BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers

No 417

Relationship and Transaction Lending in a Crisis

by Patrick Bolton, Xavier Freixas, Leonardo Gambacorta and Paolo Emilio Mistrulli

Monetary and Economic Department

July 2013

JEL classification: E44, G21

Keywords: Relationship Banking, Transaction Banking, Crisis

BIS Working Papers are written by members of the Monetary and Economic Department of the Bank for International Settlements, and from time to time by other economists, and are published by the Bank. The papers are on subjects of topical interest and are technical in character. The views expressed in them are those of their authors and not necessarily the views of the BIS.

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)

ISBN 1682-7678 (online)

Relationship and Transaction Lending in a Crisis

Patrick Bolton* Xavier Freixas† Leonardo Gambacorta‡ Paolo Emilio Mistrulli§

Abstract

We study how relationship lending and transaction lending vary over the business cycle. We develop a model in which relationship banks gather information on their borrowers, which allows them to provide loans for profitable firms during a crisis. Due to the services they provide, operating costs of relationship-banks are higher than those of transaction-banks. In our model, where relationship-banks compete with transaction-banks, a key result is that relationship-banks charge a higher intermediation spread in normal times, but offer continuation-lending at more favorable terms than transaction banks to profitable firms in a crisis. Using detailed credit register information for Italian banks before and after the Lehman Brothers' default, we are able to study how relationship and transaction-banks responded to the crisis and we test existing theories of relationship banking. Our empirical analysis confirms the basic prediction of the model that relationship banks charged a higher spread before the crisis, offered more favorable continuation-lending terms in response to the crisis, and suffered fewer defaults, thus confirming the informational advantage of relationship banking.

JEL: E44, G21

Keywords: Relationship Banking, Transaction Banking, Crisis

*Columbia University, NBER and CEPR.

†Universitat Pompeu Fabra, Barcelona Graduate School of Economics and CEPR.

‡Bank for International Settlements.

§Banca d'Italia.

1 Introduction[1]

What is the role of banks in the real economy? Beyond providing loans to firms and households, commercial banks have long been thought to play a larger role than simply that of screening loan applicants one transaction at a time. By building a relationship with the firms they lend to, banks can also play a continuing role of managing firms' financial needs as they arise, in response to either new investment opportunities or to a crisis. What determines whether a bank and a firm should seek to build a long-term relationship, or whether they should simply seek to engage in a one-off transaction? Or, equivalently, how do relationship loans differ from transaction loans? We address these questions from both a theoretical and an empirical perspective.

Relationship banking can take many forms. Moreover, in developed financial markets firms have many options available to them and can choose any combination of cheaper transaction borrowing and more expensive relationship banking that best suits their risk characteristics. Obviously, a firm will only choose the more expensive relationship-banking option if the services it obtains from the relationship bank are sufficiently valuable. Accordingly, the question arises of what type of benefits the firm obtains from a banking relationship, and how these benefits shape the choice between transaction and relationship banking.

The first models on relationship banking portray the relationship between the bank and the firm in terms of an early phase during which the bank acquires information about the borrower, and a later phase during which it exploits its *information monopoly* position (Sharpe 1990). While these first-generation models provide an analytical framework describing how the long-term relationship between a bank and a firm might play out, they do not

[1] We would like to thank Claudio Borio, Lars Norden, Greg Udell and in particular two anonymous referees for comments and suggestions. The opinions expressed in this paper are those of the authors only and do not necessarily reflect those of the Bank of Italy or the Bank for International Settlements. Support from 07 Ministerio de Ciencia e Innovación, Generalitat de Catalunya, Barcelona GSE, Ministerio de Economía y Competitividad) - ECO2008-03066, Banco de España-Excelencia en Educación-"Intermediación Financiera y Regulación" is gratefully acknowledged. This study was in part developed while Paolo Emilio Mistrulli was ESCB/IO expert in the Financial Research Division at the European Central Bank.

consider a firm's choice between transaction lending and relationship banking and which types of firms are likely to prefer one form of borrowing over the other.

The second-generation papers on relationship banking that consider this question and that have been put to the data focus on three different and interconnected roles for a relationship bank (or $R-$bank for short): *insurance, monitoring* and *screening*. The literature emphasizes these last three roles differently, with a first strand focusing more on the (implicit) insurance role of R-banks (for future access to credit and future credit terms) (Berger and Udell, 1992; Berlin and Mester 1999); a second strand underscoring more the monitoring role of $R-$banks (Holmstrom and Tirole 1997, Boot and Thakor 2000, Hauswald and Marquez 2000); and a third strand playing up the greater screening abilities (of new loan applications) of R-banks due to their access to both hard and soft information about the firm (Agarwal and Hauswald 2010, Puri et al. 2010).

A fourth somewhat distinct role of relationship banks, which we center on in this paper, is *learning* about borrower's type over time. This role is closer to the one emphasized in the original contributions by Rajan(1992) and Von Thadden(1995), and puts the $R-$bank in the position of offering continuation lending terms that are better adapted to the specific circumstances in which the firm may find itself in the future. The model of relationship-lending we develop here builds on Bolton and Freixas (2006), which considers firms' choice of the optimal mix of financing between borrowing from an $R-$bank and issuing a corporate bond. Most firms in practice are too small to be able to tap into the corporate bond market, and the choice between issuing a corporate bond or borrowing from a bank is not really relevant to them. However, as we know from Detragiache, Garella and Guiso (2000) and others,[2] these firms do have a choice between multiple sources of bank lending, and in particular they have a choice between building a banking relationship (by borrowing from an $R-$bank) or simply seeking a loan on a one-off basis from a transaction lender (or $T-$bank for short). Accordingly, we modify the model of Bolton and Freixas (2006) to allow for a choice between borrowing from an $R-$bank or a $T-$bank (or a combination of the two). The other key

[2] Our model thus also relates to the rich literature on firms' choice of the number of banks they deal with (Houston and James, 1996; Farinha and Santos, 2002; Detragiache, Garella and Guiso, 2000). This literature, typically does not distinguish between M or $T-$banks and mainly considers the diversification benefits of relying on multiple bank funding sources.

modification of the Bolton and Freixas (2006) model is to introduce aggregate business-cycle risk, to allow firms to differ in their exposure to this risk, and to consider how the response of $R-$banks to a crisis differs from that of $T-$banks.

The main predictions emerging from the theoretical analysis are that firms will generally seek a mix of $R-$banking and $T-$banking in an effort to reduce their cost of borrowing. Mainly, the firms relying on $R-$banking are the ones that are more exposed to business-cycle risk and that have the riskier cash flows. These firms are prepared to pay higher borrowing costs on their relationship loans in order to secure better continuation financing terms in a crisis. The firms relying on a banking relationship are better able to weather a crisis and are less likely to default than firms relying only on transaction lending, even though the underlying cash flow risk of firms borrowing from an $R-$bank is higher than that of firms relying only on $T-$banking.

As intuitive as these predictions are, they differ in important ways from those of other relationship banking theories. Table 1 summarizes the main differences in the empirical predictions of the four different types of models of relationship banking. Our main finding is that, consistent with our predictions and those of ex-ante screening models, $R-$banks display lower loan delinquency rates relative to $T-$bank. However, unlike the predictions of screening-based models, we also find that $T-$banks raised loan interest rates more than $R-$banks in crisis times, providing further support for our *learning* hypothesis of relationship lending.

Our study is the first to consider how relationship lending responds to a crisis in a comprehensive way both from a theoretical and an empirical perspective. Similar to Detragiache, Garella and Guiso (2000) we rely on detailed credit register information on loans granted by Italian banks to Italian firms. Our sample covers loan contracts between a total of 179 Italian banks and more than 72.000 firms during the period 2007-2010, with the collapse of Lehman Brothers marking the transition to the crisis. The degree of detail of our data goes far beyond what has been available in previous studies of relationship banking. For example, one of the most important existing studies by Petersen and Rajan (1994) only has data on firms' balance sheets and on the characteristics of their loans, without additional specific information on the banks firms are borrowing from.[3] As a result they cannot

[3] They have a dummy variable taking the value 1 if the loan was granted by a bank and 0 if granted by another financial institution, but they do not have information on which

control for bank specific characteristics. We are able to do so for both bank and firm characteristics since we observe each bank-firm relationship. More importantly, by focusing on multiple lender situations we can run estimates with both bank and firm fixed effects, thus controlling for observable and unobservable supply and demand factors. We are therefore able to uncover the effects of bank-firm relationship characteristics on lending precisely. The richness of our data set allows us to estimate our model with and without bank and firm fixed effects. It turns out that our results differ significantly depending on whether we include or exclude these fixed effects, suggesting that further research may be called for to corroborate Petersen and Rajan's findings as well as those of other similar studies. Also, unlike the vast majority of the studies, our database includes detailed information on interest rates for each loan. This allows us to investigate bank interest rate setting in good and bad times in a direct way, without relying on any assumptions.[4]

Overall, our study suggests that relationship banking plays an important role in dampening the effects of negative shocks following a crisis. The firms that rely on relationship banks are less likely to default on their loans and are better able to withstand the crisis thanks to the more favorable continuation lending terms they can get from $R-$banks. These findings suggest that the focus of Basel III on core capital and the introduction of countercyclical capital buffers could enhance the role of $R-$banks in crises and reduce the risk of a major credit crunch especially for the firms that choose to rely on $R-$banks.

The paper is structured as follows. In section 2 we describe the theoretical model of $T-$banking and $R-$banking and in section 3 we deal with how firms combine the two forms of funding. In section 4 we compare the firm's benefits from pure $T-$banking with the ones of mixed finance, and the implication for

bank granted the loan and they do not have balance sheet information on the bank.

[4]In one related paper Gambacorta and Mistrulli (2013) investigate whether bank and lender-borrower relationship characteristics had an impact on the transmission of the Lehman default shock by analysing *changes* in bank lending rates over the period 2008:Q3-2010:Q1. Bonaccorsi di Patti and Sette (2012) take a similar approach over the period 2007:Q2-2008:Q4, while Gobbi and Sette (2012) consider 2008:Q3-2009:Q3. Albertazzi and Marchetti (2010) and De Mitri et al. (2010) complement the previous studies by investigating the effect of the financial crisis on *lending growth*. In this paper, we focus instead on the *level* of lending rates and the quantity of credit (instead than their respective changes). Moreover, we analyse the behaviour of relationship and transactional banks by comparing bank prices and quantities both in "normal" times and in a crisis. Although our results are not perfectly comparable, they are consistent with the above cited papers.

the capital buffers the banks have to hold. In Section 5 we test the empirical implications of the model and section 6 concludes.

2 The model

We consider the financing choices of a firm that may be more or less exposed to business-cycle risk. The firm may borrow from a bank offering relationship-lending services, an $R-$bank, or from a bank offering only transaction services, a $T-$bank. As we explain in greater detail below, $R-$banks have higher intermediation costs than $T-$banks, $\rho_R > \rho_T$, because they have to hold more equity capital against the expectation of more future roll-over lending. We shall assume that the banking sector is competitive, at least ex ante, before a firm is locked into a relationship with an $R-$bank. Therefore, in equilibrium each bank just breaks even and makes zero supra-normal profits. We consider in turn, 100% $T-$ bank lending, 100% $R-$bank lending, and finally a combination of R and $T-$bank lending.

2.1 The Firm's Investment and Financial Options

The firm's manager-owners have no cash but have an investment project that requires an initial outlay of $I = 1$ at date $t = 0$ to be obtained through external funding. If the project is successful at time $t = 1$, it returns V^H. If it fails, it is either liquidated, in which case it produces V^L at time $t = 1$, or it is continued in which case the project's return depends on the firm's type, H or L. For the sake of simplicity, we assume that the probability of success of a firm is independent of its type. An $H-$firm's expected second period cash flow is V^H, while it is zero for an $L-$firm. The probability that a firm is successful at time $t = 1$ is observable, and the proportion of $H-$firms is known. Moreover, both the probability of success and the proportion of $H-$firms change with the business cycle, which we model simply as two distinct states of the world: a good state for *booms* ($S = G$) and a bad state for *recessions* ($S = B$). Figure 1 illustrates the different possible returns of the project depending on the bank's decision to liquidate or to roll over the unsuccessful firm at time $t = 1$.[5]

[5] A model with potentially infinitely-lived firms subject to periodic cash-flow shocks and that distinguishes between the value to the firm and to society of being identified as an H-type, would be a better representation of actual phenomena. In a simplified way our

We denote the firms' probability of success at $t = 1$ as p_S, with $p_G > p_B \geq 0$. We further simplify our model by making the idiosyncratic high (V^H) and low (0) returns of firms at time $t = 2$ independent of the business cycle; only the population of $H-$firms, which we denote by ν_S will be sensitive to the business cycle. Finally, recession states ($S = B$) occur with probability θ and boom states ($S = G$) occur with the complementary probability $(1 - \theta)$.

The prior probability (at time $t = 0$) that a firm is of type H is denoted by ν. This probability belief evolves to respectively ν_B in the recession state and ν_G in the boom state at time $t = 1$, with $\nu_B < \nu_G$. The conditional probability of a firm being of type H knowing it has defaulted in time $t = 1$ will be denoted by

$$\overline{\nu} \equiv \frac{(1-\theta)(1-p_G)\nu_G + \theta(1-p_B)\nu_B}{(1-p)}.$$

As in Bolton and Freixas (2006), we assume that the firm's type is private information at time $t = 0$ and that neither R nor T banks are able to identify the firm's type at $t = 0$. At time $t = 1$ however, $R-$banks are able to observe the firm's type perfectly by paying a monitoring cost $m > 0$, while $T-$banks continue to remain ignorant about the firm's type (or future prospects).

Firms differ in the observable probability of success $p = \theta p_B + (1 - \theta)p_G$. For the sake of simplicity we take $p_G = p_B + \Delta$ and assume that p_G is *uniformly* distributed on the interval $[\Delta, 1]$, so that p_B is $U \sim [0, 1 - \Delta]$ and p is $U \sim [(1 - \theta)\Delta, 1 - \theta\Delta]$. Note that for every p there is a unique pair (p_B, p_G) so that all our variables are well defined.

Firms can choose to finance their project either through a *transaction bank* or through a *relationship bank* (or a combination of transaction and relationship loans). To keep the corporate financing side of the model as simple as possible, we do not allow firms to issue equity. The main distinguishing features of the two forms of lending are the following:

1. **Transaction banking**: a transaction loan specifies a gross repayment $r_T(p)$ at $t = 1$. If the firm does not repay, the bank has the right to liquidate the firm and obtains V^L. But the bank can also offer to roll

model can be reinterpreted so that the value of β takes already into account this long run impact on the firms' reputation. Still, a systematic analysis of intertemporal effects would require tracking the balance sheets for both the firm and of two types of banks as state variables of the respective value functions and would lead to an extremely complex model.

over the firm's debt against a promise to repay $r_T^S(p_S)$ at time $t = 2$. This promise $r_T^S(p_S)$ must, of course, be lower than the firm's expected second period pledgeable cash flow, which is V^H for an $H-$firm and zero for an $L-$firm. Thus, if the transaction bank's belief ν_S that it is dealing with an $H-$firm is high enough, so that

$$r_T^S(p_S) \leq \nu_S V^H,$$

the firm can continue to period $t = 2$ even when it is unable to repay its debt $r_T(p)$ at $t = 1$. If the bank chooses not to roll over the firm's debt, it obtains the liquidation value of the firm's assets V^L at $t = 1$.

The market for transaction loans at time $t = 1$ is competitive and since no bank has an informational advantage on the credit risk of the firm the roll-over terms $r_T^S(p_S)$ are set competitively. Consequently, if gross interest rates are normalized to 1, competition in the $T-$banking industry implies that

$$\nu_S r_T^S(p_S) = r_T(p), \tag{1}$$

(when the project fails at time $t = 1$ the firm has no cash flow available towards repayment of $r_T(p)$; it therefore must roll over the entire loan to be able to continue to date $t = 2$).

