could have produced some discontinuities in my time-series, I repeated all estimations by dropping the last few periods of my dataset.

[21] Another way of taking into account of securitized loan has been adding up them to the other loans (the same methodology is used in Albertazzi and Marchetti, 2010; and De Mitri et al, 2010) in two of my regressors: Bad Loans and Total Loans. In fact, because of securitizations, outstanding loans could decrease without an actual reduction in credit granted. However, results of my two variables related to loans remained unmodified after this check.

[22] Actually, if this had been the case, then my variable Relationship Duration should have become insignificant, while it remains statistically and economically significant (on my entire sample time; before; and after the crisis). Nonetheless,

could have affected my findings on other specific covariates.[23] However, this hypothesis seems to be contradicted by the descriptive statistics. As shown in Figure 6, secured interbank exposures – as a share of total interbank domestic between-group exposures – decreased as from 2002, and this development did not change in the post-crisis period.[24] Nevertheless, I further checked this issue running equations (1.1) – (2.3) after splitting the interbank between-group exposures into *unsecured* and *secured* components. Them, I handled in two alternative ways: either I subtracted the secured loans from my dependent variables; or I used the ratio secured/unsecured interbank exposures among my explanatory variables. Results are equivalent in the two cases. Table 9 reports an example of this kind of check for the second and third step. Although the additional variable secured/unsecured interbank exposures is significantly positive, results remain basically unchanged.

5.8 Contemporaneous borrowers and lenders

In my dataset, some pairs of banks lend to, and borrow from, each other at the same time. In order to verify whether such particular relationships depend on specific determinants, I repeated all my exercises without this sub-sample of banks and limiting the analysis on this sub-sample. All results were confirmed. In particular, in the second step limited to this sub-sample, I found that the variable Liquidity Shocks Correlation was always significantly negative, supporting the idea of Cocco et al. (2009) that customer relationships allow these banks to always insure against liquidity risk.

5.9 Outliers and quantile regressions

Results were confirmed when I allowed for outliers in the variables of my dataset, progressively removing 10, 15 and 20% of tail observations. Results were similar even running quantile regressions in all steps of my analysis, though the levels of significance suffered from minor changes. This suggests that the existence and the determinants of interbank customer relationships do not change after different thresholds.

5.10 Cooperative banks and branches of foreign banks

---

allowing for collateralized exposures is useful, because otherwise (although interbank customer relationships continued to exist and banks continued to privilege counterparties with a pre-existing relationship) one might conjecture that, after the outset of the crisis, lending banks started to ask for collateral even to their usual counterparties; or even one might conjecture that interbank customer relationships survived only thanks to an increase of collateral.

[23] For example, an increase of the collateral could explain the sharp irrelevance of rating agencies and borrowers' credit scores after the crisis.

[24] The secured exposures are the interbank assets and liabilities in the form of repos, which are backed exposures by definition.

A set of checks was performed on cooperative banks and branches of foreign banks because these two types of institutions are often regarded as dissimilar from other banks. I either removed both of these banks from all steps of my analysis or in turn one type of them. The results remained stable.[25] Finally, I re-estimated my three steps alternatively on the two types of banks, even though the number of observations became much smaller. The most interesting effect of this check was that φ becomes greater than one, indicating that interbank customer relationships do not exist between pairs of banks which are both cooperative or both foreign, while they exist in all remaining cases.

6. Conclusions

As far as I know, the existence of customer relationships between pairs of banks has never been tested, and is of particular interest given the recent financial crisis. In fact, the literature on customer relationships between banks and firms predicts that lender-banks ensure the availability of credit to borrower-firms mainly during crises or however when these are in difficulty. If the same holds when both borrower and lender are banks, as this paper hypotheses, then one reason why during the crisis between-group domestic interbank exposures in Italy did not decline and banks did not lose mutual trust may be traced back to the existence of interbank customer relationships. This outcome has a relevant policy implication because suggests that mutual confidential knowledge among banks and stable interbank relationships ease redistribution of liquidity among banks even during a crisis.

My empirical analysis demonstrates that in Italy stable and close interbank customer relationships exist, persist over time, and worked well during the recent crisis. Moreover, this paper analyzed the determinants of the duration of interbank customer relationships; and the characteristics of borrowing and lending banks that more rely on interbank customer relationships. The main findings can be summarized as follows.

First, Italian interbank customer relationships are long. My data show that, during a sample period of 11 years, they lasted on average at least 5 consecutive years. The duration of interbank relationships is longer if borrowing banks are illiquid, small, non-rated or well-rated, and if are highly-absorbed by lending activity with firms, households and foreign intermediaries. On the other side, the duration of interbank relationships is longer if lending banks are liquid, well-capitalized,

[25] In the first step, in particular, φ always remained less than one. In the second and third step, the branches of foreign banks were not able to modify the results; whereas the only effect caused by the removal of the cooperative banks was rendering some variables insignificant.

and are less engaged in other kinds of activities. On both borrowing and lending side, the duration of relationships is likely to increase if banks maintain connections with an higher number of counterparties.

Second, relevant interbank borrowers and lenders present inferable characteristics. Relevant interbank borrowers tend to be large-sized and to have high and volatile liquidity needs. Their capitalization is solid; their loan portfolio appears safe; and their business is successful and multifaceted: loans, shares, and non-domestic investments are high. Moreover, when banks are net-lenders inside their domestic group or abroad, the probability of being a relevant interbank borrower increases. Relevant lending banks are not the most liquid banks, have a less amount of loans, shares, and abroad activities and as a consequence they do not need to be highly-capitalized, although have good ratings.

Third, during stable financial times, banks seem to select each other on the basis of observable and testable monitoring factors and indicators; and use the judgments of rating agencies as a means of selection.

Fourth, after the outset of the crisis, however, the presence of rating and the level of credit scores become irrelevant, and borrowing banks seem to be selected on the basis of a preexisting relationship, but not on the basis of observable indicators, which indeed signal situations of difficulty. Moreover, not only the crisis did not hamper interbank customer relationships, but it made healthier banks willing to be relevant interbank lenders, and allowed lenders of relevant borrowers not to deprive their counterparties of interbank loans, outcomes consistent with the literature on bank-firm relationships.

References

Acharya V., D. Gromb and T. Yorulmazer (2008).“Imperfect Competition in the Inter-Bank Market for Liquidity as a Rationale for Central Banking,” working paper, London Business School; CEPR Discussion paper series n. 6984.

Affinito M. and F. Farabullini (2009), “Does the Law of One Price Hold in Euro-Area Retail Banking?,” *International Journal of Central Banking*, 5-1, 5-37.

Affinito M. and E. Tagliaferri (2010), “Why do (or did?) Banks Securitize their Loans? Evidence from Italy,” *Journal of Financial Stability*, 6-4, 189-202.

Albertazzi U. and D. Marchetti (2010), “Credit Supply, Flight to Quality and Evergreening: an Analysis of Bank-Firm Relationships after Lehman, Banca d’Italia Working Papers, 756.

Allen F. and D. Gale (2000). “Financial Contagion,” *Journal of Political Economy*, 108, 1-33.

Allen F. and E. Carletti (2008), “The Role of Liquidity in Financial Crises,” Jackson Hole Symposium on Maintaining Stability in a Changing Financial System, August 21-23, 2008.

Allen F., E. Carletti and D. Gale (2008), “Interbank Market Liquidity and Central Bank Intervention”, *Journal of Monetary Economics*, 56, 639-652.

Angelini P., A. Nobili and M.C. Picillo (2009), “The Interbank Market after August 2007: What has Changed and Why?,” Banca d’Italia Working Papers, 731; forthcoming *Journal of Money, Credit and Banking*.

Arellano M. (1987), “Comparing Robust Standard Errors for Within-Group Estimators”, *Oxford Bulletin of Economics and Statistics*, 49, 431-434.

Ashcraft A.B. and H. Bleakley (2006), “On the Market Discipline of Informationally-Opaque Firms: Evidence from Bank Borrowers in the Federal Funds Market,” *Federal Reserve Bank of New York Staff Reports*, 257.

Berger A.N. (1991), “Market Discipline in Banking,” *Proceedings of a Conference on Bank Structure and Competition*, Federal Reserve Bank of Chicago.

Berger A.N., S.M. Davies, and M.J. Flannery (2000), “Comparing Market and Supervisory Assessments of Bank Performance: Who Knows what when?,” *Journal of Money, Credit, and Banking*, 32, 3, 641-67.

Berger AN. and G.F. Udell (1995), Relationship Lending and Lines of Credit in Small Firm Finance, *Journal of Business* 68, 351–381.

Berglöf E. and E.L. von Thadden (1994), “Short-Term versus Long-Term Interests: Capital Structure with Multiple Investors”, *Quarterly Journal of Economics*, 109, 1055-1084.

Berlin M. and L. Mester (1999), “Deposits and Relationship Lending,” *Review of Financial Studies*, 12, 3, 579-607.

