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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 to profitable firms during a crisis. Due to the services they provide, operating costs of relationship-banks are higher than those of transaction-banks. Relationship-banks charge a higher intermediation spread in normal times, but offer continuation-lending at more favourable terms than transaction banks to profitable firms in a

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crisis. Using credit register information for Italian banks before and after the Lehman Brothers' default, we test the theoretical predictions of the model. (*JEL: E44, G21*)

1 Introduction[1]

How do banks help their corporate borrowers through a crisis? Beyond providing loans to firms, commercial banks have long been thought to play a larger role than simply screening loan applicants one transaction at a time. By building a relationship with the firms they lend to, banks also play a continuing role of managing firms' financial needs as they arise, whether in response to new investment opportunities or to a crisis. What determines whether a bank and a firm build a long-term relation, or whether they simply engage in a market transaction? And, how do relationship and transaction lending differ in a crisis? Our knowledge so far is still limited. To quote Allen Berger, "What we think we know about small versus large banks (...) in small business lending may not be true and we know even less about them

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during financial crises".[2] We address these questions from both a theoretical and empirical perspective.

Existing theories of relationship banking typically do not allow for aggregate shocks and crises. Thus, we expand the relationship lending model of Bolton and Freixas (2006) by introducing an aggregate shock along idiosyncratic cash-flow risk for non-financial corporations. In the expanded model firms differ in their exposure to the aggregate shock and therefore may have different demands for the financial flexibility provided by relationship banking. To be able to bring the model to the data we introduce a further critical modification to the Bolton and Freixas model by allowing firms to borrow from multiple banks on either a transaction or relationship basis.[3]

The main predictions from the theoretical analysis are four. First, the firms relying on a banking relation (or, for short, $R-$banking) are better able to weather a crisis and are less likely to default than firms relying only on transaction lending (or $T-$banking), 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. Second, the firms relying on $R-$banks are prepared

[2] Keynote address, Conference on Small Business Financing, ECB, Frankfurt, 13 December 2012. See also Berger et al (2014).

[3] The Bolton and Freixas (2006) model of relationship banking considers firms' choice of the optimal mix of financing between a long-term banking relationship and funding through a corporate bond issue. Most firms in practice are too small to be able to tap 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) these firms do have a choice between multiple sources of bank lending (see also Bolton and Scharfstein, 1996; Houston and James, 1996; Farinha and Santos, 2002).

to pay higher borrowing costs on their relationship loans in normal times in order to secure better continuation financing terms in a crisis. Interest rates on $R-$loans are countercyclical: they are higher than interest rates on $T-$loans in normal times and lower in crisis times. Third, firms will generally seek a mix of relationship lending and transaction lending. Fourth, relationship banks need a capital buffer to be used in order to preserve the lending relationship in bad times.

We test these predictions by looking at bank lending to firms in Italy before and after the Lehman Brother's default. We use the extremely detailed credit registry information on corporate lending by Italian banks, which allows us to track Italian firms' borrowing behavior before and after the crisis of 2008-09 at the individual firm and bank level. The empirical analysis confirms the predictions of the model. In particular, 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 and financial flexibility advantage of relationship banking.

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. Our sample covers loan contracts by a total of 179 Italian banks to more than 72.000 firms over the time period ranging from 2007 to 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 characteristics of their loans, without additional specific information on the banks firms are borrowing from.[4] Our results also complement the findings in Bodenhorn (2003), who uses data for a single bank to study the effects of relationship lending during the credit crunch that occurred in 1857 in the United States, and Jiangli, Unal, and Yom (2008), who analyze the effects of relationship banking during the 1998 Asian crisis by means of a private-sector, firm-level survey conducted by the World Bank.[5]

While the above mentioned studies are able to control for either bank or firm specific characteristics, we are able to do so for both, 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 precisely uncover the effects of bank-firm relationship characteristics on lending. It turns out that our results differ significantly depending on whether we include or exclude these fixed effects, revealing that the lack of detailed information on each loan may lead to biases if, as one may expect, the heterogeneity of banks (small, regional, large, mutual, etc.) maps into different lending behaviors that only bank fixed effects can iden-

[4] They have a dummy variable taking the value 1 if the loan has been granted by a bank and 0 if granted by another financial institution, but they do not have information on which bank has granted the loan and they do not have balance sheet information on the bank.