For simplicity, we will assume that in the boom state an unsuccessful firm will always be able to get a loan to roll over its debt $r_T(p)$:

$$\frac{r_T(p)}{\nu_G} \leq V^H. \tag{2}$$

A sufficient condition for this inequality to hold is that it is satisfied for $p_G = \Delta$.[6]

By the same token, in a recession state firms with a high probability of success will be able to roll over their debt $r_T(p)$ if ν_B is such that

$$\frac{r_T(p)}{\nu_B} \leq V^H, \tag{3}$$

This will occur only for values of p_B above some threshold $\hat{p}_B$ for which condition (3) holds with equality, a condition that, under our assumptions, is equivalent to $p \geq \widehat{p}$, where $\widehat{p} = \hat{p}_B + (1-\theta)\Delta$. In other words,

[6] Note that the condition is not necessary as in equilibrium some firms with low p may not be granted credit at time $t = 0$ anyway.

for low probabilities of success $p < \widehat{p}$, an unsuccessful firm at $t = 1$ in the recession state will simply be liquidated, and the bank then receives V^L, and for higher probabilities of success, $p \geq \widehat{p}$ (or $p_B \geq \hat{p}_B$) an unsuccessful firm at $t = 1$ in the recession state will be able to roll over its debt. Figure 2 illustrates the different contingencies for the case $p_B \geq \hat{p}_B$.

2. **Relationship banking**: Under relationship banking the bank incurs a monitoring cost $m > 0$ per unit of debt,[7] which allows the bank to identify the type of the firm perfectly in period 1. A bank loan in period 0 specifies a repayment $r_R(p)$ in period 1 that has to compensate the bank for its higher funding costs $\rho_R > \rho_T$.

   The higher cost of funding is due to the need of holding higher amounts of capital that are required in anticipation of future roll-overs. It can be shown, by an argument along the lines of Bolton and Freixas (2006), that as the R-banks are financing riskier firms, even if, on average their interest rates will cover the losses, they need additional capital. In addition R-banks refinance H-firms and they do so by supplying lending to those firms that do not receive a roll-over from $T-$banks. As a consequence, they also need more capital because of capital requirements due to the expansion of lending to $H-$firms.

   If the firm is unsuccessful at $t = 1$ the relationship bank will be able to extend a loan to all the firms it has identified as $H-$firms and then determines a second period repayment obligation of r_R^1. As the bank is the only one to know the firm's type, there is a bilateral negotiation over the terms r_R^1 between the firm and the bank. We let the firm's bargaining power be $(1 - \beta)$ so that the outcome of this bargaining process is $r_R^1 = \beta V^H$ and the $H-$firm's surplus from negotiations is $(1 - \beta)V^H$.

In sum, the basic difference between transaction lending and relationship lending is that transaction banks have lower funding costs at time $t = 0$ but at time $t = 1$ the firm's debt may be rolled over at *dilutive* terms if the transaction bank's beliefs that it is facing an $H-$firm ν_B are too pessimistic.

[7] Alternatively, the monitoring cost could be a fixed cost per firm, and the cost would be imposed on the proportion ν of good firms in equilibrium. This alternative formulation would not alter our results.

Moreover, the riskiest firms with $p < \widehat{p}$ will not be able to roll over their debts with a transaction bank in the recession state. Relationship banking instead offers higher cost loans initially against greater roll-over security but only for $H-$firms.

3 Equilibrium Funding

Our set up allow us to determine the structure of funding and interest rates at time $t = 1$ and $t = 2$ under alternative combinations of transaction and relationship loans. We will consider successively the cases of pure transaction loans, pure relationship loans, and a combination of the two types of loans. We assume for simplicity that the intermediation cost of dealing with a bank, whether $T-$bank or $R-$bank is entirely 'capitalized' in period 0 and reflected in the respective costs of funds, ρ_T and ρ_R. We will assume as in Bolton and Freixas (2000, 2006) that $H-$firms move first and $L-$firms second. The latter have no choice but to imitate $H-$firms by pooling with them, for otherwise they would perfectly reveal their type and receive no funding.

Transaction Banking: Suppose that the firm funds itself entirely through transaction loans. Then the following proposition characterizes equilibrium interest rates and funding under transaction loans.

Proposition 1: *Under $T-$banking, firms characterized by $p \geq \widehat{p}$ are never liquidated and pay an interest rate*

$$r_T^S = \frac{1}{\nu_S}$$

on their rolled over loans.

For firms with $p < \widehat{p}$ there is no loan roll-over in recessions, and the roll-over of debts in booms is granted at the equilibrium repayment promise:

$$r_T^G = \frac{1}{\nu_G}.$$

The equilibrium lending terms in period 0 are then:

$$r_T(p) = 1 + \rho_T \text{ for } p \geq \widehat{p}. \tag{4}$$

$$r_T(p) = \frac{1 + \rho_T - \theta(1 - p_B)V^L}{\theta p_B + 1 - \theta} \text{for } p < \widehat{p}.$$

Proof: See the Appendix. ■

Relationship Banking: Consider now the other polar case of exclusive lending from an $R-$bank. The equilibrium interest rates and funding dynamics are then given in the following proposition.

Proposition 2: *Under relationship-banking there is always a debt roll-over for $H-$firms at equilibrium terms*

$$r_R^1 = \beta V^H.$$

The equilibrium repayment terms in period 0 are then given by:

$$r_R(p) = \frac{1 + \rho_R - (1-p)[(1-\overline{\nu})V^L + \overline{\nu}(1-m)\beta V^H]}{\theta p_B + (1-\theta)p_G}. \quad (5)$$

Proof: See the Appendix. ■

Combining T and $R-$banking: In the previous two cases of either pure T banking or pure $R-$banking the structure of lending is independent of the firm's type. When we turn to the combination of T and $R-$banking, the firms' choice might signal their type. As mentioned this implies that the $L-$firms will have no choice but to mimick the $H-$firms.

Given that transaction loans are less costly ($\rho_T < \rho_R$) it makes sense for a firm to rely as much as possible on lending by $T-$banks. However, there is a limit on how much a firm can borrow from $T-$banks, if it wants to be able to rely on the more efficient debt restructuring services of $R-$banks. The limit comes from the existence of a debt overhang problem if the firms are overindebt with $T-$banks.

To see this, let L_R and L_T denote the loans granted by respectively $R-$banks and by $T-$banks at $t = 0$, with $L_R + L_T = 1$. Also, let r_R^{RT} and r_T^{RT} denote the corresponding repayment terms under each type of loan. When a firm has multiple loans an immediate question arises: what is the seniority structure of these loans? As is common in multiple bank lender situations, we shall assume that $R-$bank loans and $T-$bank loans are *pari passu* in the event of default. Under this assumption, the following proposition holds:

Proposition 3: *The optimal loan structure for $H-$firms is to maximize the amount of transactional loans subject to satisfying the relationship lender's incentive to roll over the loans at $t = 1$.*

The firm borrows:

$$L_T = \frac{(p + (1-p)\overline{\nu})\left[\beta V^H(1-m) - V^L\right]}{1 + \rho_T - V^L}. \tag{6}$$

in the form of a transaction loan, and $(1 - L_T)$ *from an R-bank at* $t = 0$ *at the following lending terms:*

$$r_T^{RT} = \frac{(1+\rho_T) - (1-p)(1-\overline{\nu})V^L}{p + (1-p)\overline{\nu}}, \tag{7}$$

and,

$$r_R^{RT} = \frac{1}{p}\left[(1+\rho_R) - \frac{(1-p)V^L}{(1-L_T)}\right]. \tag{8}$$

At time $t = 1$ *both transaction and relationship-loans issued by* $H-$ *firms are rolled over by the R-bank. Neither loan issued by an* $L-$ *firm is rolled over.*

Proof: See the Appendix. ■

As intuition suggests: *i)* pure relationship lending is dominated under our assumptions; and *ii)* if the bank has access to securitization or other forms of funding to obtain funds on the same terms as $T-$banks, then it can combine the two.

Note finally that, as $T-$loans are less expensive, a relatively safe firm (with a high p) may still be better off borrowing only from $T-$banks and taking the risk that with a small probability it won't be restructured in bad times. We turn to the choice of optimal mixed borrowing versus 100% $T-$financing in the next section.

4 Optimal funding choice

When would a firm choose mixed financing over 100% $T-$financing? To answer this question we need to consider the net benefit to an $H-$firm from choosing a combination of R and $T-$bank borrowing over 100% $T-$bank borrowing. We will make the following plausible simplifying assumptions in order to focus on the most interesting parameter region and limit the number of different cases to consider:

Assumption A1: Both $(\rho_R - \rho_T)$ and m are small enough.

Assumption A2: $\beta V^H - V^L$ is not too large so that it satisfies:

$$\beta V^H - V^L < \min\left\{\frac{(1+\rho_T)[\frac{(1-\theta)}{\nu_G} + \frac{\theta}{\nu_B} - 1]}{(1-[(1-\theta)\nu_G + \theta\nu_B])}, \frac{\theta(1-p_B)(V^H - V^L)}{(1-p)(1-\overline{\nu})}\right\}$$

These two conditions essentially guarantee that relationship banking has an advantage over transaction banking. For this to be true, it must be the case that: First, the intermediation cost of relationship banks is not too large relative to that of transaction banks. Assumption A1 guarantees that this is the case. Second, the cost of rolling over a loan with the $R-$bank should not be too high. This means that the $R-$bank should have a bounded ex post information monopoly power. This is guaranteed by assumption A2.

To simplify notation and obtain relatively simple analytical expressions, we shall also assume that $V^H > \frac{r_T(p)}{\nu_B}$. The last inequality further implies that $V^H > \frac{r_T(p)}{\nu_G}$, as $\nu_G > \nu_B$, so that the firm's debts will be rolled over by the $T-$bank in both *boom* and *bust* states of nature. Note that when this is the case the transaction loan is perfectly safe, so that $r_T(p) = 1 + \rho_T$, as in equation (4).

We denote by $\Delta\Pi(p) = \Pi^T(p) - \Pi^{RT}(p)$ the difference in expected payoffs for an $H-$firm from choosing 100% $T-$financing over choosing a combination of T and $R-$loans and establish the following proposition.

Proposition 4: *Under assumptions A1 and A2, the equilibrium funding in the economy will correspond to one of the three following configurations:*

1. $\Delta\Pi(p_{\min}) \equiv \Delta\Pi((1-\theta)\Delta) > 0$*: monitoring costs are excessively high and all firms prefer* 100% *transactional banking.*

2. $\Delta\Pi(p_{\max}) \equiv \Delta\Pi(1-\theta\Delta) > 0$ *and* $\Delta\Pi(p_{\min}) \equiv \Delta\Pi((1-\theta)\Delta) < 0$*: Safe firms choose pure $T-$banking and riskier firms choose a combination of $T-$banking and R-banking.*

3. $\Delta\Pi(p_{\max}) \equiv \Delta\Pi(1-\theta\Delta) < 0$*: all firms choose a combination of $T-$banking and $R-$banking.*

Proof: See the Appendix. ■

We are primarily interested in the second case, where we have coexistence of 100% $T-$banking by the safest firms along with other firms combining $T-$Banking and $R-$banking. Notice, that under assumptions A1 and A2, it is possible to write

$$\begin{aligned}\Delta\Pi((1-\theta)\Delta) &= (\rho_R - \rho_T)(1-L_T^*) + (1-(1-\theta)\Delta)\left[\overline{\nu} m \beta V^H\right] \\ &+\theta\Delta(1+\rho_T) + (1-(1-\theta)\Delta)(1-\overline{\nu})(\beta V^H - V^L) \\ &-(1+\rho_T)[\frac{(1-\theta)(1-\Delta)}{\nu_G} + \frac{\theta}{\nu_B}] \end{aligned} \quad (9)$$

and

$$\begin{aligned}\Delta\Pi(1-\theta\Delta) &= (1+\rho_R) - (\rho_R - \rho_T)L_T^* - \theta\Delta\left[\overline{\nu}(1-m)\beta V^H + (1-\overline{\nu})V^L\right] \\ &-(1-\theta\Delta)(1+\rho_T) + \theta\Delta\beta V^H \\ &-(1+\rho_T)[\frac{\theta\Delta}{\nu_B}]. \end{aligned} \quad (10)$$

Under assumption A1 $(\rho_R - \rho_T)$ and m are small, so that a sufficient condition to obtain $\Delta\Pi(1-\theta\Delta) > 0$ is to have $\theta\Delta$ sufficiently close to zero. Indeed, then we have:

$$\Delta\Pi(1-\theta\Delta) \approx (\rho_R - \rho_T)(1-L_T^*) > 0$$

To summarize the predictions of our theoretical model on the basis of the parameter constellation corresponding to case 2 are the following:

- $R-$banks charge higher lending rates at the initial stage.
- The safest firms will choose to be financed through transaction loans. $R-$banks will specialize in riskier firms that will combine $R-$loans with an amount of transaction loans that is sufficiently small not to destroy the incentives of the bank to invest in relationship banking.

- In the recession state firms financed exclusively by $T-$banks will either be denied credit or will face higher interest rates to roll over their loans than $R-$banks.
- In a crisis, the rate of default on firms financed exclusively through transaction loans will be higher than the rate on firms financed by $R-$banks.
- Finally, the capital buffer of an R-bank will have to be higher than the one of a $T-$bank, which is consistent with $R-$banks quoting higher interest rates in normal times.

5 Empirical analysis

We now turn to the empirical investigation of relationship banking over the business cycle. How do relationship banks help their corporate borrowers? As we have argued, the literature can be divided into four different types of theories of relationship banking: 1) relationship-banks offer implicit interest rate and lending insurance to firms; 2) relationship-banks monitor firms and prevent them from engaging in projects that are not creating value; 3) relationship-banks screen firm types and weed out excessively risky borrowers; and 4) relationship-banks learn the firm's type as it evolves and offer roll-over loan at favorable terms to the most creditworthy firms in recessions.

These four different categories of relationship-banking theories have different predictions in terms of delinquency rates, cost of credit, and credit availability over the business cycle (see Table 1). We test these different predictions and specifically ask whether:

1) According to the (implicit) insurance theory, $R-$banks do not have better knowledge about firms' types and therefore delinquency rates are similar to those experienced by $T-$banks in crisis times (see panel I in Table 1). Moreover, by this theory firms that borrow from $R-$banks pay higher lending rates in return for more loans in both states of the world (see, respectively, panel II and III in Table 1).

2) According to the monitoring theory (in the vein of Holmstrom and Tirole, 1997), only firms with low equity capital choose a monitored bank loan from an $R-$bank, while firms with sufficient cash (or collateral) choose

cheaper loans from a $T-$bank. By this theory adverse selection is a minor issue, and monitoring is simply a way to limit the firm's interim moral hazard problems. The monitoring theory predicts higher delinquency rates for $R-$banks than $T-$banks, as well as higher lending rates given that $R-$banks build relationships mainly with high-risk low-capital firms.

3) According to the ex-ante screening theory, whereby $R-$banks rely on both hard and soft information to weed out bad loan applicants, $R-$banks have lower default rates in crisis times than $T-$banks. And also, given the ex-post monopoly of information advantage for $R-$banks, whether $R-$banks charge higher lending rates both in good times and in bad times for the loans they roll over.

4) According to the learning theory, $R-$banks do not know the firm's type initially but learn it over time. This theory predicts that $R-$banks charge higher lending rates in good times on the loans they roll over, but in bad times they lower rates to help their best clients through the crisis. In contrast, $T-$banks offer cheaper loans in good times but roll over fewer loans in bad times. Also, according to this theory we should observe lower delinquency rates in bad times for $R-$banks that roll over their loans (note that this latter prediction is also consistent with the ex-ante screening theory).

5.1 Methodology and data

To test these predictions, we proceed in two steps. First we analyze how firms' default probability in bad times is influenced by the fact that the loan is granted by an $R-$bank or a $T-$bank. Second, we analyze (and compare) lending and bank interest rate setting in good times and bad times.

The first challenge is to select two dates that represent different states of the world, possibly caused by an exogenous shock that hit the economy. To this end we investigate bank-firm relationships prior and after the Lehman Brothers' default (September 2008) the date typically used to evaluate the effects of the global financial crisis (Schularick and Taylor, 2011).

In particular, we consider the case of Italy that is an excellent laboratory for three reasons. First, the global financial crisis was largely unexpected (exogenous) and had a sizable impact on Italian firms, especially small and medium-sized ones that are highly dependent on bank financing. Although Italian banks have been affected as well by the financial crisis, systemic stability has not been endangered and government intervention has been negligible in comparison to other countries (Panetta et al. 2009). Second, multiple lending is a long-standing characteristic of the bank-firm relationship in Italy (Foglia et al. 1998, Detragiache et al. 2000). Third, the detailed data available for Italy allow us to test hypothesis of the theoretical model without making strong assumptions. For example, the availability of data at the bank-firm level on both quantity and prices allows us to overtake some of the identification limits encountered by the bank lending channel literature in disentangling loan demand from loan supply shifts (Kashyap and Stein, 1995; 2000).