Bhattacharya S. and D. Gale (1987), “Preference Shocks, Liquidity and Central Bank Policy,” in W. Barnett and K. Singleton (eds.), *New Approaches to Monetary Economics*, Cambridge University Press, 69-88.

Bhattacharya S. and P. Fulghieri (1994), “Uncertain Liquidity and Interbank Contracting,” *Economics Letters*, 44, 287-294.

Boot A.W.A. and A.V. Thakor (1994), “Moral Hazard and Secured Lending in an Infinitely Repeated Credit Market Game”, *International Economic Review*, 35, 899-920.

Brunnermeier, M. (2009), “Deciphering the 2007-08 Liquidity and Credit Crunch,” *Journal of Economic Perspectives*.

Cassola N., C. Holthausen and M. Lo Duca (2008), "The 2007/2008 Turmoil: a Challenge for the Integration of the Euro Area Money Market?, European Central Bank, mimeo.

Cocco J.F., F.J. Gomes, N.C. Martins (2009), "Lending Relationships in the Interbank Market," *Journal of Financial Intermediation*, 18, 24–48.

de Haas R. and I. van Lelyveld (2010), "Internal Capital Markets and Lending by Multinational Bank Subsidiaries," *Journal of Financial Intermediation*, 19, 1–25.

Degryse H. and P. van Cayseele (2000), Relationship Lending within a Bank-Based System: Evidence from European Small Business Data, *Journal of Financial Intermediation,* 9, 90–109.

DeYoung R., M.J. Flannery, W.W. Lang and S.M. Sorescu (1998), "The Informational Advantage of Specialized Monitors: The Case of Bank Examiners", Working paper.

De Mitri S., G. Gobbi and E. Sette (2010), "Relationship Lending in a Financial Turmoil", Banca d'Italia Working Papers, 772.

Diamond D. (1991), "Monitoring and Reputation: the Choice between Bank Loans and Privately Placed Debt", *Journal of Political Economy*, 99, 689-721.

Dinger V. and J. von Hagen (2009), "Does Interbank Borrowing Reduce Bank Risk?", *Journal of Money, Credit, and Banking*, 41,2-3, 491-506.

Dudley W. (2008), "May You Live in Interesting Times: The Sequel', Remarks at the Federal Reserve Bank of Chicago's 44th Annual Conference on Bank Structure and Competition, Chicago.

Ferri G. and P. Marullo Reedtz (1989), "Mercato interbancario e gestione degli attivi bancari: tendenze recenti e linee di sviluppo", Banca d'Italia, *Temi di discussione*, 117.

Flannery M., S. Kwan and M. Nimalendran (2004), "Market Evidence on the Opaqueness of Banking Firms' Assets," *Journal of Financial Economics*, 71, 419-460.

Flannery M.J. (1996), "Financial Crises, Payment System Problems, and Discount Window Lending", *Journal of Money, Credit, and Banking*, 28 (4), 804-824.

Freixas X. and J. Jorge (2007), "The Role of Interbank Markets in Monetary Policy: A Model with Rationing", working paper, Universitat Pompeu Fabra.

Freixas X., B. Parigi and J.C. Rochet (2004), "The Lender of Last Resort: A 21th Century Approach", *Journal of the European Economic Association*, 2, 1085-1115.

Freixas X., B. Parigi, and J.C. Rochet (1999), "Systemic Risk, Interbank Relations, and Liquidity Provision by the Central Bank", Working paper, Universitat Pompeu Fabra.

Furfine C.H. (1999), "The Microstructure of the Federal Funds Market", Financial Markets, Institutions and Instruments. Vol. 8., 24-44.

Furfine C.H. (2000), "Interbank Payments and the Daily Federal Funds Rate", *Journal of Monetary Economics*, 46 (2), 535–553.

Furfine C.H. (2001), "Banks as Monitors of Other Banks: Evidence from the Overnight Federal Funds Market," *The Journal of Business*, 74 (1), 33–58.

Furfine C.H. (2002), "The Interbank Market During a Crisis", *European Economic Review*, 46, 809-820.

Furfine C.H. (2004), "Public Disclosures and Calendar-Related Movements in Risk Premiums: Evidence from Interbank Lending*", Journal of Financial Markets*, 7, 97-116.

Furfine C.H. (2009), "The Liquidity of Liquid Markets during the Financial Crisis", mimeo.

Gyntelberg J. and P. Wooldridge (2008), "Interbank Rate Fixings during the Recent Turmoil', BIS Quarterly Review, 59-72.

Heckman J.J. (1978), "Simple Statistical Models for Discrete Panel Data Developed and Applied to Test the Hypothesis of True State Dependence against the Hypothesis of Spurious State Dependence," Annales de l'INSEE, 30/31, 227-269.

Heckman J.J. and B. Singer (1984), "Econometric Duration Analysis", *Journal of Econometrics*, 24, 63-132.

Heider F., M. Hoerova and C. Holthausen (2009), "Liquidity Hoarding and Interbank Market Spreads: The Role of Counterparty Risk", Paper presented at the CEPR-CREI-Journal of Financial Intermediation Conference on the Financial Crisis, Universitat Pompeu Fabra, Barcelona.

Houston J.F., C. James and D. Marcus (1997), "Capital Market Frictions and the Role of Internal Capital Markets in Banking," *Journal of Financial Economics*, 46, 135–164.

Kashyap A., R. Rajan and J. Stein (2002), "Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit-Taking," *Journal of Finance*, 57, 1, 33-73.

Kaufman G.G. (1991), "Lender of last resort: A contemporary perspective. *Journal of Financial Services Research* 5, 95–110.

Kiefer N.M. (1988), "Economic Duration Data and Hazard Functions", Journal of Economic Literature 26, 646-679.

King T.B. (2008), "Discipline and Liquidity in the Interbank Market," *Journal of Money, Banking and Credit*., 40, 2-3, 295-317.

Lummer S.L. and J.J. McConnell (1989), "Further evidence on the bank lending process and the capital-market response to bank loan agreements," *Journal of Financial Economics* 25, 99–122.

Michaud F. and C. Upper (2008), "What Drives Interbank Rates? Evidence from the Libor Panel", BIS Quarterly Review. March, 47-58.

Morgan D. (2002), "Rating Banks: Risk and Uncertainty in an Opaque Industry," *American Economic Review*, 92, 4, 874-888.

Ongena S. and D.C. Smith (2001), "The Duration of Bank Relationships," *Journal of Financial Economics*, 61, 3, 449-75.

Peek J., E.S. Rosengren and G.M.B. Tootell (1999), "Is Bank Supervision Central to Central Banking", *Quarterly Journal of Economics*, 114, 629–653.

Petersen M. and R. Rajan (1994), "The Benefits of Lending Relationships: Evidence from Small Business Data, *Journal of Finance* 49, 1367–1400.

Petersen M. and R. Rajan (1995), "The Effect of Credit Market Competition on Lending Relationships, *Quart. J. Econ.* 110, 406–443.

Porzio C., F. Battaglia, A. Meles and M.G. Starita (2009), "Financial Turmoil and Asymmetric Information Theory: Evidence from E-MID Platform," University of Napoli Parthenope, mimeo.

Rajan R.G. (1992), "Insiders and Outsiders: The Choice between Informed and Arm's-Length Debt," *The Journal of Finance* 47, 1367–1400.

Repullo R. (2005). "Liquidity, Risk Taking, and the Lender of Last Resort," *International Journal of Central Banking,* 1, 47-80.

Rochet, J.C. and J. Tirole (1996), "Interbank Lending and Systemic Risk", *Journal of Money, Credit, and Banking*, 28, 733-762.

Schwartz A.J. (1992), "The Misuse of the Fed's Discount Window", Federal Reserve Bank of St. Louis Review September-October, 58–69.

Taylor J.B. and J. C. Williams (2009), "A Black Swan in the Money Market", *American Economic Journal: Macroeconomics*, 1, pp. 58-83.