[5] More generally, our work relates to the vast literature on the determinants of relationship lending and its effect on firms' access to credit in non-crisis times; see Boot (2000), Ongena and Smith (2000), and Degryse, Kim, and Ongena (2009) for exhaustive reviews.

tify. Also, unlike the vast majority of existing empirical studies, our database includes detailed information on interest rates for each loan. This allows us to investigate bank interest rate determination in good and bad times in a direct way, without relying on any assumptions.[6]

A related study by Santos and Winton (2008) comparing the choice between syndicated bank loans and public bond issues focuses on a different set of firms from ours, namely US publicly traded firms. It considers a somewhat different empirical question: Its main finding is that in recessions loan spreads rise more for more bank-dependent issuers (under their definition, those issuers with no recent public bond issues). They attribute this greater rise in loan spreads to the greater market power of banks dealing with more bank-dependent firms.[7] These findings are not necessarily inconsistent with ours, as they do not preclude the possibility that for the more bank-dependent firms the relative cost of capital of a bank loan relative to a bond issue is

[6]One of the main novelties of our paper is that we match our findings using testable predictions derived from a theoretical model. In particular, we derive implications on the level of interest rates for *T-banking* and *R-banking* in normal and crisis times that have not been tested so far. In a related paper Gambacorta and Mistrulli (2014) 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 (2015) consider 2008:Q3-2009:Q3. Albertazzi and Marchetti (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 of focusing on changes), using a theoretical model to discipline our econometric analysis. 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 directly comparable, they are consistent with the findings in the above cited papers.

[7]More recently, Santos (2011) also found that during and following the subprime crisis, firms borrowing from banks with larger losses paid higher loan spreads.

lower in recessions. Indeed, the more bank-dependent firms might well get better terms on bond issues in booms and, by revealed preference, they have chosen the cheaper alternative in recessions.

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.

Related Literature: Relationship banking can take different forms, and most of the existing literature emphasizes benefits from a long-term banking relation to borrowers that are different from the financial flexibility benefits that we model. The first models on relationship banking portray the relation 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 relation between a bank and a firm might play out, they do not 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. They also do not allow for any firm bargaining power at the default and renegotiation stage, as we do following Diamond and Rajan (2000, 2001, and 2005).

The second-generation studies of relationship banking that consider this question and that have been put to the data focus on three different and interconnected roles for an $R-$bank: insurance, monitoring and screening. A first strand of studies focuses on the (implicit) insurance role of $R-$banks against the risk of changes in future credit terms (Berger and Udell, 1992; Berlin and Mester 1999); a second strand focuses on the monitoring role of $R-$banks (Holmstrom and Tirole 1997, Boot and Thakor 2000, Hauswald and Marquez 2006); and a third strand plays 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). Our theory is closest to a fourth strand which emphasizes the $R-$banks' ability to learn about changes in the borrower's creditworthiness, and to adapt lending terms to the evolving circumstances the firm finds itself in (Rajan, 1992 and Von Thadden, 1995). Interestingly, these four different strands have somewhat different empirical predictions. Overall, our empirical results suggest that only the predictions of the fourth strand of theories are fully confirmed in our data. While all theories predict that $R-$banks have lower loan delinquency rates than $T-$banks, only the fourth strand of theories predicts that $T-$banks raise loan interest rates more than $R-$banks in crisis times.

The structure of the paper is the following. In Section 2 we describe the theoretical model of $T-$banking and $R-$banking and in Section 3 the combination of the two forms of funding by firms. In Section 4 we compare the firm's benefits from pure $T-$banking with the ones of mixed finance, and the implication for the capital buffers the banks have to hold. In Section 5 we describe the database and in Section 6 we test the model's predictions. Section 7 compares our results with those derived by other types of theories of relationship banking. The last section 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 combine borrowing from a bank offering relationship-lending services, an $R-$bank, with borrowing from a bank offering only transaction services, a $T-$bank. As we motivate below, $R-$banks have higher intermediation costs than $T-$banks, $\rho_R > \rho_T$, because they have to hold a larger buffer of costly 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 at $t = 1$ 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 $t = 1$.[8]

We denote the firms' probability of success at $t = 1$ in each state $S = G, B$ as p_S, with $p_G > p_B \geq 0$, and the firm's ex-ante expected probability of success as $p = \theta p_B + (1-\theta)p_G$. We further simplify our model by making the idiosyncratic high (V^H) and low (0) payoffs of firms at $t = 2$ 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

[8] A model with potentially infinitely-lived firms subject to periodic cash-flow shocks would be a better representation of reality. In a simplified way our model can be reinterpreted so that the value of β takes already into account this long run impact on firms' reputation. Still, a systematic analysis of intertemporal effects would require tracking the balance sheets for both the firm and the two types of banks as state variables of the respective value functions and would lead to an extremely complex model.