The visual inspection of lending and bank interest rates dynamics in Figure 3 helps us to pick up two dates that can be considered good and bad times. In particular, we select the second quarter of 2007 as good times because lending dynamic reached a peak, while the interest rate spread applied on credit lines levelled to a minimum value (see the green circles in panel (a) and (b) of Figure 3). We consider a bad time the first quarter of 2010 characterized by a negative growth of bank lending to firms and a very high level of the intermediation spread (see the red circles in panel (a) and (b) of Figure 3). The selection of these two dates is remains consistent also by using alternative indicators such as real GDP and stock market capitalization (see panel (c) in Figure 3). We have not considered in our analysis the period from 2011 onwards that has been influenced by the effects of the Sovereign debt crisis.

The second choice to be made is how to distinguish $T-$banks from $R-$banks. As we have seen in the theoretical part of the paper relationship lending is a sort of implicit contract that ensures the availability of finance to the firm and allows the bank to partake in the returns. The theoretical literature agrees on the fact that in order to establish long-lasting and close relationships banks need to gather information about the firm (Boot 2000; Berger and Udell 2006).

As measure of relationship banking we consider in the baseline regressions the informational distance between lenders and borrowers.[8] The empirical literature has clearly shown that the distance affects the ability of banks to gather soft information, i.e. information that is difficult to codify, which is a crucial aspect of lending relationships (see Berger et al. 2005, Agarwal and Hauswald 2010). We therefore divide $R-$banks and $T-$banks according to

[8] There is not a clear consensus in the literature on the way relationship characteristics are identified. In Appendix C, we have checked the robustness of the results using alternative measures for relationship lending.

the distance between the lending bank headquarters and firm headquarters, that we interpret as a form of informational distance. Branches of foreign banks are considered as $T-$banks.

We argue that distance is strictly related to monitoring costs and, in general, to the ability of banks to gather soft information. In particular, we argue that the distance between banks' and firms' headquarters is a proxy for the cost of producing soft information. Indeed, distance affects the ability of loan officers, typically in charge of gathering this kind of information,[9] to pass it through many hierarchical layers within a bank. Stein (2002) shows that when the production of soft information is decentralized, the incentives to gather it crucially depends on the ability of the agent to convey information to the principal.

Distance may affect the transmission of information (i.e. the ability of branch loan officers to harden soft information) within banks since banks' headquarters may be less able to interpret the information they receive from distant branch loan officers than from close ones. This is in line with Cremer, Garicano and Prat (2007) showing that there is a trade-off between the efficiency of communication within organizations and the scope of their activity. In other terms, communication is more difficult when headquarters and branches "differ" a lot. Differences of this kind are related to distance for three main reasons. First, the more banks' headquarters are far away from borrowers the more costly is for headquarters to gather information directly and, as a consequence, the greater is the information asymmetry between headquarters and branches. This may reasonably imply a high risk of misunderstandings between branches and headquarters. Second, distance may also be a proxy for cultural differences, which again may render the transmission of information difficult. Third, communication problems may stem from differences between headquarters and loan officers in terms of their "institutional" memory which are more likely to occur in case branch loan officers and headquarters are located in very different areas (Berger and Udell 2004).

In particular, to take into account of informational distance, we introduce two dummy variables: $R-$bank is equal to 1 if firm k is headquartered in

[9]Soft information it is gathered through repeated interaction with the borrower and then it requires proximity. Banks in order to save on transportation costs delegate the production of soft information to branch loan officers since they are those within bank organizations which are the closest to borrowers. Alternatively, one can consider the geographical distance between bank branches and firms' headquarters. However, Degryse and Ongena (2005) find that this measure has little relation to informational asymmetries.

the same province where bank j has its headquarters; $T-$bank is equal to 1 if $R-$bank=0. Monitoring costs can be considered as a positive function of the distance. This means that a bank can act as an $R-$bank for a firm headquartered in the same province and as a $T-$bank for firms that are far away.

Regarding credit risk, the challenge we face is to identify risk and to distinguish it from asymmetric information, so that we need two different measures. Our theoretical framework is here helpful in clarifying the issue. Indeed, ex ante all banks know that some firms are more risky than others without investing in relationship banking. This is the knowledge $T-$banks posses that is represented in our model by p, the probability of success and by a $Z-$score in our empirical analysis. The $Z-$score constitutes an indicator of the ex-ante probability of default. These scores can be mapped into four levels of risk: 1) safe; 2) solvent; 3) vulnerable; 4) risky. The $Z-$score is inversely related to the probability of firms' success p analyzed in the theoretical model which is a proxy for how sensitive firms are with respect to the business cycle. The model predicts that it exists a critical threshold for the probability of success in bad time $\hat{p}_B$ such that for any $p_B > \hat{p}_B$ firms prefer pure transactional banking and for any $p_B < \hat{p}_B$ firms prefer to combine the maximum of transactional banking and the minimal amount of relationship banking. This means that we should investigate the existence of a minimum $\widehat{Z}-$score such that for any $Z < \widehat{Z}$ firms prefer pure transactional banking and for any $Z > \widehat{Z}$ firms prefer to combine the two kinds of banking relationship.

Measuring asymmetric information and the role of relationship banks in gathering it is more complex. Indeed, no contemporaneous variable could reflect soft information that is private to the firm and the relationship bank. Consequently it is only ex post that a variable may reflect the skills of relationship banking in refinancing the good firms and liquidating the bad ones. This superior soft information will imply that relationship banking will have a lower rate of defaults. This is why in order to distinguish $H-$firms from $L-$firms we can observe the realization of defaults.

The data come from the Credit Register (CR) maintained by the Bank of Italy and other sources. Table 2 gives some basic information on the dataset after having dropped outliers (for more information see the data Appendix B).

The table is divided horizontally into three panels: i) all firms, ii) $H-$firms (not gone into default after during the financial crisis) and iii) $L-$firms (defaulted ones). In the rows we divide bank-firm relationships in: i) pure relationship lending: firms which have business relationship with $R-$banks only; ii) mixed banking relationship: firms which have business relationships with both $R-$banks and $T-$banks; iii) pure transactional lending: firms which have business relationship with $T-$banks only.

Several clear patterns emerge. First, the situations in which firms have only relationships with $R-$banks (10% of the cases) and $T-$banks (44% of the cases) are numerous but the majority of firms borrow from both kinds of banks (46%). Second, the percentage of defaulted firms that received lending by $T-$banks only is relatively high (64% of the total). Third, in the case of pure $R-$banking or combined RT $-$banking firms benefit of a lower increase of the spread in bad time. Fourth, $R-$banking is associated with a higher level of the capital ratio to be used as buffer against contingencies in good times. The slack depends upon the business cycle and it is absorbed in bad times. Interestingly, the size of the average $T-$bank is four times that of the average $R-$bank (100 vs 25 billions). This is in line with Stein (2002) who points out that the internal management problem of very large intermediaries may induce these banks to rely solely on hard information, in order to align the incentives of the local managers with the headquarters.

These patterns are broadly in line with the prescription of the theoretical model. However, these indications are only very preliminary because the bank-lending relationship is influenced not only by firms' type but also by other factors (sector of firm's activity, firm's age, firm's location, bank-specific characteristics, etc) for which we are not able to control for in the sample descriptive statistics reported in Table 2.

5.2 Empirical model and results

As a first step of the analysis we focus on the relationship between the probability for a firm k to go into default and the composition of her *transactional* vs *relationship* financing. The baseline cross section equation estimates the marginal probability of firm k to go into default in the 6 quarters that followed Lehman's collapse (2008:q3-2010:q1) as a function of the share of loans that such firm has borrowed form a $T-$bank in 2008:q2. In particular, we estimate the following marginal probit model:

$$MP(\textit{Firm k's default=1}) = \alpha + \zeta + \pi T - share_k + \varepsilon_k \qquad (11)$$

where α and ζ are, respectively, vectors of bank and industry-fixed effects and $T - share_k$ is the pre-crisis proportion of transactional loans (in value) for firm k. The results reported in Table 3 indicate that a firm financed via $T-$banking has a higher probability to go into default.[10] This marginal effect increase with the share of $T-$bank financing and reach the maximum of around 0.3% when $T-share_k$ is equal to 1. This effect is not only statistically significant but also relevant from an economic point of view because the average default rate for the whole sample in the period of investigation was around 1.0%. This result remains pretty stable by enriching the set of controls with additional firm-specific characteristics (see panel II in Table 3) or by calculating the proportion of transactional loans $T - share_k$ not in value but in terms of the number of banks that finance firm k (see panel III in Table 3).

The positive coefficient π is consistent with two possible explanations of the nature of relationship lending, namely "learning" and "ex-ante screening" (see Table 1): in both cases relationship banks ($R-$banks) are better able than transactional banks ($T-$banks) in learning firms type. Therefore, to distinguish between these two cases we need to analyze lending and interest rate settings of $R-$banks and $T-$banks in good times and in bad times (see panel II and III of Table 1).

In the second step of the analysis we investigate bank's loan and price setting. Our focus on multiple lending is very useful to solve potential iden-

[10] In principle the reliability of this test may be bias by the possible presence of "evergreening", a practice aimed at postponing the reporting of losses in the balance sheet. Albertazzi and Marchetti (2010) find some evidence of "evergreening" practices in Italy in the period 2008:Q3-2009:Q1, although limited to small banks. We think that evergreening is less of a concern in our case for three reasons.

First, evergreening is a process that by nature cannot postpone the reporting of losses for a too long time. In our paper, we consider the period 2008:Q3-2010:Q1 that is 18 months after Lehmann's default and therefore there is a higher probability that banks have reported losses.

Second, there is no theoretical background to argue that evergreening can explain the difference we document between T-banks and R-banks. Both kinds of banks may have a similar incentive to postpone the reporting of losses to temporarily inflate stock prices and profitability.

Third, in the case that R-banks have more incentive to evergreen loans the definition of default used in the paper limits the problem. In particular, we consider a firm as in default when at least one of the loans extended is reported to the credit register as a defaulted one ("the flag is up when at least one bank reports the client as bad"). This means that a R-bank cannot effectively postpone the loss simply because a T-banks will report it.

tification issue because the availability of data at the bank-firm level allow us to include in the econometric model both bank and firm fixed effects. In particular, the inclusion of fixed effects allows us to control for all (observable and unobservable) time-invariant bank and borrower characteristics and to detect in a very precise way the effects of bank-firm relationship on the bank rate and the lending quantity over time.

We estimate two cross-sectional equations for the interest rate ($r_{j,k}$) applied by bank j on the credit line of firm k and the logarithm of outstanding loans in real terms ($L_{j,k}$) supplied by bank j on total credit lines of firm k:

$$r_{j,k} = \nu + \beta + \gamma T\text{-bank}_{j,k} + \varepsilon_{j,k} \tag{12}$$

$$L_{j,k} = \delta + \phi + \mu T\text{-bank}_{j,k} + \varepsilon_{j,k} \tag{13}$$

where ν and δ are bank-fixed effects and β and ϕ are firm-fixed effects. Here $Z-$scores (proxies for the prior probability of success p) are not included because (observable and unobservable) firm characteristics are captured by firm-fixed effects. Both equations are estimated over good time (2007:q2) and bad time (2010:q1).

The results are reported in Table 4.[11] In line with the prediction of the model, the coefficients show that $T-$banks (compared to $R-$banks) provide loans at a cheaper rate in good time and at a higher rate in bad time (see columns I and II). The difference between the two coefficients $\gamma_B - \gamma_G = .123 - (-.081) = .204^{***}$ is statistically significant. As for loan quantities, other things being equal, $T-$banks always provide on average a lower amount of lending, especially in bad times (see columns III and IV). In this case the difference $\mu_G - \mu_B = -.313 - (-.275) = -0.038^{**}$ indicates that, other things being equal, $T-$banks supply around 4% less loans in bad times, relatively to good state of the world.

[11] Following Albertazzi and Marchetti (2010) and Hale and Santos (2009) we cluster standard errors ($\varepsilon_{j,k}$) at the firm level in those regressions that include bank fixed effects. Vice versa in those regressions that include specific firm fixed effects (but no bank fixed effects) we cluster standard errors at the bank group level. In this way we are able to control for the fact that, due to the presence of an internal capital market, probably financial conditions of each bank in the group is not independent of one another. For a general discussion on different approaches used to estimating standard errors in finance panel data sets, see Petersen (2009).

Equations (12) and (13) can be further enriched with interaction terms between bank-types and the $Z-$score in order to analyze if R-banks and $T-$banks behave differently with respect to borrowers with a different degree of risk:

$$r_{j,k} = \nu + \theta + \gamma T - \text{bank}_{j,k} + \gamma_Z T - \text{bank}_{j,k} * Z + \rho_Z R - \text{bank}_{j,k} * Z + \Theta X + \varepsilon_{j,k} \quad (14)$$

$$L_{j,k} = \delta + \theta + \mu T - \text{bank}_{j,k} + \mu_Z T - \text{bank}_{j,k} * Z + \psi_Z R - \text{bank}_{j,k} * Z + \Phi X + \varepsilon_{j,k} \quad (15)$$

In the above equations we can include only bank fixed effects because the introduction of the interaction terms between bank type and the $Z-$scores (this linear combination is invariant for each firm) prevent us from including firm-fixed effects. For this reason we enrich the set of controls by including a complete set of industry-province dummies (θ) and a vector X with a number of firm-specific characteristics. In particular X contains:

- a dummy US>GR that takes the value of 1 for those firms that have used their credit lines for an amount greater than the value granted by the bank, and zero elsewhere;
- a dummy that takes the value of 1 if a company is organized to give its owners limited liability, and zero elsewhere (LTD);
- a dummy that takes the value of 1 for firms with less than 20 employees (SMALL_FIRM), and zero elsewhere; this dummy aims at controlling for the fact that small firms, due to their great opacity, do not issue bonds as larger firms do;
- the length of the borrower's credit history (CREDIT HISTORY) measured by the number of years elapsed since the first time a borrower was reported to the Credit Register. This variable also tells us how much information has been shared among lenders through the Credit Register over time and it is a proxy for firms' reputation acquisition.

The results are reported in Table 5. Firms that use their credit lines for an amount greater than the value granted by the bank have to pay a higher spread that increase in bad times. Repeated interaction with the banking system also has an effect on bank interest rate setting and loan supply. The variable CREDIT_HISTORY, representing the number of years elapsed since the first time a borrower was reported to the Credit Register, is negatively (positively) correlated with rates applied to credit lines (amount of outstanding loans). Firms organized with the juridical form of an LTD pay a lower spread and need less lending because they can tap funds also on the equity and the bond markets.

The graphical interpretation of the interaction terms between bank-types and the $Z-$score is reported in Figure 4. The upper panels (a) and (b) describes the effects on the interest rate, the bottom panels (c) and (d) those on the logarithm of real loans. The graph on the left illustrate the case of good times, while the second one bad times. In each graph the horizontal axis report the $Z-$score, where Z goes from 1 (safe firm) to 4 (risky firm). Transactional banking ($T-$banks) is indicated with a dotted line while relationship banking ($R-$banks) with a solid line.

The visual inspection of all graphs shows that both interest rates and loans quantities are positively correlated with $Z-$score. The positive correlation between risk and bank financing depends probably upon the fact that risky firms have a limited access to market financing. As expected also the interest rate increases with firms' risk.

In line with the prescription of the model the cost of credit of transactional lending is always lower than relationship banking in good times: the dotted line is always below the solid one for all $Z-$scores (see panel (a) of Figure 4). This pattern is reversed in bad times (panel (b)) when banks with a strong lending relationship ($R-$banks) offer lower rates to *risky* firms (those with a $Z-$score greater than 1). It is interesting to note that in line with the prescription of the model, it is always cheaper for safe firms to use transactional banking because they obtain always a lower rate from $T-$banks.

Moreover the two bottom panels of Figure 4 highlight that the roll-over effects of $R-$banks on lending is in place prevalently for *risky* firms while $safe$ firms obtain always a greater level of financing from $T-$banks both in good and bad times (the dotted line is always above the solid line for Z=1 both in panel (c) and panel (d)).

An important prescription of the theoretical model is that banks need a capital buffer to be used in order to preserve the lending relationship in bad times. Since equity is costly this implies that banks with regulatory capital slack will charge higher interest rates in good times. To test this prescription we focus on the effects of bank capital on interest rate and lending. It is worth stressing that the analysis of interest rates applied on credit lines is particularly useful for our purposes for two reasons. First, these loans are highly standardized among banks and therefore comparing the cost of credit among firms is not affected by unobservable (to the econometrician) loan-contract-specific covenants. Second, overdraft facilities are loans granted neither for some specific purpose, as is the case for mortgages, nor on the basis of a specific transaction, as is the case for advances against trade credit receivables. As a consequence, according to Berger and Udell (1995) the pricing of these loans is highly associated with the borrower-lender relationship, thus providing us with a better tool for testing the role of lending relationships in bank interest rate setting.