Figures and Tables

Table 1. Summary statistics of key variables: duration and strength of interbank customer relationships

Step	Name	Definition	Obs	Mean	Sd.Dev.	Min	25	75	Max
1st (and 3th): duration of interbank customer relationships	Duration or spell: spell that passes before the interbank relationship between each pair of banks ends or breaks	a) Computed as the average of the ongoing duration in each period (*Ts* in equation 1.1)	417,360	28.11	29.09	1	7	41	131
		b) Computed as the average of the final duration of all relationships	417,360	47.63	36.67	1	17	67	131
		c) Computed as the average of the final duration of the longest relationship of each bank	417,360	96.06	40.19	1	61	130	131
2nd (and 3th): strength of interbank customer relationships	RLI - Relevant Lender Index (equation 2.1)	Total loans from each *j* to each *i* / Total interbank loans to each *i*	460,964	0.13	0.27	0	0.01	0.27	1
	RBI - Relevant Borrower Index (equation 2.2)	Total loans from each *i* to each *j* / Total interbank loans from each *i*	460,964	0.19	0.33	0	0.01	0.36	1
2nd (and 3th): strength of interbank customer relationships	Number of lenders	Inverse of the alternative measure of RLI: one / number of banks that *i* borrows from during each period	460,964	8.07	22.46	1	1	5	77
	Number of borrowers	Inverse of the alternative measure of RBI: one / number of banks that *i* lends to during each period	460,964	5.25	12.83	1	1	3	60

Table 2. Relations among key variables

Variables			Number of borrowers	Number of lenders	RBI	RLI	T_S (spell)	
							average	max
Number of borrowers computed as, first the ***total*** number of borrowers for each lender in each period, and then the ***average*** at the same time cross-section and over time		1st quartile	**1**		1		65	103
		2nd quartile	**2**		0.50		53	106
		3rd quartile	**3**		0.33		40	102
		4th quartile	**17.98**		0.12		22	96
Number of lenders computed as, first the ***total*** number of lenders for each borrower in each period, and then the ***average*** at the same time cross-section and over time		1st quartile		**1**		1	60	106
		2nd quartile		**2**		0.50	40	99
		3rd quartile		**4**		0.28	29	86
		4th quartile		**27.58**		0.07	25	93
RBI computed as, first the ***average*** value by lender and period, and then the ***average*** at the same time cross-section and over time		1st quartile	14.30		**0.17**		26	97
		2nd quartile	2		**0.50**		53	106
		3rd quartile	1		**1**		65	103
		4th quartile	1		**1**		65	103
RLI computed as, first the ***average*** value by borrower and period, and then the ***average*** at the same time cross-section and over time		1st quartile		25.60		**0.08**	20	92
		2nd quartile		2.51		**0.43**	35	95
		3rd quartile		1		**1**	60	106
		4th quartile		1		**1**	60	106
T_S (spell)	Average computed as, first the ***final*** duration of each relationship, and then ***average*** of the final duration of all relationships	1st quartile	6.40	8.12	0.43	0.40	**10**	56
		2nd quartile	10.13	14.30	0.47	0.43	**27**	90
		3rd quartile	3.82	6.48	0.76	0.80	**53**	115
		4th quartile	1.37	1.22	0.84	0.91	**101**	124
	Max computed as, first the ***final*** duration of each relationship, and then ***average*** of the final duration of each bank's longest relationship	1st quartile	3.72	6.12	0.65	0.53	17	**35**
		2nd quartile	6.85	9.82	0.52	0.48	41	**93**
		3rd quartile	5.10	8.12	0.69	0.70	66	**129**
		4th quartile	5.10	8.12	0.69	0.70	66	**129**

Figure 1. Interbank loans in Italy

(end-of-month stocks in millions of euros)

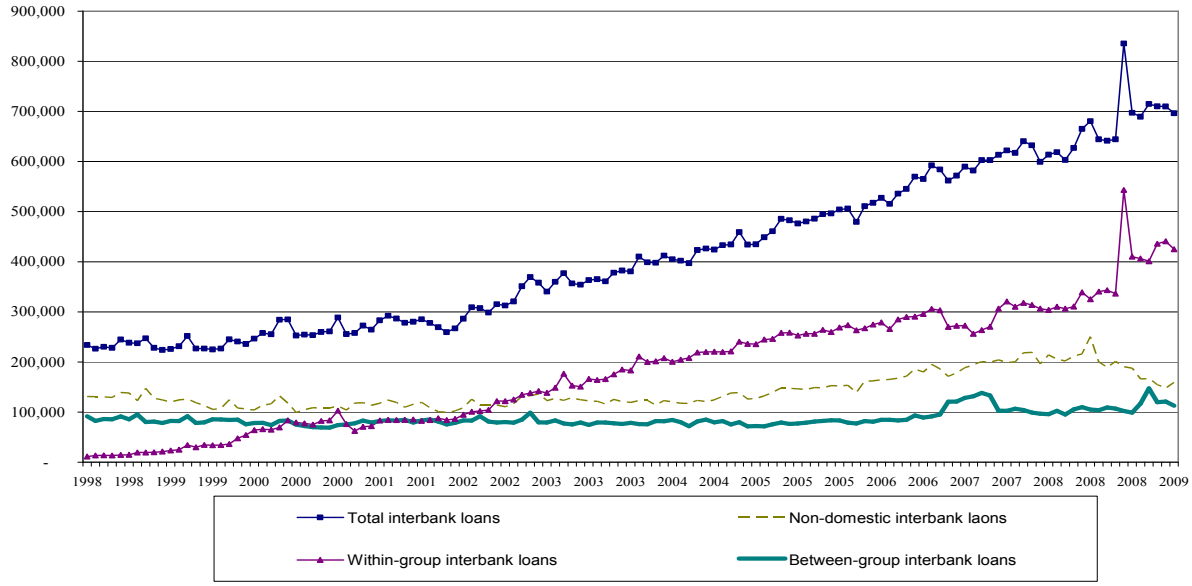


Figure 2. Interbank loans in Italy

(end-of-month percentage share on total assets)

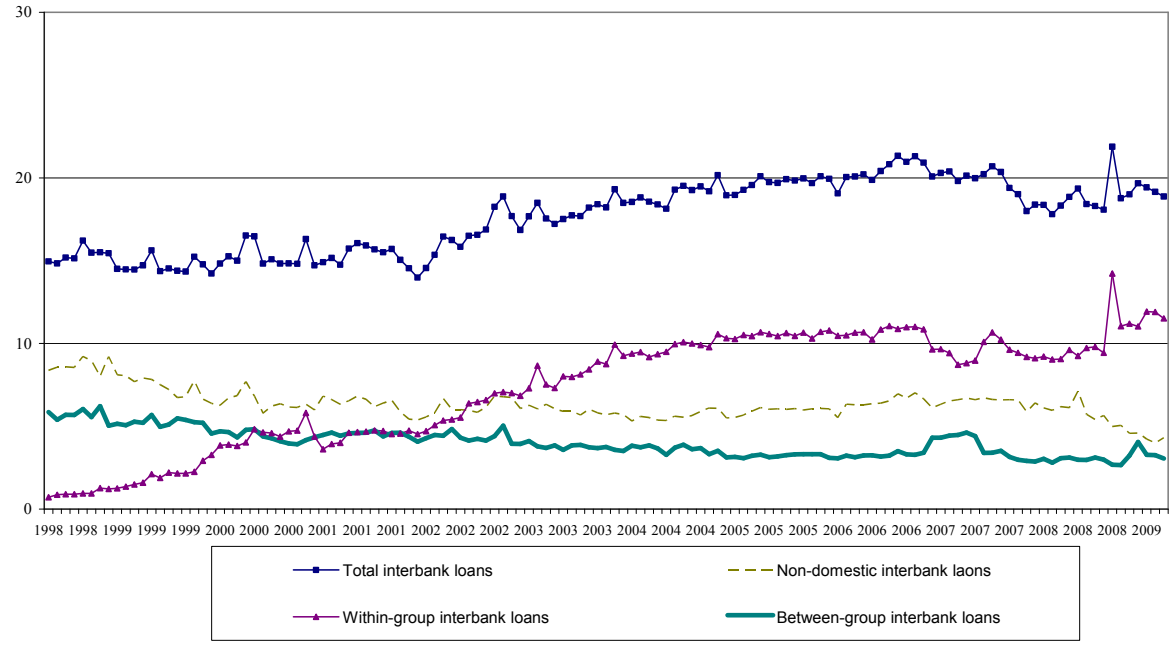


Figure 3. RLI and RBI, computed on end-of-month exposures

(average values in each month)

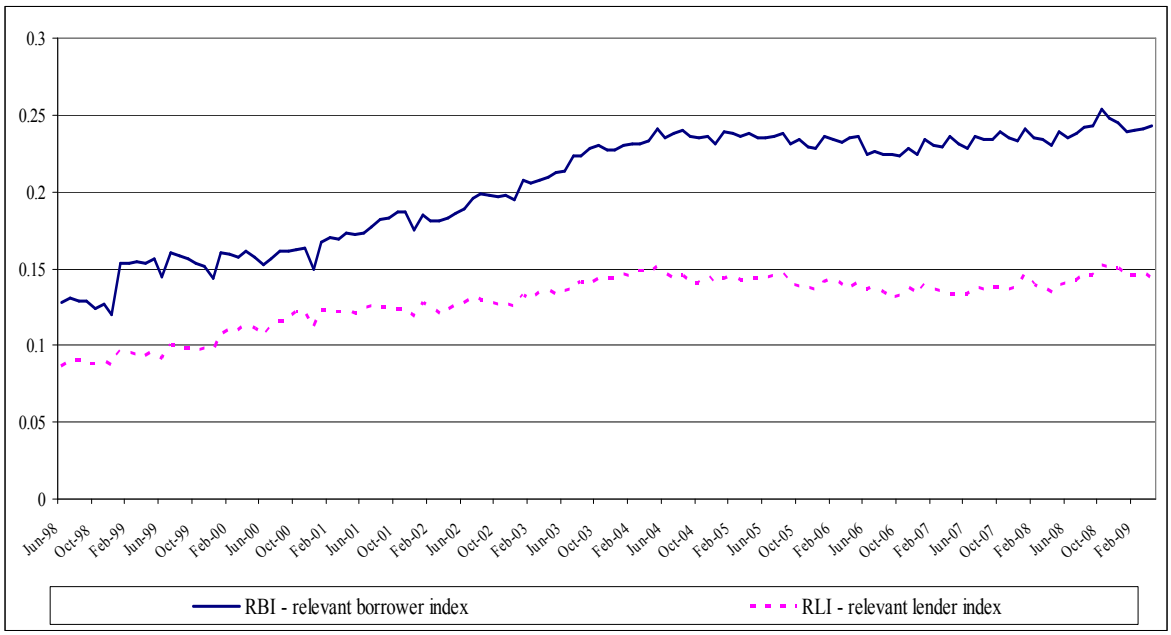


Figure 4. Average number of banks lending to and borrowing from each bank

(average values in each month; equivalent to the inverses of RLI and RBI, computed on the number of relationships)