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 that a firm is of type H after it has defaulted in $t = 1$ 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.

Firms differ in the observable ex-ante probability of success p. 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 $t = 1$. At time $t = 1$, $T-$banks have no additional information. If the firm does not repay, the bank has the right to liquidate the firm and obtains V^L. But the firm's debt can also be rolled over against a promised repayment $r_T^S(p_S)$ at time $t = 2$ (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 $t = 2$). The roll-over can be by either the original $T-$bank or by any competing $T-$bank. The promised repayment $r_T^S(p_S)$ cannot exceed V^H, the $H-$firm's second period pledgeable cash flow (recall that the pledgeable cash-flow for an $L-$firm is zero). Thus, if a new $T-$bank's belief ν_S that it is dealing with an $H-$firm is high enough that

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

it will be happy to roll over the loan $r_T(p)$. 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

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

If $r_T(p) > \nu_S V^H$ only the original $T-$bank may still be willing to roll over the loan: If the firm defaults at time $t = 1$ the original bank obtains the liquidation value of the firm's assets V^L.[9] Therefore, the original bank is willing to roll over the loan if and only if $V^L \leq \nu_S V^H$.

For simplicity, we will assume that in the boom state an unsuccessful firm will always be able to roll over its debt $r_T(p)$ with another $T-$bank. That is, we will assume that the following sufficient condition holds:

$$\frac{r_T((1-\theta)\Delta)}{\nu_G} \leq V^H.$$[10]

In the recession state, we assume that $V^L > \nu_B V^H$, so that the original $T-$bank will never want to roll over the loan. However, firms with a high probability of success will still be able to roll over the loan with a new $T-$bank if ν_B is such that

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

This will occur only for values of p_B above some threshold $\hat{p}_B$ for which condition (2) 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, 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 re-

[9]For simplicity firms in bankruptcy cannot be reorganized and must be liquidated. The general idea is that default involves efficiency losses, so that the value V^L can also be thought of as the maximum of the firm's reorganization and liquidation values in bankruptcy.

ceives 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,[11] 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 compensates the bank for its higher unit funding costs $\rho_R > \rho_T$.

   The higher unit cost of funding is due to the need to hold higher amounts of capital in anticipation of future roll-overs. It can be shown, by an argument along the lines of Bolton and Freixas (2006), that since R-banks refinance H-firms, and do so by supplying lending to those firms that do not receive a roll-over from $T-$banks, they need additional capital against these future loans.

   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

[11] 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.

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 $(1-\beta)V^H$. We will, of course, assume the $(1-m)\beta V^H > V^L$ so that $R-$banks find it profitable to restructure unsuccessful $H-$firms.

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. Moreover, the riskiest firms, with $p < \widehat{p}$, will not be able to roll over their debts with a $T-$bank in the recession state. This is so because for $p < \widehat{p}$, $T-$loans have a negative net present value.[12] Consequently, firms financed by $T-$banks will either obtain credit from other lenders in a competitive market, (if $p \geq \widehat{p}$ or in the good state of nature G) or else they have a higher value under liquidation. Relationship banking instead offers higher cost loans initially against greater roll-over security but only for $H-$firms.

[12] If a firm is financed exclusively with $T-$loans no bank knows its type, so that, on average, rolling over its loan has a negative net present value in recessions when $p < \widehat{p}$. Recall that firm type (H or L) is assumed to be independent of the probability of success p at time 1. Therefore a $T-$bank cannot learn anything from the firm's failure at time 1. The $T-$bank's prior is only updated in response to the aggregate shock, so that the posterior $\nu_1 \in \{\nu_B, \nu_G\}$.

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. Moreover, we also follow Bolton and Freixas (2000, 2006) in assuming that, with one exception, there is perfect competition among banks in both periods. The exception is that at $t = 1$, $R-$banks face no competition as they benefit from an ex post informational monopoly.[13]. In any case, both $R-$banks and $T-$banks make zero profits over the two periods.