In particular, we estimate the following equations where we include the regulatory capital-to-risk weighted assets ratio (CAP, lagged one period to mitigate endogeneity problems), a set of bank-zone dummies (z) and a set of other bank-specific controls (Y).

$$r_{j,k} = \beta + z + \gamma T - \text{bank}_{j,k} + \nu CAP_j + \Psi Y + \varepsilon_{j,k} \tag{16}$$

$$L_{j,k} = \phi + z + \mu T - \text{bank}_{j,k} + \lambda CAP_j + \Xi Y + \varepsilon_{j,k} \tag{17}$$

The vector Y contains in particular the dummy $US > GR$, described above, and:

- a dummy for mutual banks ($MUTUAL$), which are subject to a special regulatory regime (Angelini et al., 1998);
- a dummy equal to 1 if a bank belongs to a group and 0 elsewhere;
- a dummy equal to 1 if a bank has received government assistance and 0 elsewhere.

The results reported in Table 6 indicate that banks with larger capital ratios are better able to protect the lending relationship with their clients. Well-capitalized banks have an higher capacity to insulate their credit portfolio from the effects of an economic downturn by granting an higher amount of lending at a lower interest rate. To get a sense of the economic impact of the above-mentioned results, during a downturn a bank with a capital ratio 5 percentage points greater with respect to another one supplies 5% more loans at an interest rate 20 basis points lower. This result on the effects of bank capital is in line with the bank lending channel literature which indicates that well-capitalized banks are better able to protect their clients in the case of monetary policy shocks (Kishan and Opiela, 2000; Gambacorta and Mistrulli, 2004).

Interestingly, the positive effect of bank capital in protecting the lending relationship is more important for $R-$banks that for $T-$banks. This can be tested by replacing νCAP in equation (16) with

$$\upsilon_T T - bank * CAP + \upsilon_R R - bank * CAP$$

and λCAP in equation (17) with

$$\lambda_T T - bank * CAP + \lambda_R R - bank * CAP$$

In particular, the coefficients υ_T and υ_R take the values of -0.054*** (s.e. 0.008) and -0.038*** (s.e. 0.010), respectively, and are statistically different. A similar result is obtained in the lending equation, where λ_T and λ_R have the values of -0.025*** (s.e. 0.005) and -0.006* (s.e. 0.003), respectively, and are statistically different one from the other. Making a parallel with the example above, this means that during a downturn a $R-$bank ($T-$bank) with a capital ratio 5 percentage points greater with respect to another one supplies 12% more loans at an interest rate 27 basis points lower (3% and 19 basis point for a $T-$bank).

As a final step of the empirical evidence we test the theoretical prescription on bank capital endowments (see Section 5). In particular, since $T-$banks have a lower incentive of making additional loans to good firms in distress we should observe that these banks detain a lower buffer of capital against contingencies with respect to $R-$banks prior to the crisis.

In order to test this prediction we have estimated the following cross sectional equation on our sample of 179 banks:

$$CAP_j = z + \tau T - share_j + \Psi Y + \Phi Z + \varepsilon_j \tag{18}$$

where the dependent variable CAP_j is the regulatory capital-to-risk weighted assets of bank j at 2008:q2, prior to Lehman's default. The variable $T - share_j$ is the proportion of transactional loans (in value) for bank j, a set of bank-zone dummies (z), a set of bank-specific controls (Y) and a set of bank credit portfolio-specific controls (Z). Bank specific characteristics include not only bank's size and the liquidity ratio (liquid assets over total assets) but also the retail ratio between deposits and total bank funding (excluding capital). All explanatory variables are taken at 2008:q1 in order to mitigate endogeneity problems. The results reported in Table 7 indicate that, indipendently of the model specification chosen, a pure $T-$bank that have a credit portfolio composed excludively of transactional loans ($T-share_j = 1$) have a capital buffer more than 3 percentage points lower than a pure $R-$bank, whose portfolio is composed exclusively of relationship loans ($T-share_j = 0$).

One distinctive feature of our dataset is that, by focusing on multiple lending, we are allowed to run estimates with both bank and firm fixed effects, controlling for observable and unobservable supply and demand factors. In this way we are able to clearly detect the effects of bank-firm relationship characteristics on lending, not biased by the omission of some variables that may affect credit conditions. To show this we have therefore re-run all the models without bank and firm fixed effects. These new set of results, not reported for the sake of brevity but available from the authors upon request, indicates that $T-$bank coefficients are often different, and even change their sign in one third of the cases. In particular, not introducing fixed-effects, $T-$banks are shown to supply relatively more lending but at higher prices. This is an important aspect of our work because we show that not controlling for all unobservable bank and firm characteristics biases the results and in particular, the benefits of relationship lending tends to be overestimated on prices and underestimated on quantities.

The bias can be shown by comparing Figure 4 (that gives a graphical interpretation of the results of the models with fixed effects reported in Table) with Figure 5 that shows the graphical analysis of the same models reported in Table 5 without fixed effects. In Figure 5 the dotted line for $T-$banks move upwards with respect to Figure 4, in other words $T-$banks supply relatively more loans and charge higher interest rates when fixed effects are dropped compared to the case when they are plugged into the equation.

Interestingly from our perspective, this last result also supports the way we identify transactional and relationship banking. Indeed, the sign of this bias is consistent with the view that $R-$banks are better able than $T-$banks at gathering soft information and then better able at discriminating between good and bad borrowers. To explain this let's think about two firms that have the same $Z-$score but one is, in reality, riskier than the other. According to our model, $R-$banks are better able to discriminate between the two while $T-$banks are not. This happens because $T-$banks use only hard information (incorporated in the $Z-$scores) while $R-$banks rely on both hard and soft information. If this is true then the riskiest firm would prefer to ask $T-$banks for a loan since these banks are less able to distinguish good from bad borrowers. As a consequence, the riskiest firm will in theory get better price conditions and a larger amount of credit compared to the case in which $T-$banks were able to evaluate their risk correctly. However, $T-$banks are perfectly aware that the bank-firm matching is not random and in particular that their set of the pool of applicants is, on average, riskier than $R-$banks. As a consequence, $T-$banks will charge higher interest rates, anticipating that they will tend to make more mistakes in their loan restructuring choices, compared to $R-$banks or, in other terms, that they will tend to lend "too much" and this is exactly what we get in Figure 5 where we are not controlling for this endogenous matching. On the contrary, by using fixed effects we get rid of the fact that the bank-firm matching is not random since we compare $R-$banks' and $T-$banks' behavior keeping constant and homogenous the level of default risk between banks' type. Only in this last case we are able to compare $R-$banks with $T-$banks perfectly since the interest rate spread between these two types of banks (and their different lending behavior) only reflect the different role they perform in the credit market. Thus the interest spread between $R-$banks and $T-$banks in good times reported in Figure 4 (using fixed effects) is a unbiased measure of the premium that firms pay in order to get a loan restructuring in bad times.

6 Conclusion

We have found that relationship banking is an important mitigating factor of crises. By helping profitable firms to retain access to credit in time of crisis relationship banks dampen the effects of a credit crunch. However, the role relationship banks can play in a crisis is limited by the amount of excess equity capital they are able to hold in anticipation of a crisis. Banks entering the crisis with a larger equity capital cushion are able to perform their relationship banking role more effectively. These results are consistent with other empirical findings for Italy (see, amongst others, Albertazzi and Marchetti (2010) and Gobbi and Sette (2012)).

Our analysis suggests that if more firms could be induced to seek a long-term banking relation, and if relationship banks could be induced to hold a bigger equity capital buffer in anticipation of a crisis, the effects of crises on corporate investment and economic activity would be smaller. However, aggressive competition by less well capitalized and lower-cost transaction banks is undermining access to relationship banking. As these banks compete more aggressively more firms will switch away from $R-$banks and take a chance that they will not be exposed to a crisis. And the more firms switch the higher the costs of $R-$banks. Overall, the fiercer competition by $T-$banks contributes to magnifying the amplitude of the business cycle and the procyclical effects of bank capital regulations.

References

[1] Agarwal, S. and Hauswald R. (2010), "Distance and Private Information in Lending", *Review of Financial Studies*, 23, 2757-2788.

[2] Albertazzi, U. and Marchetti D. (2010), "Credit Supply, Flight to Quality and Evergreening: An Analysis of Bank-Firm Relationships after Lehman", Bank of Italy, Temi di discussione, 756.

[3] Angelini, P., Di Salvo P. and Ferri G. (1998), "Availability and Cost of Credit for Small Businesses: Customer Relationships and Credit Cooperatives", *Journal of Banking and Finance*, 22, 925-954.

[4] Berger, A.N., Miller N.H., Petersen M.A. , Rajan R.G., Stein J.C.(2005), "Does function follow organizational form? Evidence from the lending practices of large and small banks", *Journal of Financial Economics*, 76(2), 237-269.

[5] Berger, A.N. and Udell G.F. (1992), "Some Evidence on the Empirical Significance of Credit Rationing", *Journal of Political Economy*, 100(5), 1047-1077.

[6] Berger, A.N. and Udell G.F. (1995). "Relationship Lending and Lines of Credit in Small Firm Finance", *Journal of Business*, 68, 351–379.

[7] Berger, A.N. and Udell, G.F. (2004), "The Institutional Memory Hypothesis and the Procyclicality of Bank Lending Behavior", *Journal of Financial Intermediation*, 13, 458-495.

[8] Berger, A.N. and Udell, G.F. (2006), "A More Complete Conceptual Framework for SME Finance", *Journal of Banking and Finance*, 30, 2945–2966.

[9] Berlin, M. and Mester, L. (1999), "Deposits and Relationship Lending", *Review of Financial Studies*, 12(3), 579-607.

[10] Bolton, P. and X. Freixas (2000), "Equity, Bonds and Bank Debt: Capital Structure and Financial Market Equilibrium under Asymmetric Information", *Journal of Political Economy,* 108, 324–351.

[11] Bolton, P. and Freixas X. (2006), "Corporate Finance and the Monetary Transmission Mechanism", *Review of Financial Studies*, 3, 829–870.

[12] Bonaccorsi di Patti, E. and Sette, E. (2012), "Bank Balance Sheets and the Transmission of Financial Shocks to Borrowers: Evidence from the 2007-2008 Crisis", Bank of Italy, Temi di discussione, 848.

[13] Boot, A.W.A. (2000), "Relationship banking: What do we know?", *Journal of Financial Intermediation*, 9, 7-25.

[14] Boot, A. and A. Thakor, (2000), "Can Relationship Banking Survive Competition?," Journal of Finance, American Finance Association, vol. 55(2), 679-713, 04.

[15] Cremer, J., Garicano L., and Prat A. (2007), "Language and the Theory of the Firm", *Quarterly Journal of Economics*, 1, 373-407.

[16] De Mitri, S., Gobbi G. and Sette E. (2010), "Relationship Lending in a Financial Turmoil," Bank of Italy, Temi di discussione, 772.

[17] Degryse, H. and Ongena S. (2005), "Distance, Lending Relationships, and Competition," *Journal of Finance*, 60(1), 231-266.

[18] Detragiache, E., Garella, P. and Guiso, L. (2000), "Multiple versus Single Banking Relationships: Theory and Evidence", *Journal of Finance*, 55, 1133-1161.

[19] Farinha, L.A. and Santos J.A.C. (2002), "Switching from Single to Multiple Bank Lending Relationships: Determinants and Implications", *Journal of Financial Intermediation*, 11(2), 124–151.

[20] Foglia, A., Laviola, S. and Marullo Reedtz, P. (1998), "Multiple Banking Relationships and the Fragility of Corporate Borrowers", *Journal of Banking and Finance*, 22, 1441-1456.

[21] Gambacorta, L. and Mistrulli P. (2004), "Does Bank Capital Affect Lending Behavior?", *Journal of Financial Intermediation*, 13, 436–457.

[22] Gambacorta, L. and Mistrulli P. (2013), "Bank Heterogeneity and Interest Rate Setting: What Lessons have we Learned since Lehman Brothers?", *Journal of Money Credit and Banking*, forthcoming.

[23] Gobbi, G. and Sette E. (2012), "Relationship Lending in a Financial Turmoil", Bank of Italy, mimeo.

[24] Hale, G. and Santos, J.A.C. (2009), "Do banks price their informational monopoly?", *Journal of Financial Economics*, 93, 185-206.

[25] Hauswald, R. and R. Marquez (2000), "Relationship Banking, Loan Specialization and Competition", Proceedings, Federal Reserve Bank of Chicago, May, 108-131.

[26] Holmstrom, B. and Tirole J. (1997), "Financial Intermediation, Loanable Funds and the Real Sector", *Quarterly Journal of Economics*, 112(3), 663–691.

[27] Houston, J. and James C. (1996), "Bank Information Monopolies and the Mix of Private and Public Debt Claims", *The Journal of Finance*, 51(5), 1863–1889.

[28] Kashyap, A. and Stein J.C. (1995), "The Impact of Monetary Policy on Bank Balance Sheets", *Carnegie Rochester Conference Series on Public Policy*, 42, 151-195.

[29] Kashyap, A. and Stein J.C. (2000), "What Do a Million Observations on Banks Say About the Transmission of Monetary Policy", *American Economic Review*, 90, 407-428.

[30] Kishan, R.P. and Opiela T.P. (2000), "Bank Size, Bank Capital and the Bank Lending Channel", *Journal of Money, Credit and Banking*, 32, 121–141.

[31] Panetta, F., Angelini P. (coordinators), Albertazzi, U., Columba, F., Cornacchia, W., Di Cesare, A., Pilati, A., Salleo, C., Santini, G., (2009), "Financial sector pro-cyclicality: lessons from the crisis", Bank of Italy Occasional Papers Series, 44.

[32] Petersen, M.A. (2009), "Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches", *Review of Financial Studies*, 22, 435–480.

[33] Petersen, M. and Rajan R. (1994), "The Benefits of Lending Relationships: Evidence from Small Business Data", *The Journal of Finance*, 49, 3–37.

[34] Puri, M., Rocholl J. and Sascha S. (2010) "On the Importance of Prior Relationships in Bank Loans to Retail Customers"; mimeo, SSRN: http://ssrn.com/abstract=1572673 or http://dx.doi.org/10.2139/ssrn.1572673

[35] Rajan, R. (1992), "Insiders and Outsiders: The Choice Between Informed Investors and Arm's Lenght Debt", *Journal of Finance*, 47(4), 1367–1400.

[36] Schularick, M. and Taylor A.M. (2011), "Credit booms gone bust: monetary policy, leverage and financial crises, 1870-2008", *American Economic Review*, forthcoming.

[37] Sharpe, S.A. (1990), "Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships", *Journal of Finance*, 45(4), 1069–1087.

[38] Stein, J.C. (2002), "Information Production and Capital Allocation: Decentralized Versus Hierarchical Firms", *Journal of Finance*, 57, 1891-1921.

[39] Von Thadden, E. L. (1995), "Long-term contracts, short-term investment and monitoring", *Review of Economic Studies*, 62, 557–575.

Appendix A. Mathematical proofs

Proof of Proposition 1

We shall characterize the equilibrium lending terms and loan refinancing using backwards induction. These lending terms and roll-over decisions will depend on whether we are considering a safe firm for which condition (3) holds ($p \geq \widehat{p}$) or a risky firm ($p < \widehat{p}$).

- If the project is successful, firms are able to repay their loan out of their cash flow V^H. This occurs with probability p_S. In this case the firm continues to period 2 and gets V^H if it is an $H-$firm.
- If the project fails at time $t = 1$, firms with $p \geq \widehat{p}$ will be able to roll over their debts. Their debt will then be rolled over against a promised repayment of $r_T^S(p_S)$ that reflects state of nature S. When with $p \geq \widehat{p}$, $H-$firms are able to make sufficiently high promised expected repayments $\nu_B r_T^B(p_B)$ even in the recession state, so that for these firms we have $r_T(p)$ given by the break-even condition:

$$r_T(p) = 1 + \rho_T.$$

- If, instead $p < \widehat{p}$, liquidation occurs in state B if the firm is not successful, which happens with probability $\theta(1 - p_B)$. The gross interest rate $r_T(p)$ is then given by the break even condition:

$$[p + (1 - \theta)(1 - p_G)]\, r_T(p) + \theta(1 - p_B)V^L = 1 + \rho_T.$$

Proof of Proposition 2

$H-$firms are then able to secure new lending at gross interest rate $r_R^1 = \beta V^H$ in both recession and boom states. Under these conditions, the first period gross interest rate $r_R(p)$ is given by the break-even condition:

$$pr_R(p) + (1 - p)[\overline{\nu}(1 - m)\beta V^H + (1 - \overline{\nu})V^L] = 1 + \rho_R,$$

where[12]

$$\overline{\nu} \equiv \frac{(1 - \theta)(1 - p_G)\nu_G + \theta(1 - p_B)\nu_B}{(1 - p)}$$

[12] We assume again that the intermediation cost of dealing with an $R-$bank is entirely 'capitalized' in period 0.