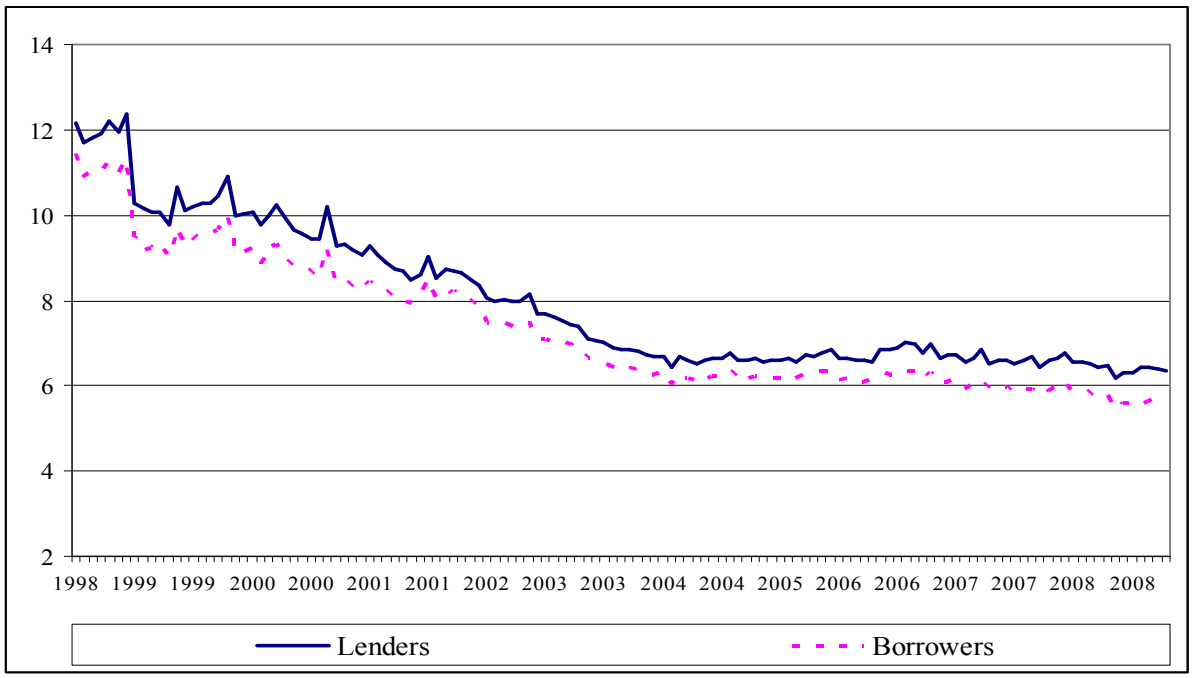
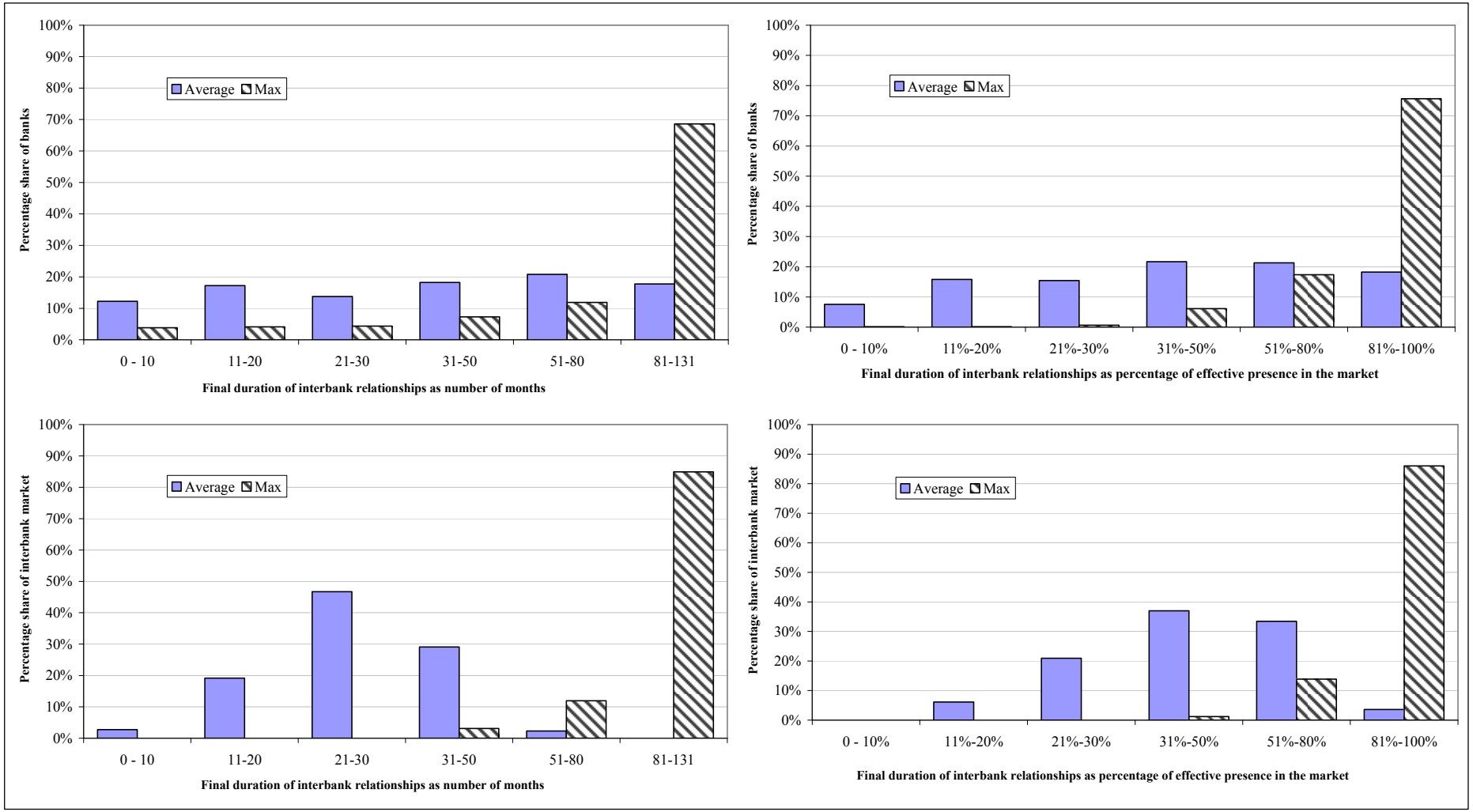


Figure 5. Distribution of *final* duration of interbank customer relationships in my sample



Upper panels report distribution of final duration as percentage shares of number of banks; lower panel as percentage shares of interbank market exposures.
Left side reports duration in terms of number of months; right side as a percentage of the effective presence in the interbank market.