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*

[13]Note that if we reinterpret ρ_T and ρ_R as reflecting the average cost of capital and therefore embodying some rent, the obvious result is that competition among banks is always beneficial.

never liquidated and have repayment obligation r_T^S

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

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:*

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

The equilibrium lending terms in period 0 *are then:*

$$r_T(p) \;=\; 1+\rho_T \text{ for } p \geq \widehat{p}. \tag{3}$$

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

Proof: See Appendix A. ■

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:*

$$r_R(p) = \frac{1 + \rho_R - (1-p)[(1-\overline{\nu})V^L + \overline{\nu}(1-m)\beta V^H]}{\theta p_B + (1-\theta)p_G}. \tag{4}$$

Proof: See Appendix A. ■

Combining T and $R-$banking: 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 to 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 firm has too much $T-$debt. To see this, let L_R and L_T denote the loans granted by respectively an $R-$bank 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 a first 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. A second question concerns the bargaining game at $t = 1$ when the firm is financed with a combination of $R-$loans and $T-$loans.

For simplicity, we assume a sequential structure where the $H-$firm and the $R-$bank move first and strike a restructuring deal. The firm could reject the offer of the $R-$bank and seek to obtain a better deal from a $T-$bank in a second round. However, the $T-$bank does not know why renegotiation with the informed $R-$bank failed. If it failed because the firm is of type L then the $T-$bank does not want to renegotiate its loan either. We solve for an equilibrium where $T-$banks have *pessimistic* out-of-equilibrium beliefs, such that they assume that renegotiation with the $R-$bank failed only because the firm is of type L. These are self-confirming beliefs, as under those beliefs no $H-$firm would ever deviate and seek to renegotiate with a $T-$bank.

Proposition 3: *Conditional on borrowing from an $R-$bank, the optimal loan structure for $H-$firms is to maximize the amount of transactional loans subject to satisfying the relationship lender's roll-over constraint at $t = 1$.*

The firm borrows:

$$L_T = \frac{(p + (1-p)\overline{\nu})\left[\beta V^H(1-m) - V^L\right]}{1 + \rho_T - V^L}. \tag{5}$$

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

$$r_T^{RT} = \frac{(1+\rho_T) - (1-p)(1-\overline{\nu})V^L}{p + (1-p)\overline{\nu}}, \tag{6}$$

and

$$r_R^{RT} = \frac{1}{p}\left[(1+\rho_R) - (1-p)V^L\right], \tag{7}$$

so that $r_R^{RT} > r_T^{RT}$.

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 Appendix A. ■

As intuition suggests pure relationship lending is dominated by a combination of transaction and relationship lending. There is a limit, however, on how much a firm can borrow from a $T-$bank, as the $R-$bank must prefer to roll over the debts of an unsuccessful $H-$firm at $t = 1$ rather than liquidate the firm. In other words, the following roll-over constraint must be satisfied:

$$\beta V^H(1-m) - r_T^{RT} L_T \geq L_R V^L. \tag{8}$$

The left hand side 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 debt 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. The reason why the $R-$bank also repays r_T^{RT} is that otherwise the $T-$bank might bargain for a fraction of the continuation profits of the $H-$firm. This implies that for an $R-$bank to commit to restructure an $H-$firm that has defaulted in the first period it has to have sufficient capital, a point that can be empirically tested. 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 $L_R V^L$.

The proof of Proposition 3 establishes that a firm of type p borrowing from both an $R-$bank and $T-$banks faces the following rate structure:

1. At $t=0$ the cost of borrowing through $T-$loans is lower than for $R-$loans. A firm-type p thus seeks to minimize its funding cost by choosing the highest possible L_T compatible with constraint (8). This firm's cost minimization problem is then given by:

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

subject to (8), where $r_R^{RT}(p)$ is given by the $R-$bank's break-even condition:

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

$$L_T[-(1+\rho_R)+(1-p)(\overline{\nu}r_T^{RT}(p)+(1-\overline{\nu})V^L)]+(1+\rho_R) \tag{9}$$
$$-(1-p)\left[\overline{\nu}(1-m)\beta V^H+(1-\overline{\nu})V^L\right].$$

As we show in the proof of Proposition 3, when we replace $pr_R^{RT}(p)(1-L_T)$ in the firm's objective function by its value in (9), the funding cost minimization problem reduces to:

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

subject to (8). Note that the coefficient multiplying L_T is strictly negative, given that $r_T^{RT}(p)$ satisfies the $T-$bank break-even condition:

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

and since $\rho_R > \rho_T$.