Proof of Proposition 3

If $R-$banks have no incentive to roll over the firm's joint debts of $H-$firms, then the benefits of combining the two types of debt are lost and the firm would be better off with 100% $T-$bank financing. Consequently, the combinations of the two types of debt, L_R and L_T, is of interest only in so far as the $R-$bank has an incentive to use its information to restructure the debts of unsuccessful $H-$firms.

This means that combining both types of debts only makes sense if the following constraint is satisfied:

$$\beta V^H(1-m) - r_T^{RT} L_T \geq L_R V^L. \tag{19}$$

The LHS represents what the $R-$bank obtains by rolling over all the period $t = 1$ debts of an unsuccessful $H-$firm. When there is a combination of $T-$debt and $R-$debt, a roll-over requires not only that the $R-$bank extends a new loan to allow the firm to repay r_R^{RT} at $t = 1$, but also that it extends a loan to allow the firm to repay r_T^{RT} to the $T-$bank. As a result, the $R-$bank can hope to get only $\beta V^H(1-m) - r_T^{RT} L_T$ by rolling over an unsuccessful $H-$firm's debts. This amount must be greater than what the $R-$bank can get by liquidating the firm at $t = 1$, namely $L_R V^L$.

$T-$banks know that if they are lending to an $H-$firm their claim will be paid back by the $R-$bank, provided the above condition (19) is met. So they will obtain the par value, r_T^{RT} for sure if they lend to an $H-$firm and a fraction L_T of the residual value V^L if, instead the firm is an $L-$firm. The corresponding rate is therefore:

$$r_T^{RT} = \frac{(1+\rho_T) - (1-p)(1-\overline{\nu})V^L}{p + (1-p)\overline{\nu}}. \tag{20}$$

As intuition suggests, constraint (19) holds only if the amount of $T-$bank debt the firm takes on is below some threshold. To establish this, note that replacing $L_R = 1 - L_T$ condition (19) can be rewritten as:

$$\beta(1-m)V^H - V^L \geq L_T(r_T^{RT} - V^L). \tag{21}$$

Substituting for r_T^{RT} we obtain that the following maximum amount of transaction lending is consistent with efficient restructuring:

$$L_T \left[\frac{(1+\rho_T) - (1-p)(1-\overline{\nu})V^L}{p + (1-p)\overline{\nu}} - V^L \right] \leq \beta V^H(1-m) - V^L, \tag{22}$$

which simplifies to:

$$L_T \left[\frac{(1+\rho_T) - V^L}{p + (1-p)\overline{\nu}} \right] \leq \beta V^H (1-m) - V^L \tag{23}$$

Implying that:

$$L_T \leq \frac{(p + (1-p)\overline{\nu}) \left[\beta V^H (1-m) - V^L \right]}{1 + \rho_T - V^L}.$$

As the firm optimally chooses the amounts L_T and L_R, it will choose the combination that maximizes Π^{RT}, which is equivalent to minimizing the total funding cost ϕ

$$\phi = p\, r_R^{RT}(p)(1 - L_T) + p\, r_T^{RT} L_T$$

under the constraint (19) that guarantees that the $R-$bank has an incentive to restructure $H-$firms.

The expression for ϕ can be simplified by using the break even constraint for the $R-$bank, which is given by:

$$\begin{aligned} & p\, r_R^{RT}(1 - L_T) + \\ & (1-p) \left[\overline{\nu}((1-m)\beta V^H - r_T^{RT} L_T) + (1-\overline{\nu})(1-L_T)V^L \right] \\ & \qquad = (1+\rho_R)(1-L_T) \end{aligned} \tag{24}$$

or,

$$p\, r_R^{RT}(1 - L_T) =$$
$$(1+\rho_R)(1-L_T) - (1-p) \left[\overline{\nu}((1-m)\beta V^H - r_T^{RT} L_T) + (1-\overline{\nu})(1-L_T)V^L \right]$$

Collecting terms in L_T on the right hand side we then get:

$$p\, r_R^{RT}(1 - L_T) =$$

$$\begin{aligned} & L_T[-(1+\rho_R) + (1-p)(\overline{\nu} r_T^{RT} + (1-\overline{\nu})V^L)] + (1+\rho_R) \\ & -(1-p) \left[\overline{\nu}(1-m)\beta V^H + (1-\overline{\nu})V^L \right] \end{aligned} \tag{25}$$

Replacing $p r_R^{RT}(1 - L_T)$ by its value in (25) and ignoring constant factors we thus obtain the equivalent funding cost minimization problem :

$$\min_{L_T} [-(1+\rho_R) + ((1-p)\overline{\nu} + p) r_T^{RT} + (1-p)(1-\overline{\nu})V^L)] L_T$$

But notice that the coefficient

$$[-(1+\rho_R)+((1-p)\overline{\nu}+p)r_T^{RT}+(1-p)(1-\overline{\nu})V^L)]>0$$

as r_T^{RT} satisfies

$$((1-p)\overline{\nu}+p)r_T^{RT}+(1-p)(1-\overline{\nu})V^L=1+\rho_T$$

and $\rho_R>\rho_T$.

Consequently the condition (19) is always binding. This allows to replace L_T in (24) leading to:

$$pr_R^{RT}(1-L_T)+(1-p)V^L=(1+\rho_R)(1-L_T) \qquad (26)$$

thus obtaining the expression for r_R^{RT}.

Proof of Proposition 4

Let $\Delta\Pi=\Pi^T-\Pi^{RT}$ denote the difference in expected payoffs for an $H-$firm from choosing 100% $T-$financing over mixed financing, where

$$\Pi^T=p(2V^H-r_T(p))+(1-\theta)(1-p_G)(V^H-\frac{r_T(p)}{\nu_G})+\theta(1-p_B)(V^H-\frac{r_T(p)}{\nu_B})$$

for $p\geq\widehat{p}$, where $r_T(p)=1+\rho_T$ and

$$\Pi^T=p(2V^H-r_T(p))+(1-\theta)(1-p_G)(V^H-\frac{r_T(p)}{\nu_G})$$

for $p<\widehat{p}$, where

$$r_T(p)=\frac{1+\rho_T-\theta(1-p_B)V^L}{\theta p_B+1-\theta}$$

and,

$$\Pi^{RT}=p(2V^H-r_R^{RT}(p)(1-L_T)-r_T^{RT}(p)L_T)+(1-p)(1-\beta)V^H$$

- Consider first the case $p\geq\widehat{p}$

  Combining these expressions $\Delta\Pi$ can be written as follows:

$$\begin{aligned}\Delta\Pi(p) &= p(r_R^{RT}(p)(1-L_T)+r_T^{RT}(p)L_T-r_T(p))\\ &+(1-\theta)(1-p_G)[\beta V^H-\frac{r_T(p)}{\nu_G}]+\\ &+\theta(1-p_B)(\beta V^H-\frac{r_T(p)}{\nu_B})\end{aligned} \qquad (27)$$

The first term,

$$p(r_R^{RT}(1-L_T)+r_T^{RT}(p)L_T)-r_T(p)),$$

reflects the difference in the costs of funding when the firm is successful, which occurs with probability p. The other terms measure the difference for a non successful firm between the benefits of relationship banking and those of transactional banking.

To simplify the expression for $\Delta\Pi(p)$ let

$$\Sigma \equiv p[r_R^{RT}(p)(1-L_T)+r_T^{RT}(p)L_T]$$

From the break even condition (24) we then obtain that

$$\begin{aligned}\Sigma &= (1+\rho_R)(1-L_T)+(1-p)\overline{\nu}\ r_T^{RT}(p)L_T \\ &\quad +p\ r_T^{RT}(p)L_T-(1-p)\left[\overline{\nu}(1-m)\beta V^H+(1-\overline{\nu})(1-L_T)V^L\right]\end{aligned}$$

Substituting for

$$r_T^{RT}=\frac{(1+\rho_T)-(1-p)(1-\overline{\nu})V^L}{p+(1-p)\overline{\nu}}$$

the above expression simplifies to:

$$\Sigma=(1+\rho_R)-(\rho_R-\rho_T)L_T-(1-p)\left[\overline{\nu}(1-m)\beta V^H+(1-\overline{\nu})(1-L_T)V^L\right]-(1-p)(1-\overline{\nu})L_TV^L \tag{28}$$

Substituting for Σ in $\Delta\Pi(p)$ we obtain:

$$\begin{aligned}\Delta\Pi(p) &= \Sigma-p\ r_T(p)+(1-\theta)(1-p_G)[(1-\beta)V^H-\frac{r_T(p)}{\nu_G}]+ \\ &\quad \theta(1-p_B)\left[\beta)V^H-\frac{r_T(p)}{\nu_B}\right]\end{aligned}$$

we obtain:

$$\Delta\Pi(p) = (1+\rho_R) - (\rho_R - \rho_T)L_T^* - \tag{29}$$

$$(1-p)\left[\overline{\nu}(1-m)\beta V^H + (1-\overline{\nu})V^L\right] - p(1+\rho_T) + (1-p)\beta V^H$$

$$-(1+\rho_T)[\frac{(1-\theta)(1-p_G)}{\nu_G} + \frac{\theta(1-p_B)}{\nu_B}]$$

Differentiating with respect to p_B and noting that

$$\frac{dp_G}{dp_B} = \frac{dp}{dp_B} = 1$$

and that:

$$\frac{dL_T^*}{dp} = \frac{(1-\overline{\nu})\left[\beta V^H(1-m) - V^L\right]}{1+\rho_T}$$

$$\frac{d\Delta\Pi(p)}{dp_B} = -(\rho_R - \rho_T)\frac{dL_T^*}{dp_B} - \frac{d(1-p)\overline{\nu}}{dp_B}\left[(1-m)\beta V^H - V_L\right] \tag{30}$$

$$+V_L - (1+\rho_T) - \beta_M V^H$$

$$+(1+\rho_T)[\frac{(1-\theta)}{\nu_G} + \frac{\theta}{\nu_B}]$$

Using

$$\frac{d(1-p)\overline{\nu}}{dp_B} = -\left[(1-\theta)\nu_G + \theta\nu_B\right]$$

and

$$\frac{dL_T^*}{dp_B} = \frac{\left[(1-m)\beta V^H - V^L\right]}{1+\rho_T}(1 - [(1-\theta)\nu_G + \theta\nu_B])$$

we further obtain:

$$\frac{d\Delta\Pi(p)}{dp_B} = -(\rho_R - \rho_T)\frac{\left[(1-m)\beta V^H - V^L\right]}{1+\rho_T}(1 - [(1-\theta)\nu_G + \theta\nu_B]) \quad (31)$$

$$+ [(1-\theta)\nu_G + \theta\nu_B]\left[(1-m)\beta V^H - V^L\right]$$

$$+ V^L - (1+\rho_T) - \beta V^H$$

$$+ (1+\rho_T)[\frac{(1-\theta)}{\nu_G} + \frac{\theta}{\nu_B}]$$

Or, equivalently,

$$\frac{d\Delta\Pi(p)}{dp_B} = -(\rho_R - \rho_T)\frac{\left[(1-m)\beta V^H - V^L\right]}{1+\rho_T}(1 - [(1-\theta)\nu_G + \theta\nu_B]) \quad (32)$$

$$- [(1-\theta)\nu_G + \theta\nu_B]\, m\beta V^H$$

$$- (\beta V^H - V^L)(1 - [(1-\theta)\nu_G + \theta\nu_B])$$

$$+ (1+\rho_T)[\frac{(1-\theta)}{\nu_G} + \frac{\theta}{\nu_B} - 1]$$

Now, under assumption **A1** the first two terms are negligeable, while under assumption **A2** the last two terms are positive, leading to $\frac{d\Delta\Pi(p)}{dp_B} > 0$.

- Next, consider the case $p < \widehat{p}$.

Proceeding as before, $\Delta\Pi$ can be written as follows:

$$\begin{aligned} \Delta\Pi(p) &= p(r_R^{RT}(p)(1-L_T) + r_T^{RT}(p)L_T - r_T(p)) \\ &\quad + (1-\theta)(1-p_G)[\beta V^H - \frac{r_T(p)}{\nu_G}] + \\ &\quad - \theta(1-p_B)(1-\beta)V^H \end{aligned} \quad (33)$$

We will simply show that A1 and A2 are sufficient conditions for $\Delta\Pi(p) < 0$

The first term,

$$p(r_R(p)(1-L_T)+r_T^{RT}(p)L_T)-r_T(p)),$$

reflects the difference in the costs of repaying the loan when the firm is successful, which occurs with probability p. The other terms measure the difference for a non successful firm between the benefits of relationship banking and those of transactional banking.

To simplify the expression for $\Delta\Pi(p)$ let

$$\Sigma \equiv p[r_R^{RT}(p)(1-L_T)+r_T^{RT}(p)L_T]$$

From the break even condition (24) we then obtain that

$$\begin{aligned}\Sigma &= (1+\rho_R)(1-L_T)+(1-p)\overline{\nu}r_T^{RT}(p)L_T \\ &\quad +p\; r_T^{RT}(p)L_T-(1-p)\left[\overline{\nu}(1-m)\beta V^H+(1-\overline{\nu})(1-L_T)V^L\right]\end{aligned}$$

Substituting for

$$r_T^{RT}=\frac{(1+\rho_T)-(1-p)(1-\overline{\nu})V^L}{p+(1-p)\overline{\nu}}$$

the above expression simplifies to:

$$\Sigma=(1+\rho_R)-(\rho_R-\rho_T)L_T-(1-p)\left[\overline{\nu}(1-m)\beta V^H+(1-\overline{\nu})V^L\right] \quad (34)$$

Substituting for Σ in $\Delta\Pi(p)$ we obtain:

$$\begin{aligned}\Delta\Pi(p) &= \Sigma-p\;r_T(p)+(1-\theta)(1-p_G)[(\beta V^H-\frac{r_T(p)}{\nu_G}]+ \\ &\quad -\theta(1-p_B)\left[(1-\beta)V^H\right]\end{aligned}$$

As $\nu_G<1$, the expression $p\;r_T(p)+(1-\theta)(1-p_G)\frac{r_T(p)}{\nu_G}$ has a lower bound $\Gamma=r_T(p)\left[p+(1-\theta)(1-p_G)\right]$

but $p+(1-\theta)(1-p_G)=\theta p_B+1-\theta$, so that replacing $r_T(p)$ we obtain $\Gamma=1+\rho_T-\theta(1-p_B)V^L$

As a consequence, we obtain

$$\begin{aligned}\Delta\Pi(p) &< \Sigma - \Gamma + (1-\theta)(1-p_G)\beta V^H + \\ &-\theta(1-p_B)\left[(1-\beta)V^H\right]\end{aligned}$$

which after replacement of Σ and Γ leads to

$$\begin{aligned}\Delta\Pi(p) &< (\rho_R - \rho_T)(1-L_T^*) \\ &-(1-p)\left[\overline{\nu}(1-m)\beta V^H + (1-\overline{\nu})V^L\right] + (1-p)\beta V^H \\ &+\theta(1-p_B)V^L - \theta(1-p_B)V^H\end{aligned} \tag{35}$$

Rearranging terms this expression becomes:

$$\begin{aligned}\Delta\Pi(p) &< (\rho_R - \rho_T)(1-L_T^*) + (1-p)m\beta V^H \\ &-(1-p)\left[\overline{\nu}\beta V^H + (1-\overline{\nu})V^L\right] + (1-p)\beta V^H \\ &-\theta(1-p_B)(V^H - V^L)\end{aligned} \tag{36}$$

that is

$$\begin{aligned}\Delta\Pi(p) &< (\rho_R - \rho_T)(1-L_T^*) + (1-p)m\beta V^H \\ &+(1-p)(1-\overline{\nu})\left[\beta V^H - V^L\right] \\ &-\theta(1-p_B)(V^H - V^L)\end{aligned} \tag{37}$$

Under A1 the first two terms are small. Under A2 $\left[\beta V^H - V^L\right]$ is also small so that the last term dominates and $\Delta\Pi(p) < 0$.