Table 3. Summary statistics of explanatory variables

Type	Name	Definition	Obs	Mean	Sd. Dev.	Min	25	75	Max
borrower									
Agency problems	Size	Log (Total assets)	456,099	8.30	1.92	0	7.11	9.56	12.97
	Capital	Capital / Total assets	453,247	0.09	0.07	0.01	0.05	0.10	1
	Bad loans	Bad loans / Total loans	454,373	0.05	0.09	0	0.01	0.06	1
	Structure of income/Opacity	Non-interest income / Net interest income	439,170	1.41	15.53	0	1.25	1.87	4.60
	Banks without rating (0-1)	Banks without rating (0-1)	460,964	0.51	0.50	0	0	1	1
	Rating	Rating agency scores	385,061	8.29	3.30	2	5	11	11
	ROE	Net profits / Capital	438,081	0.17	11.24	0	0.00	0.05	0.34
Liquidity needs	Funds Raising	Total deposits and bonds / Total assets	456,099	0.49	0.26	0	0.25	0.70	1
	Volatility of Liquidity	Coefficient variation of balance sheet items measuring banking liquidity: deposits, bonds issued, and euro-area Government securities held in portfolio	458,147	0.03	0.03	0	0.01	0.03	0.92
Liquidity motivations	Total loans	Total loans / Total assets	456,099	0.47	0.25	0	0.30	0.65	1
	Non-domestic assets	Non-domestic assets / Total assets	456,099	0.03	0.04	0	0.00	0.03	0.93
	Total shares	Total shares / Total assets	456,099	0.04	0.06	0	0.01	0.05	1
	Within-group interbank net-position	Within-group net interbank position	426,739	0.01	0.25	-1	0.00	0.03	1
	Non-domestic interbank net-position	Non-domestic net interbank position	426,739	-0.07	0.28	-1	0.22	0.04	1
lender									
Lending capacity	Size	Log (Total assets)	458,574	8.36	1.93	0	7.14	9.65	12.97
	Capital	Capital / Total assets	457,340	0.09	0.07	0.01	0.05	0.10	1
	Bad loans	Bad loans / Total loans	456,482	0.05	0.08	0	0.01	0.06	1
	Structure of income/Opacity	Non-interest income / Net interest income	445,772	1.50	15.70	0	1.29	1.88	3.10
	Banks without rating (0-1)	Banks without rating (0-1)	460,964	0.46	0.50	0	0	1	1
	Rating	Rating agency scores	402,523	7.97	3.36	2	5	11	11
	ROE	Net profits / Capital	448,941	0.19	12.76	0	0.00	0.05	0.34
Liquidity provisions	Funds Raising	Total deposits and bonds / Total assets	458,574	0.50	0.25	0	0.29	0.70	1
	Volatility of Liquidity	Coefficient variation of balance sheet items measuring banking liquidity: deposits, bonds issued, and euro-area Government securities held in portfolio	460,915	0.03	0.03	0	0.01	0.03	0.94
Liquidity motivations	Total loans	Total loans / Total assets	458,574	0.47	0.25	0	0.31	0.65	1
	Non-domestic assets	Non-domestic assets / Total assets	458,574	0.03	0.04	0	0.00	0.03	0.91
	Total shares	Total shares / Total assets	458,574	0.04	0.06	0	0.01	0.05	0.95
borrower and lender									
Duration	Lending relationship duration	Number of consecutive months since the start of lending relationship between each pair of banks	460,964	26.21	29.24	1	4	38	131
	Borrowing relationship duration	Number of consecutive months since the start of borrowing relationship between each pair of banks	460,964	26.41	29.61	1	4	38	131
Liquidity	Liquidity shocks correlation	Correlation between the liquidity shocks of each pair of banks	447,448	0.05	0.52	-1	-0.29	0.42	1
Interaction outside the interbank market	Securities Interaction (lender vs.borrower)	Securities held by the lender issued by the borrower / Total securities held by the lender issued by banks	458,574	0.14	0.34	0	0	0.03	1
	Securities Interaction (borrower vs. lender)	Securities held by the borrower issued by the lender / Total securities held by the borrower issued by banks	459,723	0.21	0.40	0	0	0.05	1

Table 4. Explanatory variables: matrixes and effects

Matrix → / ↓ Effect	$K^{B}_{j,t}$ **borrower's regressors**	$K^{L}_{i,t}$ **lender's regressors**	$K^{LB}_{i,j,t}$ **borrower's and lender's regressors**
(1) Persistency			Relationship Duration
(2) Agency problems	Size Capital Bad Loans Opacity Banks without Rating Rating ROE		
(3) Lending capacity		Size Capital Bad Loans Opacity Banks without Rating Rating ROE	
(4) Liquidity situation	Fund Raising Volatility of Liquidity	Fund Raising Volatility of Liquidity	Liquidity Shock Correlation
(5) Liquidity motivations	Total Loans Non-Domestic Assets Total Shares Within-Group Interbank Net-Position Non-Domestic Interbank Net-Position	Total Loans Non-Domestic Assets Total Shares	
(6) Interaction outside the interbank market			Borrower-lender Securities Interaction Lender-borrower Securities Interaction

Table 5. First step: stability and existence of interbank customer relationship

Variables			estimations							marginal effects	
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(6)	(7)
φ			0.576 ***	0.608 ***	0.618 ***	0.626 ***	0.634 ***	0.644 ***	0.638 ***		
			0.003	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.005*		
borrower	Agency problems	Size		1.218 ***	1.163 ***	1.253 ***	1.198 ***	1.178 ***	1.209 ***	-31	-10
				0.007	*0.008*	*0.011*	*0.011*	*0.013*	*0.016*		
		Capital		-0.568 *	-0.543 *	-0.452 **	-0.421 **	-0.111 ***	-0.195 ***	5	5
				0.183	*0.184*	*0.146*	*0.142*	*0.049*	*0.085*		
		Bad loans						0.930 *ns*	0.856 *ns*	ns	ns
								0.142	*0.122*		
		Structure of income/Opacity						-0.998 **	-0.998 **	1	1
								0.001	*0.001*		
		Banks without rating (0-1)				-0.719 ***	-0.797 **	-0.714 ***	-0.673 ***	61	37
						0.070	*0.082*	*0.082*	*0.078*		
		Rating				1.090 ***	1.072 ***	1.077 ***	1.104 ***	-33	-21
						0.016	*0.017*	*0.018*	*0.019*		
		ROE						-0.999 **	-0.999 *	1	1
								0.001	*0.001*		
	Liquidity needs	Funds Raising		6.452 ***	6.749 ***	4.692 ***	5.049 ***	6.154 ***	5.244 ***	-97	-66
				0.541	*0.584*	*0.383*	*0.425*	*0.569*	*0.470*		
		Volatility of Liquidity						5.339 ***	2.972 **	-7	-5
								2.303	*1.285*		
	Liquidity motivations	Total loans		-0.262 ***	-0.295 ***	-0.208 ***	-0.230 ***	-0.142 ***	-0.127 ***	52	37
				0.018	*0.021*	*0.014*	*0.016*	*0.013*	*0.011*		
		Non-domestic assets						0.555 ns	0.132 ns	ns	ns
								0.210	*0.050*		
		Total shares						1.174 ns	0.747 ns	ns	ns
								0.319	*0.207*		
		Within-group interbank net-position						-0.164 ***	-0.206 ***	5	3
								0.010	*0.012*		
		Non-domestic interbank net-position						-0.171 ***	-0.211 ***	44	29
								0.009	*0.012*		
		Number of lenders							-0.991 ***		7
									0.001		
lender	Lending capacity	Size		1.193 ***	1.266 ***	1.145 ***	1.212 ***	1.149 ***	1.305 ***	-11	-8
				0.008	*0.011*	*0.008*	*0.011*	*0.012*	*0.016*		
		Capital		-0.299 ***	-0.103 ***	-0.296 ***	-0.118 ***	-0.021 ***	-0.019 ***	27	17
				0.069	*0.029*	*0.070*	*0.034*	*0.007*	*0.008*		
		Bad loans						3.304 ***	2.379 ***	-3	-2
								0.425	*0.302*		
		Structure of income/Opacity						0.998 ns	0.999 ns	ns	ns
								0.002	*0.001*		
		Banks without rating (0-1)			1.026 ns		1.073 ns	1.488 ***	0.878 ns	2	ns
					0.099		*0.109*	*0.155*	*0.096*		
		Rating			1.055 ***		1.042 ***	0.991 ns	1.095 ***	ns	2
					0.015		*0.015*	*0.015*	*0.017*		
		ROE						-0.996 ***	-0.995 *	1	1
								0.001	*0.004*		
	Liquidity provisions	Funds Raising		-0.511 ***	-0.493 ***	-0.686 ***	-0.662 ***	-0.679 ***	-0.619 ***	47	25
				0.027	*0.028*	*0.039*	*0.039*	*0.046*	*0.041*		
		Volatility of Liquidity						12.591 ***	5.073 ***	-10	-7
								3.380	*1.400*		
	Liquidity motivations	Total loans		2.713 ***	1.878 ***	2.543 ***	1.790 ***	2.969 ***	1.786 ***	-87	-56
				0.151	*0.112*	*0.147*	*0.111*	*0.224*	*0.133*		
		Non-domestic assets						0.977 ns	0.246 ns	ns	ns
								0.369	*0.097*		
		Total shares						24.198 ***	6.850 ***	-21	-15
								7.884	*2.206*		
		Number of borrowers							-0.979 ***		19
									0.001		
borrower & lender	Liquidity	Liquidity shocks correlation		1.069 **	1.047 ns	1.006 ns	0.984 ns	1.023 ns	0.980 ns	ns	ns
				0.035	*0.035*	*0.033*	*0.034*	*0.036*	*0.035*		
	Interaction outside the interbank market	Securities Interaction (borrower vs. lender)		-0.631 ***	-0.605 ***	-0.598 ***	-0.572 ***	-0.590 ***	-0.499 ***	2	1
				0.033	*0.035*	*0.032*	*0.033*	*0.037*	*0.033*		
		Securities Interaction (lender vs. borrower)		-0.527 ***	-0.552 ***	-0.574 ***	-0.593 ***	-0.603 ***	-0.453 ***	1	1
				0.025	*0.026*	*0.030*	*0.031*	*0.035*	*0.027*		
	Counterpart dummies			*yes*	*yes*	*yes*	*yes*	*yes*	*yes*		
	Constant		-0.551 ***	-0.497 ***	-0.481 ***	-0.469 ***	-0.456 ***	-0.439 ***	-0.450 ***		
			0.005	*0.006*	*0.006*	*0.006*	*0.007*	*0.007*	*0.007*		
	Number of observations		417,360	389,585	340,254	317,745	273,197	270,028	249,053		