Appendix B. Technical details regarding the data

We construct the database by matching four different sources.

i) The Credit Register (CR) containing detailed information on all loan contracts granted to each borrower (i.e. the amount lent, the type of loan contract, the tax code of the borrower).

ii) The Bank of Italy Loan Interest Rate Survey, including information on interest rates charged on each loan reported to the CR and granted by a sample of more than 200 Italian banks; this sample accounts for more than 80% of loans to non-financial firms and is highly representative of the universe of Italian banks in terms of bank size, category and location. We investigate overdraft facilities (credit lines) for three main reasons. First, this kind of lending represents the main liquidity management tool for firms – especially the small ones (with fewer than 20 employees) that are prevalent in Italy – which cannot afford more sophisticated instruments. Second, since these loans are highly standardized among banks, comparing the cost of credit among firms is not affected by unobservable (to the econometrician) loan-contract-specific covenants. Third, overdraft facilities are loans granted neither for some specific purpose, as is the case for mortgages, nor on the basis of a specific transaction, as is the case for advances against trade credit receivables (Berger and Udell, 1995).

iii) The Supervisory Reports of the Bank of Italy, from which we obtain the bank-specific characteristics (size, liquidity, capitalization, funding structure). Importantly, for all the banks in the sample, we obtain information on the credit concentration of the local credit market in June 2008. We compute Herfindahl indexes for each province (similar to counties in the US) using the data on loans granted by banks.

iv) The CERVED database, which includes balance sheet information on about 500,000 companies, mostly privately owned. Balance sheet data are taken at $t-1$. This is important since credit decisions in t on how to set firms' interest rates on credit lines are based on balance sheet information that has typically a lag.[13]

We match these four sources obtaining a dataset of bank-firm lending re-

[13] For more information, see http://www.cerved.com/xportal/web/eng/aboutCerved/aboutCerved.jsp. The methodology for the calculation of the $Z-$score, computed annually by CERVED, is provided in Altman et al. (1994).

Table B1 Summary statistics

Z score in 2008:Q4	Obs.	T-bank (1)	Credit History (2)	LTD	Log Loans	Spread 2007:Q2 (3)	Spread 2010:Q1 (3)
1=Safe	4,045	0.68	10.92	0.991	7.48	3.81	5.38
2=Solvent	7,968	0.69	10.36	0.995	7.65	3.94	5.65
3=Vulnerable	67,614	0.71	10.33	0.981	7.89	4.39	6.33
4=Risky	106,697	0.72	9.35	0.963	7.91	4.88	7.33
Total	186,324	0.72	9.78	0.971	7.88	4.64	6.86

Note: (1) Share of loans that is granted by a bank that has its headquarter outside the same province where the firm has its headquarter. (2) Number of years elapsed since the first time a borrower was reported to the Credit register. (2) Interest rate on credit lines minus one month interbank rate.

lationships. In the paper we focus on multiple lending by selecting those firms which have a credit line with at least two Italian banks in June 2008. This limits the analysis to 216,000 observations. However, around 80% of Italian non-financial firms have multiple lending relationships, so this selection does not limit our study from a macroeconomic point of view.

We clean outliers from the data, cutting the top and bottom fifth percentile of the distribution of the dependent variables we use in the regression. An observation has been defined as an outlier if it lies within the top or bottom fifth percentile of the distribution of the dependent variables ($r_{j,k}$ and $L_{j,k}$). After these steps our sample reduces to around 185,000 observations (75,000 firms), which we use for the empirical analysis. The following table gives some basic information on the main variables used in the regressions.

Appendix C. Robustness checks

We have checked the robustness of the results in several ways.

(1) *Main bank*. As there is not a clear consensus on the way relationship characteristics are identified, we have tested the robustness of the results by including in the baseline regressions an additional measure of relationship banking, namely a dummy for the "main bank". In particular, we have first calculated the share of loans granted by each bank to the firm and constructed two variables: i) the highest share of lending granted by the

main bank ($Maxsh$); ii) a dummy ($Main$) that is equal to one if that bank grants the highest share of lending to the firm. However, as in several cases many banks had a pretty low and similar share of total lending, we have decided to consider as "main bank" only those financial intermediaries that granted not only the highest share but also at least one quarter of the total loans.

We have therefore modified equations (11)-(13) for the marginal probit model, the interest rate ($r_{j,k}$) and outstanding loans in real terms ($L_{j,k}$) in the following way:

$$MP(\textit{Firm k's default}= \textit{1}) = \alpha+\zeta+\pi T-share_k+\lambda Maxsh_k+\kappa(T-share_k*Maxsh_k)+\varepsilon_k \tag{11'}$$

$$r_{j,k} = \nu+\beta+\gamma T-bank_{j,k}+\varpi Main_{j,k}+\iota(T-bank_{j,k}*Main_{j,k})+\varepsilon_{j,k} \tag{12'}$$

$$L_{j,k} = \delta+\phi+\mu T-bank_{j,k}+\tau Main_{j,k}+\delta(T-bank_{j,k}*Main_{j,k})+\varepsilon_{j,k} \tag{13'}$$

where α, ν and δ are bank-fixed effects, ζ is a vector of industry fixed effects, β and ϕ are firm-fixed effects.

The results reported in Table C1.1 indicates that the highest the share of loan granted to a firm the lower is the probability that the firm goes into default. At the same time, the effect of transactional loans on default probability is still in place and similar in magnitude with respect to that in Table 3. In particular, the probability for a firm to go into default increases with the share of $T-$bank financing and reach the maximum of around 0.4% when $T-share_k$ is equal to 1. This result remains pretty stable by enriching the set of controls with additional firm-specific characteristics (see panel II in Table C1) or by calculating the proportion of transactional loans $T-share_k$ not in value but in terms of the number of banks that finance firm k (see panel III in Table C1).

The main results of our work remain also with respect to the two cross-sectional equations (12') and (13'). In line with the predictions of the model, Table C2 indicates that $T-$banks (compared to $R-$banks) provide loans at a cheaper rate in good time and at a higher rate in bad time (see columns I and II). As for loan quantities, other things being equal, T-banks always provide on average a lower amount of lending, especially in bad times (see columns III and IV). Interestingly, we find that a bank with a high share of lending to a given firm tends to grant *always* lower interest rates and to further reduce the cost of credit by more in time of crisis. However, we also find that the main bank reduce the amount of loans in a crisis. This finding is consistent with the result in Gambacorta and Mistrulli (2013) and may be interpreted as the effect of more bank risk aversion and a greater need to diversify credit risk following the crisis.

(2) *Region instead than province.* One possible objection to the definition used for the relationship dummy $R-$bank is that considering the bank and the firm as "close" only if both have headquarter in the same province could be too restrictive. For example, banks may be able to get soft information, i.e. information that is difficult to codify, which is a crucial aspect of lending relationships, also if they are headquartered inside the same region where the firm has is main seat.

We have therefore replicated the results of Table 3 and Table 4 in the main text by using a different definition for relationship and transaction banks. In particular, the $R-$bank dummy is equal to 1 if firm k is headquartered in the same region (instead than the province) where bank j has its headquarters; $T-$bank is equal to 1 if $R-$bank=0. Results reported in Tables C3 and C4 are very similar to those in the main text. Interestingly, the absolute values of coefficients are slightly reduced pointing to the fact that informational asymmetries increase with functional distance.

(3) *All foreign banks are T-banks.* In the paper we divide $R-$banks and $T-$banks according to the distance between the lending bank headquarters (at the single bank level, not at the group level) and firm headquarters. This raises some questions for foreign banks (subsidiaries and branches of foreign banks). Following this definition, branches of foreign banks are always $T-$banks. This classification is correct because lending strategic decisions are typically taken by the bank's headquarter located outside Italy.

However, these loans have not a big weigh in the database and represent only 0.04% of the cases. On the contrary, subsidiaries of foreign banks are treated as the Italian banks. This hypothesis seems plausible as these banks have legal autonomy and are subject to Italian regulation. However, to test the robustness of the results we have therefore replicated the estimations reported in Table 3 and Table 4 by imposing that all foreign bank headquartered in Italy and with legal autonomy (around 7% of observations) are $T-$banks. This means that the $T-$bank dummy is equal to 1 if firm k is not headquartered in the same province where bank j has its headquarters or bank j is a foreign bank; $R-$bank is equal to 1 if $T-$bank$=0$. Even in this robustness test results are very similar to the baseline case (see Tables C5 and C6).

(4) *New firms.* One of the main hypothesis of the model is that at $t = 0$ no bank can distinguish firms' type. To make the empirical part closer to the theoretical onet we have therefore estimated equation (11)-(13) on a subset of around 6,000 "new firms", that entered the credit register in the period 2005:Q2:2007:Q2. The results are qualitatively very similar to that obtained from the baseline equations (see Tables C7 and C8).

Figure 1

Average firm cash flows in state S

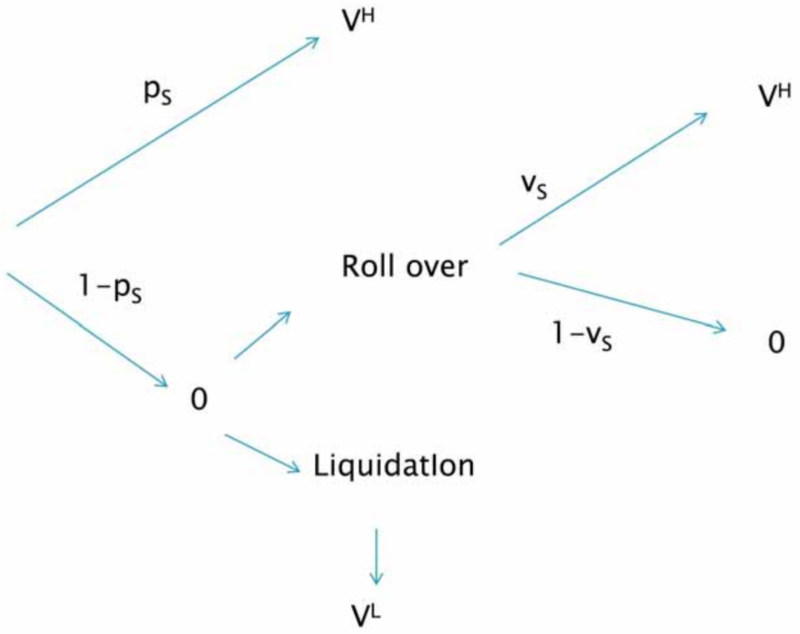


Figure 2

100% Transactional Banks Payoff

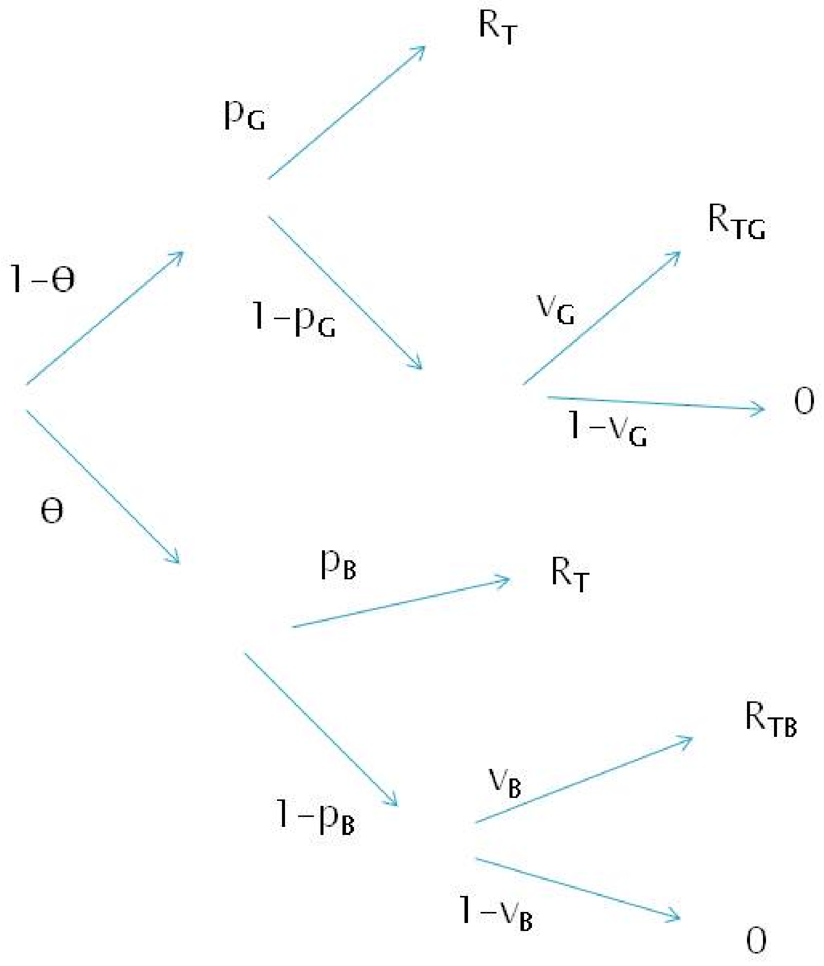
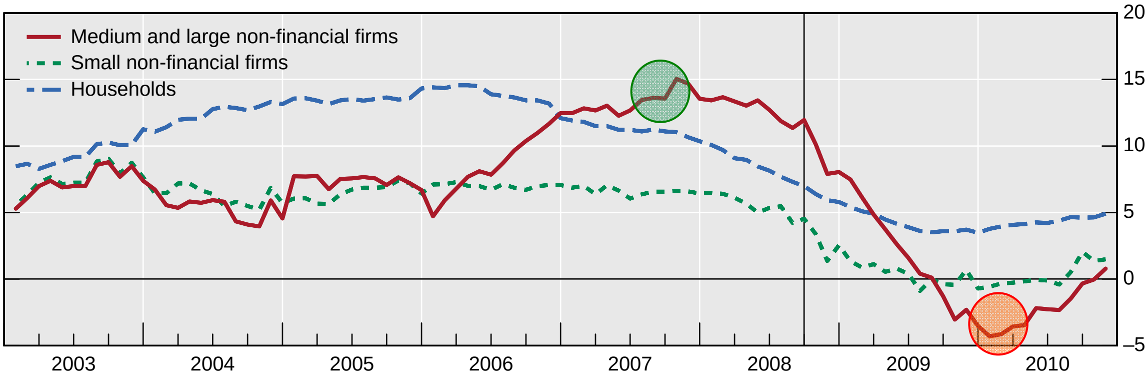


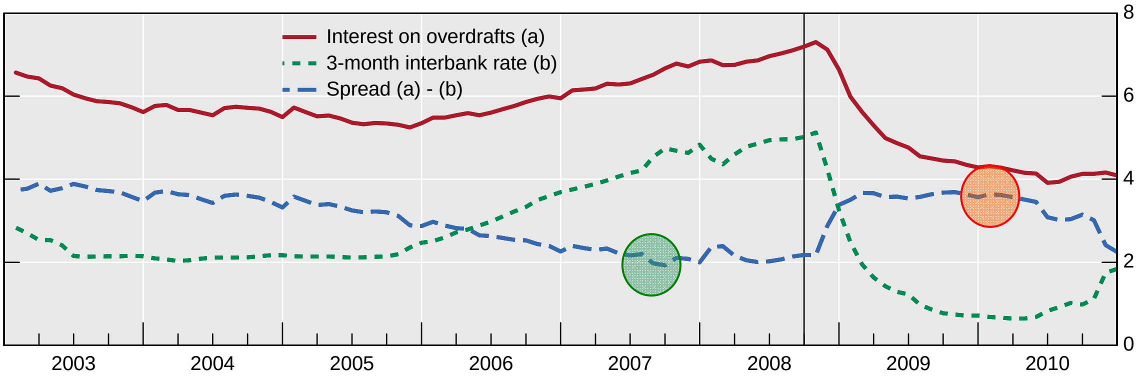
Figure 3

Bank lending, interest rates and the business cycle in Italy

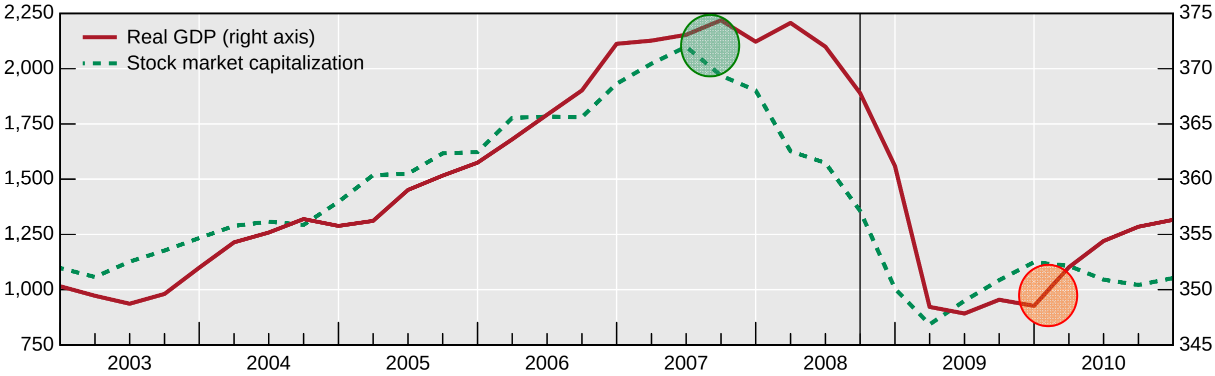
(a) Bank lending to the private sector[1, 2]



(b) Interest rate on overdraft and interbank rate[1, 3]



(c) Real GDP and stock market capitalization[4, 5]



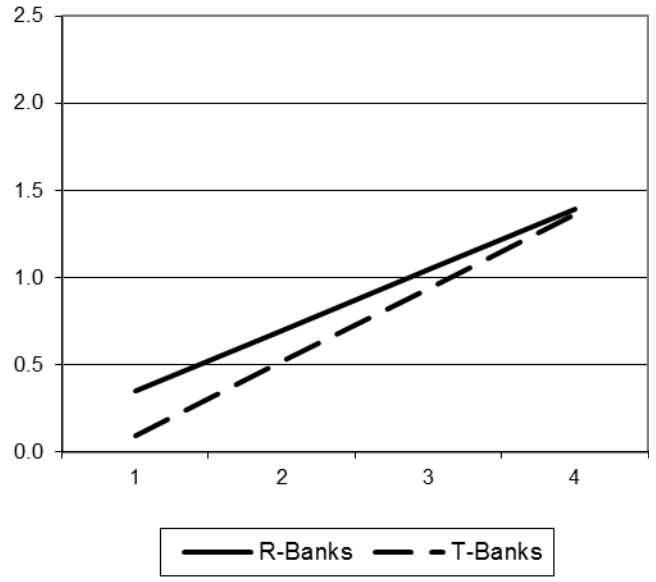
Notes. The vertical line indicates Lehman's default. [1] Monthly data. [2] Annual growth rates. Bad loans are excluded. The series are corrected for the impact of securitization activity. [3] Percentage points. Current account overdrafts are expressed in euro. [4] Quarterly data. [5] Real GDP in billions of euro. Stock market capitalization refers to the COMIT Globale Index, 31 Dec. 1972 = 100.

Sources: Bank of Italy; Bloomberg.

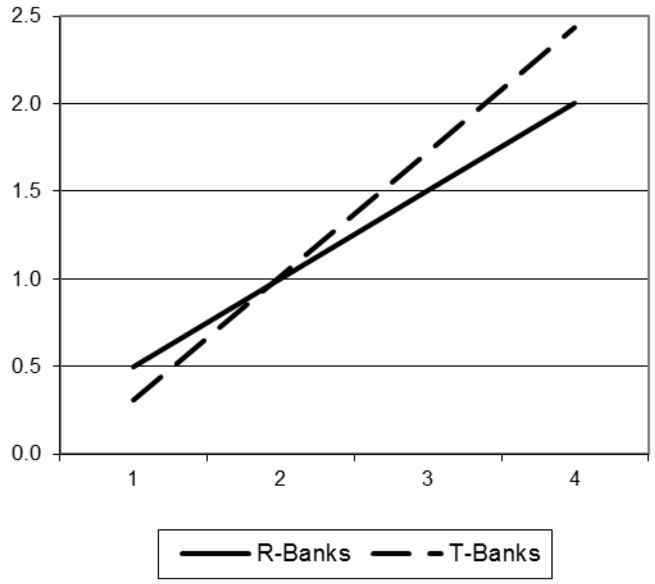
Figure 4

Lending supply and interest rate setting by banks' type and state of the world[1]

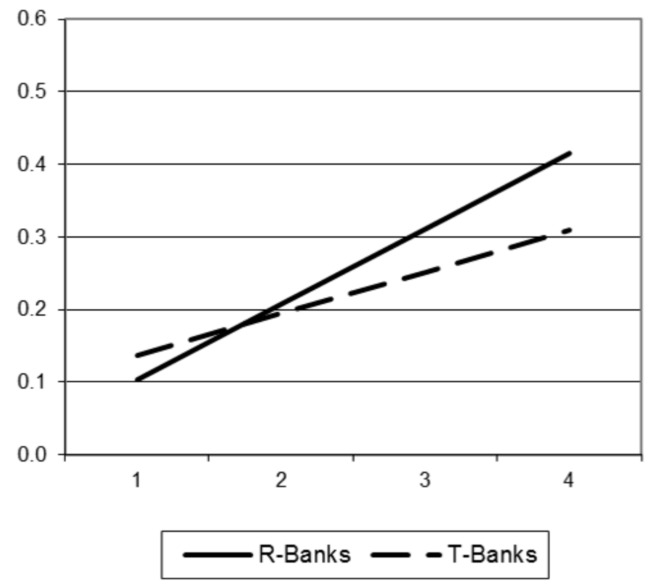
(a1) Interest rate: good times (2007:q2)



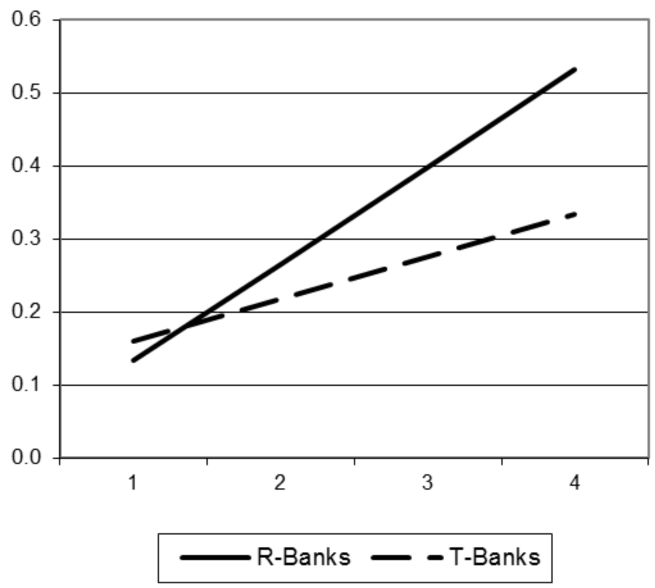
(a2) Interest rate: bad times (2010:q1)



(b1) Lending: good times (2007:q2)



(b2) Lending: bad times (2010:q1)

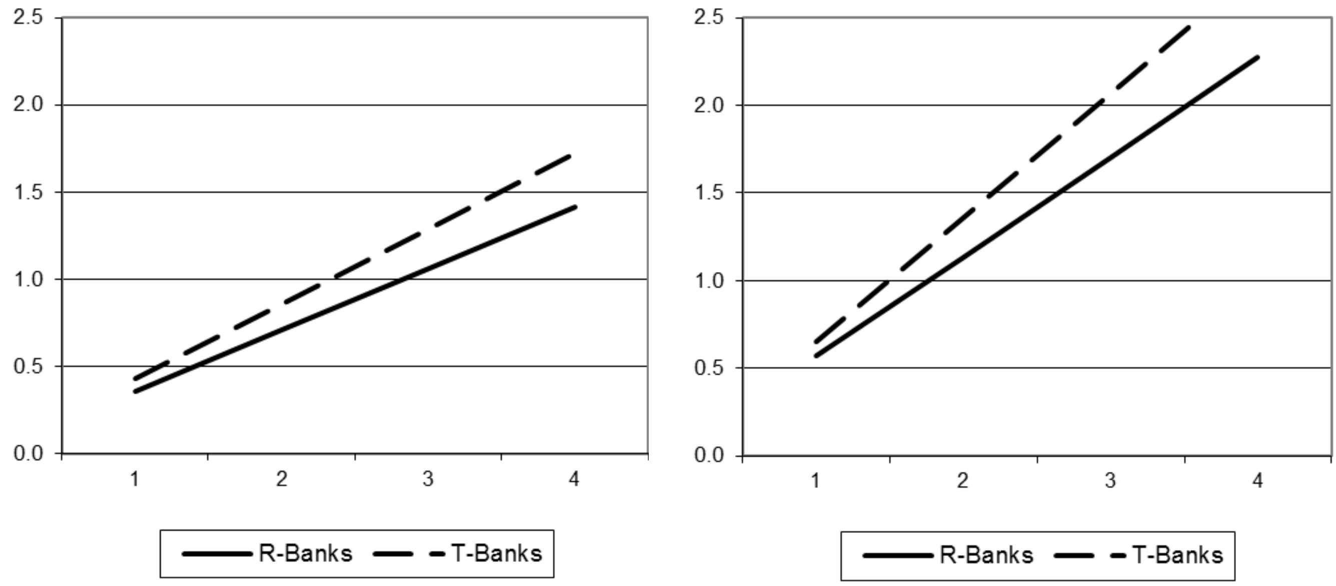


[1] This figure reports a graphical representation of the results in Table 5. The horizontal axis of each graph reports the Z-score, an indicator of the probability of default of firms. These scores can be mapped into four levels of risk: 1) safe; 2) solvent; 3) vulnerable; 4) risky. The vertical axis of graphs (a1) and (a2) indicate the level of the interest rate applied by the two bank types on credit lines to the 4 different kinds of firms; those of graphs (b1) and (b2) report the log of lending in real terms supplied by the two bank types.

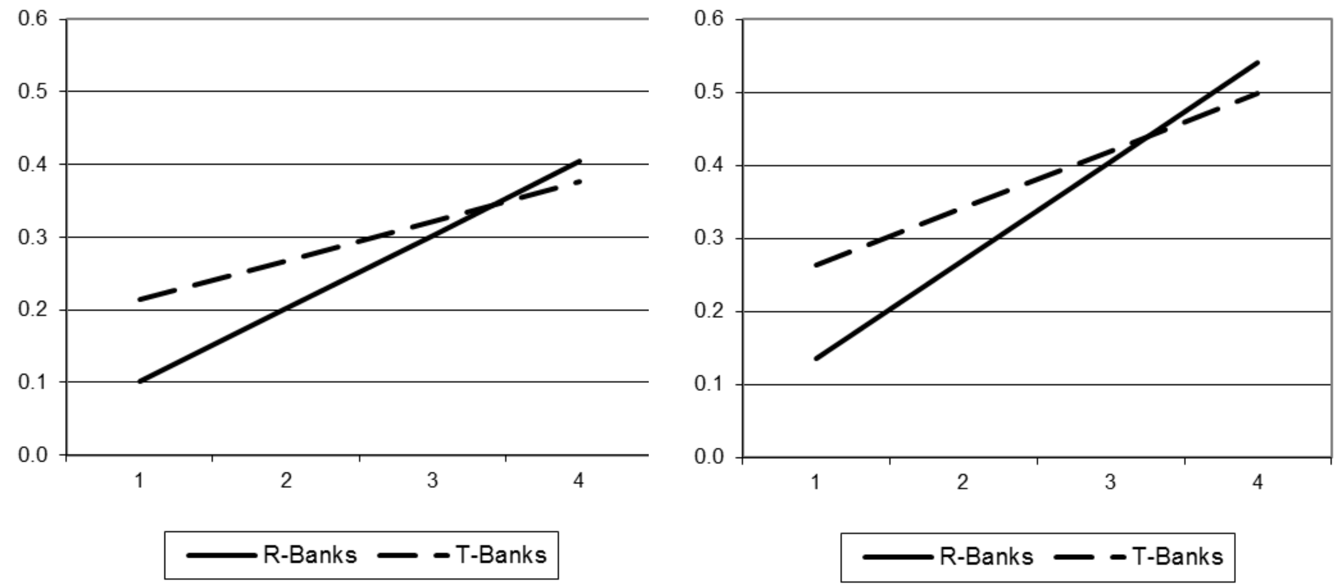
Figure 5

Graphical analysis of the results in Table 5 without fixed effects[1]

(a1) Interest rate: good times (2007:q2) | (a2) Interest rate: bad times (2010:q1)



(b1) Lending: good times (2007:q2) | (b2) Lending: bad times (2010:q1)



[1] This figure reports a graphical representation of the results obtained re-running the same models reported in Table 5 without fixed effects. The horizontal axis of each graph reports the Z-score, an indicator of the probability of default of firms. These scores can be mapped into four levels of risk: 1) safe; 2) solvent; 3) vulnerable; 4) risky. The vertical axis of graphs (a1) and (a2) indicate the level of the interest rate applied by the two bank types on credit lines to the 4 different kinds of firms; those of graphs (b1) and (b2) report the log of lending in real terms supplied by the two bank types.

Table 1 Relationship vs transactional lending: Theory

Possible explanations of relationship vs transactional lending	I. Delinquency rate	II. Lending rates		III. Lending quantities	
	Bad time	Good time	Bad time	Good time	Bad time
1. Risk-sharing	R=T	R>T	R>T	R>T	R>T
2. Interim monitoring	R>T	R>T	R>T	?	?
3. Ex-ante screening	R<T	R>T	R>T	R=T	R=T
4. Learning	R<T	R>T	R<T	?	?

Notes: R= Relationship bank (R-bank); T= Transaction bank (T-bank)

Table 2 Descriptive statistics. Bank-firm relationship

Bank-firm loan types	Obs.	%	Spread good time (2007:q2) (a)	Spread bad time (2010:q1) (b)	(b) -(a)	Log Loans good time (2007:q2) (c)	Log Loans bad time (2010:q1) (d)	(d) -(c)	Capital to asset ratio (2007:q2) (e)	Capital to asset ratio (2010:q1) (f)	(f)-(e)
					ALL FIRMS						
i) Relationship only	18693	10.1%	4.3	6.2	1.9	7.74	7.73	-0.011	9.103	8.794	-0.31
ii) Both types	84598	45.8%	4.5	6.7	2.2	7.96	8.00	0.036	8.843	8.743	-0.10
iii) Transactional only	81604	44.1%	4.8	7.1	2.3	7.78	7.81	0.029	8.547	8.793	0.25
Total	184895	100.0%	4.6	6.8	2.2	7.86	7.89	0.028	8.739	8.770	0.03
					H-FIRMS						
i) Relationship only	18489	10.1%	4.2	6.2	1.9	7.74	7.73	-0.006	9.096	8.79	-0.30
ii) Both types	84129	45.9%	4.5	6.7	2.2	7.95	7.99	0.039	8.543	8.56	0.02
iii) Transactional only	80493	44.0%	4.8	7.1	2.3	7.77	7.80	0.032	8.842	8.79	-0.05
Total	183111	100.0%	4.6	6.8	2.2	7.85	7.88	0.031	8.730	8.69	-0.04
					L-FIRMS						
i) Relationship only	206	11.6%	6.0	9.0	3.0	8.07	7.90	-0.169	8.98	8.70	-0.28
ii) Both types	439	24.6%	5.9	9.4	3.5	8.54	8.33	-0.207	8.949	9.04	0.09
iii) Transactional only	1139	63.8%	6.3	9.7	3.5	8.17	8.06	-0.113	8.648	8.88	0.24
Total	1784	100.0%	6.2	9.6	3.4	8.25	8.11	-0.143	8.760	8.90	0.14

Note: L-Firms are those that went into default in the period 2008:q3-2010:q1, H-Firms are the remaining ones.

Table 3 Effect of Bank-firm relationship on the marginal probability of a firm's default

Dependent variable: P($default_k$=1)	(I) Baseline equation		(II) Firm specific characteristics		(III) Alternative Weight	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
T-share (in value)	0.0032	***	0.0029	***		
	(0.0008)		*(0.0007)*			
T-share (number of banks)					0.0028	***
					(0.0007)	
Z			0.0051	***	0.0051	***
			(0.0005)		*(0.0001)*	
LTD			-0.0002		-0.0002	
			(0.0018)		*(0.0018)*	
Small firm			-0.0021		-0.0021	
			(0.0034)		*(0.0034)*	
CREDIT_HISTORY			-0.0002	***	-0.0001	***
			(0.0000)		*(0.0000)*	
Bank fixed effects	Yes		Yes		Yes	
Industry-province dummies	Yes		Yes		Yes	
Number of obs.	72,489		72,489		72,489	
Pseudo R^2	0.1273		0.1395		0.1397	

The models estimate the marginal probability for a firm k to go into default in the period 2008:q3-2010:q1. All explanatory variables are evaluated at 2008:q2, prior Lehman's default. The variable T- Share indicates the proportion of loans that firm k has borrowed from a transactional bank. We report the share both in loan value and in terms of number of T-banks. Parameter estimates are reported with robust standard errors in brackets (cluster at individual bank level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for industry-province dummies and bank fixed effects are not reported.