With regard to estimations, Table 5 reports the signs, hazard ratios, robust standard errors in italics, and statistical significance. Due to the inverse relationship between duration and the hazard rate, a negative sign of regressors indicates a longer duration, and a positive sign implies a shorter duration. With regard to marginal effects, Table reports the change of duration in number of months passing from the 25th to the 75th distribution percentile of each regressor (only for Specification (6) and (7). ***, **, and * denote statistical significance at 1, 5 and 10 % level; ns means not-significant.

Table 6. Second step: strength and determinants

		Variables	RLI								RBI							
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
borrower	Agency problems	Size		-0.024 ***	-0.024 ***	-0.031 ***	-0.028 ***	-0.032 ***	-0.035 ***	-0.034 ***		0.008 ***	0.007 ***	0.006 ***	0.009 ***	0.011 ***	0.008 ***	0.001
				0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*		*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
		Capital		0.209 ***	0.295 ***	0.235 ***	0.294 ***	0.261 ***	0.241 ***	0.210 ***		0.037 ***	0.023 **	0.015	0.026 ***	0.058 ***	0.019 *	-0.017
				0.010	*0.011*	*0.012*	*0.011*	*0.013*	*0.012*	*0.014*		*0.009*	*0.009*	*0.010*	*0.009*	*0.012*	*0.010*	*0.015*
		Bad loans						0.044 ***		0.037 ***						-0.069 ***		-0.052 ***
								0.008		*0.008*						*0.007*		*0.008*
		Structure of income/Opacity						-0.001 ***		-0.001 ***						-0.001		-0.001
								0.000		*0.000*						*0.000*		*0.000*
		Banks without rating (0-1)				-0.061 ***		-0.066 ***	-0.058 ***	-0.063 ***					-0.031 ***	-0.028 ***	-0.030 ***	-0.033 ***
						0.003		*0.003*	*0.003*	*0.004*					*0.003*	*0.003*	*0.004*	*0.004*
		Rating				0.001 *		0.001 **	0.000	0.000					0.003 ***	0.002 ***	0.004 ***	0.005 ***
						0.001		*0.001*	*0.001*	*0.001*					*0.000*	*0.000*	*0.001*	*0.001*
		ROE						0.000		0.000						0.000		0.000
								0.000		*0.000*						*0.000*		*0.000*
	Liquidity needs	Fund Raising			0.089 ***	0.067 ***	0.087 ***	0.054 ***	0.063 ***	0.064 ***			-0.059 ***	-0.068 ***	-0.030 ***	-0.023 ***	-0.038 ***	-0.038 ***
					0.003	*0.003*	*0.003*	*0.004*	*0.004*	*0.004*			*0.003*	*0.003*	*0.003*	*0.003*	*0.003*	*0.004*
		Volatility of Liquidity						-0.072 ***		-0.083 ***						0.013		0.019 *
								0.010		*0.011*						*0.009*		*0.011*
	Liquidity motivations	Total loans			0.103 ***	0.073 ***	0.094 ***	0.061 ***	0.066 ***	0.054 ***			0.020 ***	0.020 ***	0.005 *	0.023 ***	0.005 *	0.021 ***
					0.003	*0.003*	*0.003*	*0.003*	*0.003*	*0.003*			*0.003*	*0.003*	*0.003*	*0.003*	*0.003*	*0.003*
		Non-domestic assets						-0.153 ***		-0.139 ***						0.077 ***		0.048 ***
								0.011		*0.012*						*0.011*		*0.012*
		Total shares						-0.174 ***		-0.166 ***						0.038 ***		0.029 ***
								0.009		*0.009*						*0.008*		*0.010*
		Within-group interbank net-position								-0.040 ***								0.010 ***
										0.002								*0.002*
		Non-domestic interbank net-position								-0.035 ***								0.007 ***
										0.001								*0.001*
lender	Lending capacity	Size		0.013 ***	0.010 ***	0.015 ***	0.008 ***	0.017 ***	0.014 ***	0.019 ***		-0.056 ***	-0.055 ***	-0.066 ***	-0.048 ***	-0.051 ***	-0.055 ***	-0.051 ***
				0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*		*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
		Capital		-0.029 ***	-0.033 ***	-0.023 ***	-0.049 ***	-0.016 ***	-0.039 ***	-0.055 ***		0.067 ***	0.095 ***	0.117 ***	0.128 ***	0.087 ***	0.146 ***	0.119 ***
				0.005	*0.005*	*0.006*	*0.005*	*0.006*	*0.006*	*0.007*		*0.006*	*0.006*	*0.006*	*0.006*	*0.006*	*0.006*	*0.007*
		Bad loans								0.027 ***								-0.112 ***
										0.007								*0.009*
		Structure of income/Opacity								0.000								0.000
										0.000								*0.000*
		Banks without rating (0-1)					0.023 ***		0.024 ***	0.027 ***				-0.025 ***			-0.028 ***	-0.021 ***
							0.003		*0.003*	*0.004*				*0.004*			*0.003*	*0.004*
		Rating					-0.007 ***		-0.006 ***	-0.006 ***				-0.005 ***			-0.005 ***	-0.006 ***
							0.000		*0.001*	*0.001*				*0.001*			*0.001*	*0.001*
		ROE								0.000								0.000
										0.000								*0.000*
	Liquidity provisions	Fund Raising			-0.004	-0.005	-0.007 **	-0.004	-0.010 ***	-0.007 *			-0.029 ***	-0.034 ***	-0.040 ***	-0.012 ***	-0.045 ***	-0.054 ***
					0.003	*0.003*	*0.003*	*0.004*	*0.004*	*0.004*			*0.003*	*0.004*	*0.003*	*0.003*	*0.004*	*0.004*
		Volatility of Liquidity						-0.032 ***		-0.073 ***						0.044 ***		0.065 ***
								0.011		*0.012*						*0.013*		*0.016*
	Liquidity motivations	Total loans			-0.014 ***	-0.009 ***	-0.008 ***		-0.005 *	-0.006 *			0.090 ***	0.073 ***	0.120 ***		0.101 ***	0.091 ***
					0.002	*0.003*	*0.002*		*0.003*	*0.003*			*0.003*	*0.003*	*0.003*		*0.003*	*0.003*
		Non-domestic assets								-0.076 ***								-0.064 ***
										0.011								*0.011*
		Total shares								-0.023 **								-0.117 ***
										0.011								*0.011*
borrower & lender	Duration	Relationship duration	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***
			0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	Liquidity	Liquidity shocks correlation	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	-0.001 ***	-0.001 ***	-0.001 ***	-0.002 ***	-0.002 ***	-0.002 ***	-0.002 ***	-0.003 ***
			0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	*0.000*	*0.000*	*0.000*	*0.001*	*0.000*	*0.000*	*0.001*	*0.001*
	Interaction outside the interbank market	Securities Interaction (borrower vs. lender)	0.034 ***	0.027 ***	0.028 ***	0.020 ***	0.025 ***		0.017 ***	0.016 ***	-0.005 ***	-0.003 **	-0.007 ***	-0.009 ***	-0.003 ***		-0.005 ***	-0.007 ***
			0.001	*0.001*	*0.001*	*0.001*	*0.001*		*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*		0.001	*0.001*
		Securities Interaction (lender vs. borrower)	0.004 ***	0.004 ***	0.003 ***	0.005 ***	0.004 ***	0.005 ***	0.006 ***	0.005 ***	0.035 ***	0.024 ***	0.021 ***	0.019 ***	0.036 ***	0.037 ***	0.031 ***	0.031 ***
			0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
		Counterpart dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
		constant	0.076	0.192	0.116	0.223	0.280 **	0.252 **	-0.281	0.288 **	-0.001	-0.140	-0.146	0.750 ***	0.187	0.030	0.540 ***	0.484 ***
			30.3	*0.1*	*0.1*	*59.4*	*0.1*	*-0.1*	*77.5*	*0.1*	*32.5*	*27.7*	*27.6*	*0.1*	*45.5*	*0.1*	*0.1*	*0.1*
		Number of observations	405,520	399,964	399,964	326,123	348,944	313,517	280,165	253,200	444,335	438,232	438,232	381,688	364,682	345,024	313,379	277,541
		R-sq	0.15	0.16	0.16	0.19	0.16	0.19	0.19	0.20	0.27	0.28	0.28	0.30	0.20	0.20	0.21	0.21

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

Table 7: Third step: over the crisis - statistical significance

		RLI			RBI		
		Total period	pre-crisis	post-crisis	Total period	pre-crisis	post-crisis
borrower							
Agency problems	Size	-0.034 ***	-0.033 ***	-0.052 ***	0.001	0.003 **	-0.004
		0.001	*0.001*	*0.008*	*0.001*	*0.001*	*0.007*
	Capital	0.210 ***	0.243 ***	-0.154 *	-0.017	-0.002	-0.005
		0.014	*0.015*	*0.091*	*0.015*	*0.016*	*0.083*
	Bad loans	0.037 ***	0.040 ***	0.077	-0.052 ***	-0.045 ***	-0.117 **
		0.008	*0.008*	*0.048*	*0.008*	*0.008*	*0.047*
	Structure of income/Opacity	0.000 ***	0.000	0.000	0.000	0.000	-0.001 ***
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	Banks without rating (0-1)	-0.063 ***	-0.063 ***	-0.019	-0.033 ***	0.012 ***	-0.018
		0.004	*0.004*	*0.028*	*0.004*	*0.004*	*0.025*
	Rating	0.000	0.000	0.008 **	0.005 ***	-0.002 ***	0.005
		0.001	*0.001*	*0.004*	*0.001*	*0.001*	*0.003*
	ROE	0.000	0.000	-0.025 *	0.000	0.000	0.032 ***
		0.000	*0.000*	*0.013*	*0.000*	*0.000*	*0.011*
Liquidity needs	Fund Raising	0.064 ***	0.031 ***	0.261 ***	-0.038 ***	-0.040 ***	-0.049 ***
		0.004	*0.004*	*0.021*	*0.004*	*0.004*	*0.015*
	Volatility of Liquidity	-0.083 ***	-0.077 ***	-0.110 ***	0.019 *	0.034 ***	0.029
		0.011	*0.012*	*0.024*	*0.011*	*0.012*	*0.024*
Liquidity motivations	Total loans	0.054 ***	0.055 ***	-0.066 ***	0.021 ***	0.041 ***	-0.003
		0.003	*0.004*	*0.020*	*0.003*	*0.004*	*0.016*
	Non-domestic assets	-0.166 ***	-0.158 ***	-0.209 ***	0.029 ***	0.026 **	0.085 **
		0.009	*0.010*	*0.044*	*0.010*	*0.010*	*0.039*
	Total shares	-0.139 ***	-0.135 ***	-0.111 *	0.048 ***	-0.003	0.068
		0.012	*0.013*	*0.057*	*0.012*	*0.014*	*0.047*
	Within-group interbank net-position	-0.040 ***	-0.037 ***	-0.134 ***	0.010 ***	0.009 ***	0.018 ***
		0.002	*0.002*	*0.008*	*0.002*	*0.002*	*0.006*
	Non-domestic interbank net-position	-0.035 ***	-0.031 ***	-0.089 ***	0.007 ***	0.002	0.030 ***
		0.001	*0.002*	*0.005*	*0.001*	*0.002*	*0.004*
lender							
Lending capacity	Size	0.019 ***	0.011 ***	0.057 ***	-0.051 ***	-0.050 ***	-0.102 ***
		0.001	*0.001*	*0.008*	*0.001*	*0.001*	*0.008*
	Capital	-0.055 ***	-0.061 ***	0.131 *	0.119 ***	0.125 ***	-0.322 ***
		0.007	*0.007*	*0.068*	*0.007*	*0.007*	*0.069*
	Bad loans	0.027 ***	0.026 ***	0.197 ***	-0.112 ***	-0.104 ***	0.020
		0.007	*0.007*	*0.053*	*0.009*	*0.009*	*0.042*
	Structure of income/Opacity	0.000	0.001 ***	-0.001 ***	0.000	-0.001 ***	0.000
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	Banks without rating (0-1)	0.027 ***	0.019 ***	-0.118 ***	-0.021 ***	-0.022 ***	-0.152 ***
		0.004	*0.004*	*0.032*	*0.004*	*0.004*	*0.030*
	Rating	-0.006 ***	-0.005 ***	0.017 ***	-0.006 ***	-0.004 ***	0.004
		0.001	*0.001*	*0.004*	*0.001*	*0.001*	*0.004*
	ROE	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	*0.000*	*0.005*	*0.000*	*0.000*	*0.012*
Liquidity provisions	Funds Raising	-0.007 *	-0.009 **	0.045 **	-0.054 ***	-0.044 ***	-0.117 ***
		0.004	*0.004*	*0.021*	*0.004*	*0.004*	*0.020*
	Volatility of Liquidity	-0.073 ***	-0.047 ***	-0.176 ***	0.065 ***	0.045 ***	0.345 ***
		0.012	*0.013*	*0.036*	*0.016*	*0.016*	*0.055*
Liquidity motivations	Total loans	-0.006 *	0.002	0.120 ***	0.091 ***	0.100 ***	0.000
		0.003	*0.003*	*0.021*	*0.003*	*0.004*	*0.020*
	Non-domestic assets	-0.023 **	-0.018 *	-0.078	-0.117 ***	-0.088 ***	-0.156 ***
		0.011	*0.011*	*0.052*	*0.011*	*0.011*	*0.042*
	Total shares	-0.076 ***	-0.036 ***	-0.189 ***	-0.064 ***	-0.094 ***	-0.080
		0.011	*0.012*	*0.053*	*0.011*	*0.012*	*0.050*
borrower and lender							
Duration	Relationship duration	0.001 ***	0.001 ***	0.000 ***	0.001 ***	0.001 ***	0.001 ***
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Liquidity	Liquidity shocks correlation	0.006 ***	0.005 ***	0.007 ***	-0.003 ***	-0.002 ***	-0.002
		0.001	*0.001*	*0.002*	*0.001*	*0.001*	*0.002*
Interaction outside the interbank market	Securities Interaction (borrower vs. lender)	0.016 ***	0.007 ***	0.009 *	-0.007 ***	0.003 **	0.002
		0.001	*0.001*	*0.005*	*0.001*	*0.002*	*0.004*
	Securities Interaction (lender vs. borrower)	0.005 ***	0.006 ***	0.014 ***	0.031 ***	0.034 ***	-0.008 **
		0.001	*0.002*	*0.004*	*0.001*	*0.002*	*0.004*
Counterpart dummies		yes	yes	yes	yes	yes	yes
constant		0.288 **	0.275 **	-0.240	0.484 ***	0.442 ***	0.962 ***
		0.122	*0.117*	*0.159*	*0.133*	*0.126*	0.161
Number of observations		253,200	219,325	33,875	277,541	232,574	44,967
R-sq		0.20	0.17	0.16	0.21	0.12	0.37

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

Table 8. Third step: over the crisis - marginal effects

		RLI		RBI	
		pre-crisis	post-crisis	pre-crisis	post-crisis
		0.112	0.179	0.131	0.222
borrower					
Agency problems	Size	-35.9	-35.2	20.9	n.s.
	Capital	15.5	-5.5	n.s.	n.s.
	Bad loans	0.0	n.s.	0.0	-0.5
	Structure of income/Opacity	n.s.	n.s.	n.s.	-0.1
	Banks without rating (0-1)	-45.1	n.s.	15.7	n.s.
	Rating	n.s.	39.2	-10.2	n.s.
	ROE	n.s.	-1.1	n.s.	0.1
Liquidity needs	Funds Raising	14.4	18.8	-23.8	-21.7
	Volatility of Liquidity	-1.8	-1.7	0.8	n.s.
Liquidity motivations	Total loans	30.5	-14.0	3.7	n.s.
	Non-domestic assets	-5.9	-5.9	1.5	5.2
	Total shares	-3.4	-2.2	n.s.	n.s.
	Within-group interbank net-position	-0.9	-2.2	0.1	0.5
	Non-domestic interbank net-position	-6.9	-11.2	n.s.	7.6
lender					
Lending capacity	Size	15.4	24.7	-58.8	-64.6
	Capital	-1.8	1.1	5.6	-4.8
	Bad loans	0.0	1.1	-4.4	n.s.
	Structure of income/Opacity	0.1	-0.1	-0.1	n.s.
	Banks without rating (0-1)	29.2	-3.4	-16.8	-43.4
	Rating	-17.1	4.4	-18.8	n.s.
	ROE	n.s.	n.s.	n.s.	n.s.
Liquidity provisions	Funds Raising	-14.8	2.7	-9.4	-17.1
	Volatility of Liquidity	-0.9	-0.6	0.8	2.7
Liquidity motivations	Total loans	n.s.	17.0	29.8	n.s.
	Non-domestic assets	-4.6	n.s.	-3.0	-3.5
	Total shares	-0.9	-2.7	-2.3	n.s.
borrower and lender					
Duration	Relationship duration	20.5	3.1	13.4	16.6
Liquidity	Liquidity shocks correlation	2.7	1.1	-1.5	ns
Interaction outside the interbanki market	Securities Interaction (borrower vs. lender)	0.1	0.1	0.1	ns
	Securities Interaction (lender vs.borrower)	0.0	0.0	0.1	-0.1

Table displays the percentage change that indexes RLI and RBI undergo passing from the 25th to the 75th distribution percentile of each regressor, before and after the crisis.