Table 4 T-banking and R-banking in good times and bad times

Variables	Interest rate good time (2007:q2) (I)	Interest rate bad time (2010:q1) (II)	Log Loans good time (2007:q2) (III)	Log Loans bad time (2010:q1) (IV)
T-Bank	-0.0805***	0.1227***	-0.2753***	-0.3129***
	(0.0174)	(0.0210)	(0.0123)	(0.0110)
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Number of obs.	184,859	184,859	184,859	184,859
Adjusted R-squared	0.529	0.585	0.426	0.473

Notes: The models in column (I) and (III) are estimated in 2007:q2; those in columns (II) and (IV) in 2010:q1. The dummy T-Bank takes the value of 1 if the lending relationship is with a transactional bank. The coefficients represent the difference relative to relationship banking (R-banks). Parameter estimates are reported with robust standard errors in brackets (cluster at individual firm level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for fixed effects are not reported.

Table 5 Comparing T-banking, R-banking and firms' quality

Variables	Interest rate good time (2007:q2) (I)	Interest rate bad time (2010:q1) (II)	Log Loans good time (2007:q2) (III)	Log Loans bad time (2010:q1) (IV)
T-Bank	-0.3309***	-0.3977***	0.0795*	0.1023**
	(0.0604)	(0.0737)	(0.0393)	(0.0413)
R-Bank*Z	0.3479***	0.5016***	0.1036***	0.1329***
	(0.0148)	(0.0178)	(0.0115)	(0.0096)
T-Bank*Z	0.4238***	0.7076***	0.0575***	0.0577***
	(0.0119)	(0.0151)	(0.0092)	(0.0062)
US>GR	0.8825***	1.5181***	0.6887***	0.5667***
	(0.0193)	(0.0192)	(0.0093)	(0.0075)
LTD	-0.3697***	-0.3760***	-0.0603*	-0.0796***
	(0.0453)	(0.0561)	(0.0330)	(0.0213)
Small firm	-0.0854	0.2037	-0.3993***	-0.4688***
	(0.2295)	(0.2463)	(0.0968)	(0.0784)
CREDIT_HISTORY	-0.0475***	-0.0619***	0.0460***	0.0404***
	(0.0020)	(0.0023)	(0.0013)	(0.0009)
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	no	no	no	no
Industry-province dummies	yes	yes	yes	yes
Number of obs.	184,859	184,859	184,859	184,859
Adjusted R-squared	0.1776	0.2065	0.0865	0.0857

Notes: The models in column (I) and (III) are estimated in 2007:q2; those in columns (II) and (IV) in 2010:q1. The dummy T-Bank takes the value of 1 if the lending relationship is with a transactional bank. The coefficients represent the difference relative to relationship banking (R-banks). Parameter estimates are reported with robust standard errors in brackets (cluster at individual bank level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for industry-province dummies and fixed effects are not reported.

Table 6 Lending relationship and bank-capital

Variables	Interest rate good time (2007:q2) (I)	Interest rate bad time (2010:q1) (II)	Log Loans good time (2007:q2) (III)	Log Loans bad time (2010:q1) (IV)
T-Bank	-0.0792**	0.1940**	-0.1625***	-0.2208***
	(0.0402)	(0.0734)	(0.0282)	(0.0289)
CAP	0.0096	-0.0426***	-0.0112	0.0113**
	(0.0185)	(0.0123)	(0.0086)	(0.0052)
US>GR	0.1881***	0.1611***	0.5315***	0.1403***
	(0.0228)	(0.0430)	(0.0174)	(0.0193)
MUTUAL	-0.7812***	-1.0057***	0.0573	0.0569
	(0.1284)	(0.1066)	(0.0378)	(0.0523)
Bank group and rescue dummies	yes	yes	yes	yes
Bank zone dummies	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Number of obs.	184,859	184,859	184,859	184,859
Adjusted R-squared	0.4856	0.5433	0.4161	0.4530

Notes: The models in column (I) and (III) are estimated in 2007:q2; those in columns (II) and (IV) in 2010:q1. The dummy T-Bank takes the value of 1 if the lending relationship is with a transactional bank. The coefficients represent the difference relative to relationship banking (R-banks). Parameter estimates are reported with robust standard errors in brackets (cluster at individual bank group level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for dummies and firm fixed effects are not reported.

Table 7 Capital endowment and bank type

Variables	Baseline model (I)	Bank-specific characteristics (II)	Firm-specific characteristics (III)	Financially constrained firms (IV)
T-share	-3.839***	-3.276**	-3.091**	-3.203**
	(0.890)	(1.301)	(1.267)	(1.265)
Bank size		-0.040	0.090	0.092
		(0.280)	(0.268)	(0.264)
Bank liquidity ratio		-0.009	-0.011	-0.003
		(0.016)	(0.019)	(0.017)
Retail ratio		0.049***	0.031*	0.029*
		(0.017)	(0.017)	(0.017)
Proportion of small firms in the bank's credit portfolio			6.169	5.972
			(4.248)	(4.115)
Proportion of LTD firms in the bank's credit portfolio			-2.422	-2.141
			(3.723)	(3.712)
Average Z-score of the bank's credit portfolio			-1.611	-1.337
			(2.468)	(2.563)
Proportion of financially constrained firms (US>GR)				5.392
				(6.603)
Bank zone dummies	yes	yes	yes	yes
Number of obs.	179	179	179	179
Adjusted R-squared	0.130	0.185	0.217	0.218

Notes: The dependent variable is the regulatory capital/risk-weighted asset ratio at 2008:q2 prior to Lehman's default. The variable T-share represents the proportion of transactional loans (in value) for bank j. It takes the value from 0 (pure R-bank) to 1 (pure T-bank). All bank-specific characteristics and credit portfolio characteristic are at 2008:q1. Parameter estimates are reported with robust standard errors in brackets (cluster at individual bank level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for bank zone dummies are not reported.

Table C1 Effect of Bank-firm relationship on the marginal probability of a firm's default. Including Main bank dummy and its interaction with T-share.

Dependent variable: P($default_k$=1)	(I) Baseline equation		(II) Firm specific characteristics		(III) Alternative Weight	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
T-share (in value)	0.0042	***	0.0036	***		
	(0.0011)		*(0.0009)*			
T-share (number of banks)					0.0036	***
					(0.0015)	
Maxsh	-0.0123	***	-0.0108	***	-0.0106	***
	(0.0022)		*(0.0018)*		*(0.0019)*	
Maxsh*T-share(in value)	-0.0041	*	-0.0033	*		
	(0.0023)		*(0.0019)*			
Maxsh*T-share(number of banks)					-0.0035	*
					(0.0020)	
Z			0.0048	***	0.0048	***
			(0.0004)		*(0.0004)*	
LTD			-0.0006		-0.0006	
			(0.0017)		*(0.0017)*	
Small firm			-0.0020		-0.0020	
			(0.0032)		*(0.0032)*	
CREDIT_HISTORY			-0.0002	***	-0.0002	***
			(0.0001)		*(0.0001)*	
Bank fixed effects	Yes		Yes		Yes	
Industry-province dummies	Yes		Yes		Yes	
Number of obs.	72,489		72,489		72,489	
Pseudo R^2	0.0782		0.1190		0.1190	

The models estimate the marginal probability for a firm k to go into default in the period 2008:q3-2010:q1. All explanatory variables are evaluated at 2008:q2, prior Lehman's default. The variable T-Share indicates the proportion of loans that firm k has borrowed from a transactional bank. We report the share both in loan value and in terms of number of T-banks. The variable Maxsh indicates the highest share of lending that is granted by the main bank. Parameter estimates are reported with robust standard errors in brackets (cluster at individual bank level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for industry-province dummies and bank fixed effects are not reported.

Table C2 T-banking and R-banking in good times and bad times. Including Main bank dummy and its interaction with T-bank.

Variables	Interest rate good time (2007:q2) (I)	Interest rate bad time (2010:q1) (II)	Log Loans good time (2007:q2) (III)	Log Loans bad time (2010:q1) (IV)
T-Bank	-0.0896***	0.1086***	-0.1504***	-0.2067***
	(0.0201)	(0.0243)	(0.0121)	(0.0116)
Main	-0.0969***	-0.1705***	1.1652***	0.8594***
	(0.0232)	(0.0281)	(0.0130)	(0.0130)
Main*T-Bank	-0.0080	-0.0233	0.0325	0.0125
	(0.0301)	(0.0361)	(0.0366)	(0.0164)
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Number of obs.	184,859	184,859	184,859	184,859
Adjusted R-squared	0.529	0.586	0.585	0.570

Notes: The models in column (I) and (III) are estimated in 2007:q2; those in columns (II) and (IV) in 2010:q1. The dummy T-Bank takes the value of 1 if the lending relationship is with a transactional bank. The coefficients represent the difference relative to relationship banking (R-banks). The dummy Main is equal to one if that bank grants the highest share of lending to that firm. Parameter estimates are reported with robust standard errors in brackets (cluster at individual firm level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for fixed effects are not reported.

Table C3 Effect of Bank-firm relationship on the marginal probability of a firm's default. Changing relationship lending definition from province to region.

Dependent variable: P(default$_k$=1)	(I) Baseline equation		(II) Firm specific characteristics		(III) Alternative Weight	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
T-share (in value)	0.0024	***	0.0024	***		
	(0.0007)		*(0.0007)*			
T-share (number of banks)					0.0034	***
					(0.0007)	
Z			0.0051	***	0.0051	***
			(0.0004)		*(0.0004)*	
LTD			-0.0002		-0.0002	
			(0.0018)		*(0.0018)*	
Small firm			-0.0020		-0.0018	
			(0.0034)		*(0.0035)*	
CREDIT_HISTORY			-0.0001	**	-0.0002	**
			(0.0000)		*(0.0000)*	
Bank fixed effects	Yes		Yes		Yes	
Industry-province dummies	Yes		Yes		Yes	
Number of obs.	72,489		72,489		72,489	
Pseudo R^2	0.0612		0.1004		0.1003	

The models estimate the marginal probability for a firm k to go into default in the period 2008:q3-2010:q1. All explanatory variables are evaluated at 2008:q2, prior Lehman's default. The variable T- Share indicates the proportion of loans that firm k has borrowed from a transactional bank. We report the share both in loan value and in terms of number of T-banks. Parameter estimates are reported with robust standard errors in brackets (cluster at individual bank level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for industry-province dummies and bank fixed effects are not reported.

Table C4 T-banking and R-banking in good times and bad times. Changing relationship lending definition from province to region.

Variables	Interest rate good time (2007:q2) (I)	Interest rate bad time (2010:q1) (II)	Log Loans good time (2007:q2) (III)	Log Loans bad time (2010:q1) (IV)
T-Bank	-0.0748***	0.1038***	-0.2428***	-0.256***
	(0.0182)	(0.0217)	(0.0123)	(0.0110)
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Number of obs.	184,859	184,859	184,859	184,859
Adjusted R-squared	0.529	0.585	0.426	0.472

Notes: The models in column (I) and (III) are estimated in 2007:q2; those in columns (II) and (IV) in 2010:q1. The dummy T-Bank takes the value of 1 if the lending relationship is with a transactional bank. The coefficients represent the difference relative to relationship banking (R-banks). Parameter estimates are reported with robust standard errors in brackets (cluster at individual firm level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for fixed effects are not reported.

Table C5 Effect of Bank-firm relationship on the marginal probability of a firm's default. All foreign banks subsidiaries are T-banks.

Dependent variable: P($default_k$=1)	(I) Baseline equation		(II) Firm specific characteristics		(III) Alternative Weight	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
T-share (in value)	0.0031	***	0.0027	***		
	(0.0009)		*(0.0007)*			
T-share (number of banks)					0.0027	***
					(0.0007)	
Z			0.0051	***	0.0051	***
			(0.0004)		*(0.0004)*	
LTD			-0.0002		-0.0002	
			(0.0018)		*(0.0018)*	
Small firm			-0.0021		-0.0021	
			(0.0034)		*(0.0034)*	
CREDIT_HISTORY			-0.0002	**	-0.0002	**
			(0.0000)		*(0.0000)*	
Bank fixed effects	Yes		Yes		Yes	
Industry-province dummies	Yes		Yes		Yes	
Number of obs.	72,489		72,489		72,489	
Pseudo R^2	0.0600		0.0994		0.0994	

The models estimate the marginal probability for a firm k to go into default in the period 2008:q3-2010:q1. All explanatory variables are evaluated at 2008:q2, prior Lehman's default. The variable T- Share indicates the proportion of loans that firm k has borrowed from a transactional bank. We report the share both in loan value and in terms of number of T-banks. Parameter estimates are reported with robust standard errors in brackets (cluster at individual bank level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for industry-province dummies and bank fixed effects are not reported.

Table C6 T-banking and R-banking in good times and bad times. All foreign banks subsidiaries are T-banks.

Variables	Interest rate good time (2007:q2) (I)	Interest rate bad time (2010:q1) (II)	Log Loans good time (2007:q2) (III)	Log Loans bad time (2010:q1) (IV)
T-Bank	-0.0844***	0.1030***	-0.2737***	-0.2970***
	(0.0180)	(0.0218)	(0.0128)	(0.0115)
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Number of obs.	184,859	184,859	184,859	184,859
Adjusted R-squared	0.529	0.585	0.426	0.473

Notes: The models in column (I) and (III) are estimated in 2007:q2; those in columns (II) and (IV) in 2010:q1. The dummy T-Bank takes the value of 1 if the lending relationship is with a transactional bank. The coefficients represent the difference relative to relationship banking (R-banks). Parameter estimates are reported with robust standard errors in brackets (cluster at individual firm level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for fixed effects are not reported.

Table C7 Effect of Bank-firm relationship on the marginal probability of a firm's default. New Firms.

Dependent variable: P(default$_k$=1)	(I) Baseline equation		(II) Firm specific characteristics		(III) Alternative Weight	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
T-share (in value)	0.0120	**	0.0073	**		
	(0.0054)		(0.0035)			
T-share (number of banks)					0.0067	**
					(0.0033)	
Z			0.0036		0.0036	
			(0.0024)		(0.0024)	
LTD			-0.0018		-0.0018	
			(0.0073)		(0.0073)	
Small firm			0.0070		0.0070	
			(0.0025)		(0.0025)	
CREDIT_HISTORY			0.0033		0.0033	
			(0.0035)		(0.0035)	
Bank fixed effects	Yes		Yes		Yes	
Industry-province dummies	Yes		Yes		Yes	
Number of obs.	5,866		5,866		5,866	
Pseudo R^2	0.0596		0.1470		0.1470	

The models estimate the marginal probability for a firm k to go into default in the period 2008:q3-2010:q1. All explanatory variables are evaluated at 2008:q2, prior Lehman's default. The variable T- Share indicates the proportion of loans that firm k has borrowed from a transactional bank. We report the share both in loan value and in terms of number of T-banks. Parameter estimates are reported with robust standard errors in brackets (cluster at individual bank level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for industry-province dummies and bank fixed effects are not reported.

Table C8 T-banking and R-banking in good times and bad times. New Firms.

Variables	Interest rate good time (2007:q2) (I)	Interest rate bad time (2010:q1) (II)	Log Loans good time (2007:q2) (III)	Log Loans bad time (2010:q1) (IV)
T-Bank	-0.0844***	0.1030***	-0.2737***	-0.2970***
	(0.0180)	(0.0218)	(0.0128)	(0.0115)
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Number of obs.	5,866	5,866	5,866	5,866
Adjusted R-squared	0.529	0.585	0.426	0.473

Notes: The models in column (I) and (III) are estimated in 2007:q2; those in columns (II) and (IV) in 2010:q1. The dummy T-Bank takes the value of 1 if the lending relationship is with a transactional bank. The coefficients represent the difference relative to relationship banking (R-banks). Parameter estimates are reported with robust standard errors in brackets (cluster at individual firm level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for fixed effects are not reported.