Figure 6. Secured interbank loans

(as a share of total interbank domestic between-group exposures)

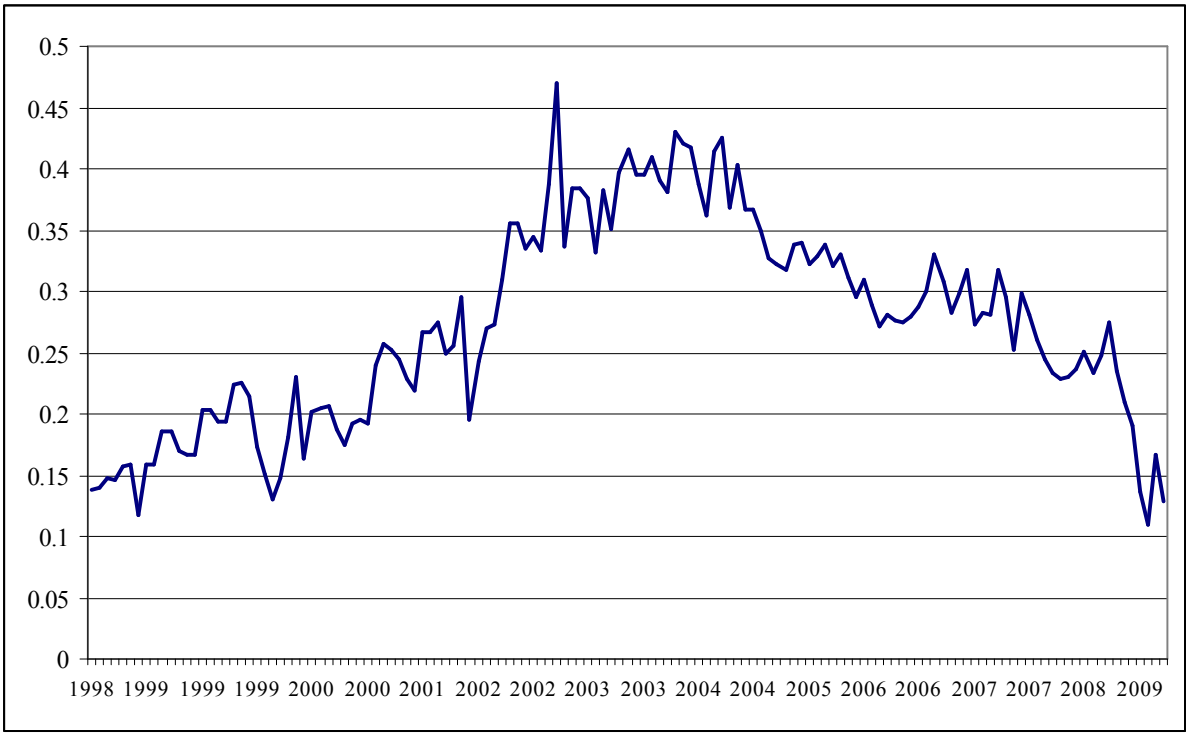


Table 9: Allowing for secured interbank loans

		RLI		RBI	
		pre-crisis	post-crisis	pre-crisis	post-crisis
borrower					
Agency problems	Size	-0.031 ***	-0.053 ***	0.001	0.001
		0.001	*0.008*	*0.001*	*0.007*
	Capital	0.238 ***	-0.136 *	-0.021	0.002
		0.014	*0.088*	*0.015*	*0.082*
	Bad loans	0.047 ***	-0.005	-0.038 ***	-0.102 **
		0.008	*0.047*	*0.008*	*0.046*
	Structure of income/Opacity	0.000	0.000	0.000	-0.001 *
		0.000	*0.000*	*0.000*	*0.000*
	Banks without rating (0-1)	-0.059 ***	0.025	0.008 **	0.006
		0.004	*0.027*	*0.004*	*0.025*
	Rating	-0.001	0.002 *	-0.001 **	0.002
		0.001	*0.001*	*0.001*	*0.003*
	ROE	0.000	-0.027 **	0.000	0.036 ***
		0.000	*0.013*	*0.000*	*0.011*
Liquidity needs	Fund Raising	0.019 ***	0.248 ***	-0.045 ***	-0.041 ***
		0.004	*0.020*	*0.004*	*0.015*
	Volatility of Liquidity	-0.084 ***	-0.095 ***	0.007 *	0.025
		0.011	*0.024*	*0.004*	*0.024*
Liquidity motivations	Total loans	0.061 ***	-0.062 ***	0.047 ***	-0.009
		0.003	*0.020*	*0.004*	*0.016*
	Non-domestic assets	-0.121 ***	-0.152 ***	0.053 **	0.098 **
		0.012	*0.055*	*0.010*	*0.038*
	Total shares	-0.153 ***	-0.118 ***	-0.007	0.026
		0.009	*0.043*	*0.013*	*0.046*
	Within-group interbank net-position	-0.035 ***	-0.138 ***	0.009 ***	0.018 ***
		0.002	*0.008*	*0.002*	*0.006*
	Non-domestic interbank net-position	-0.027 ***	-0.090 ***	-0.002	0.027 ***
		0.001	*0.005*	*0.002*	*0.004*
lender					
Lending capacity	Size	0.011 ***	0.049 ***	-0.046 ***	-0.102 ***
		0.001	*0.008*	*0.001*	*0.008*
	Capital	-0.059 ***	0.099 *	0.126 ***	-0.320 ***
		0.006	*0.066*	*0.007*	*0.067*
	Bad loans	0.031 ***	0.198 ***	-0.091 ***	0.003
		0.007	*0.051*	*0.009*	*0.041*
	Structure of income/Opacity	0.001 **	-0.001 **	-0.001 ***	0.000
		0.000	*0.000*	*0.000*	*0.000*
	Banks without rating (0-1)	0.011 ***	-0.076 ***	-0.019 ***	-0.130 ***
		0.004	*0.031*	*0.004*	*0.029*
	Rating	-0.003 ***	0.011 ***	-0.005 ***	-0.001
		0.001	*0.004*	*0.001*	*0.004*
	ROE	0.000	-0.001	0.000	-0.001
		0.000	*0.005*	*0.000*	*0.012*
Liquidity provisions	Funds Raising	-0.009 **	0.035 *	-0.039 ***	-0.128 ***
		0.004	*0.020*	*0.004*	*0.019*
	Volatility of Liquidity	-0.083 ***	-0.174 ***	0.031 **	0.326 ***
		0.012	*0.035*	*0.015*	*0.054*
Liquidity motivations	Total loans	0.006 *	0.115 ***	0.096 ***	0.006
		0.003	*0.021*	*0.004*	*0.020*
	Non-domestic assets	-0.012 *	-0.035	-0.099 ***	-0.158 ***
		0.010	*0.050*	*0.012*	*0.042*
	Total shares	-0.033 ***	-0.108 ***	-0.077 ***	-0.062
		0.011	*0.051*	*0.011*	*0.049*
borrower and lender					
Duration	Relationship duration	0.001 ***	0.000 ***	0.001 ***	0.001 ***
		0.000	*0.000*	*0.000*	*0.000*
Liquidity	Liquidity shocks correlation	0.005 ***	0.005 ***	-0.003 ***	-0.002
		0.001	*0.002*	*0.001*	*0.002*
Interaction outside the interbank market	Securities Interaction (borrower vs. lender)	0.007 ***	0.011 **	0.004 **	0.005
		0.001	*0.005*	*0.001*	*0.004*
	Securities Interaction (lender vs. borrower)	0.006 ***	0.012 ***	0.034 ***	-0.010 **
		0.001	*0.004*	*0.002*	*0.004*
Garantees	Secured / unsecured interbank loans	0.809 ***	0.609 ***	0.731 ***	0.742 ***
		0.006	*0.013*	*0.005*	*0.017*
Counterpart dummies		yes	yes	yes	yes
constant		0.226 **	-0.170	0.431 ***	1.012 ***
		0.015	*0.111*	*0.120*	*0.158*
Number of observations		219,325	33,875	232,574	44,967
R-sq		0.23	0.21	0.20	0.40

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