2. At $t=1$, $T-$loans are more expensive than $R-$loans in recessions. This follows immediately from the comparison of $r_R^1=\beta V^H$ and $r_T^B(p_B)=r_T^{RT}(p)/\nu_B$ in recessions. In particular, note that the rate on $T-$loans is then too high for the firm to be able to roll over its $T-$loans:$L_T\frac{r_T^{RT}(p)}{\nu_B} > V^H$.

3. It is, however, possible that $T-$loans are cheaper than $R-$loans in booms. But since $R-$banks have an informational advantage over $T-$banks at $t=1$, $T-$banks will not seek to roll over their debts for fear of exposing themselves to the winner's curse. That is, the $R-$bank will outbid $T-$banks on rollover loans to $H-$firms and will not agree to lend to $L-$firms. Therefore, $T-$banks will leave the rollover decision to the informed $R-$bank in equilibrium.

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 (3).

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% *transaction 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 Appendix A. ■

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

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

and

$$\begin{aligned}\Delta\Pi(1-\theta\Delta) &= (1+\rho_R)-(\rho_R-\rho_T)L_T^*-\theta\Delta\left[\overline{\nu}(1-m)\beta V^H+(1-\overline{\nu})V^L\right] \\ &-(1-\theta\Delta)(1+\rho_T)+\theta\Delta\beta V^H \\ &-(1+\rho_T)[\frac{\theta\Delta}{\nu_B}]. \qquad (11)\end{aligned}$$

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:

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

Also, to obtain $\Delta\Pi((1-\theta)\Delta) < 0$ a sufficient condition is that θ/ν_B is large enough.

To keep the analysis as tractable as possible we have made a number of non-essential yet unrealistic simplifying assumptions. We therefore do not expect our results to be reflected in the data exactly as they are stated in the propositions. Nevertheless, we do expect our main qualitative predictions on interest rates, lending volumes and firms' bankruptcies to be confirmed in the data. Some of the unnecessarily strong assumptions we have made are that:

1. $R-$banks can perfectly observe firm types at $t = 1$ and $H-$firms are riskless;

2. $H-$firm underlying values and therefore $R-$bank interest rates are insensitive to the business cycle;

3. The firms characterized by $p_B < \hat{p}_B$ are exclusively financed by $T-$banks, while the others are financed by a combination of both T and $R-$banks;

4. Banks are either $R-$banks or $T-$banks but not both. This is just a convention, as under our constant returns to scale assumption, the

same bank can in principle be an $R-$bank for one firm and a $T-$bank for another.

Clearly, in practice none of these extreme conditions are likely to be present. Accordingly, the somewhat broader qualitative predictions of our model we put to the data are:

Hypothesis 1: In a crisis, the rate of default on firms financed through transaction loans will be higher than the rate on firms financed by $R-$banks.

Hypothesis 2: $R-$banks charge higher lending rates relative to $T-$banks in good times on the loans they roll over, but in bad times they lower rates. $R-$banks increase their supply of lending (relative to $T-$banks) in bad times.

Hypothesis 3: safer firms prefer a higher proportion of transaction banking while riskier firms prefer to combine transaction banking with relationship banking.

Hypothesis 4: As it is $R-$banks that will restructure the $H-$firms in distress, under rational expectations, the capital buffer for an $R-$loan (which may require additional lending to good firms in distress) is higher than for a $T-$loan.

5 Data description

We next turn to the empirical investigation of relationship-banking over the business cycle. A key test we are interested in is whether $R-$banks charge higher lending spreads in good times and lower spreads in bad times to extend lending to their best clients through the crisis to protect their relationship banking investment. In contrast, we should observe that $T-$banks offer cheaper loans in good times but roll over fewer loans in bad times. Another related prediction from our theoretical analysis we seek to test is whether delinquency rates are lower in bad times for $R-$banks that roll over their loans compared to $T-$banks. We proceed in two steps: First, we analyze whether firms' default probability in bad times depends on whether the loan has been granted by an $R-$bank or a $T-$bank. Second, we analyze (and compare) lending and bank interest rates in good and bad times. The first challenge we face is how to identify two separate periods that correspond to the two states of the world in the model. Our approach is to distinguish and compare bank-firm relationships before and after the Lehman Brothers' default (in September 2008), the event typically used to mark the beginning of the global financial crisis in other studies (e.g. Schularick and Taylor, 2012).

Our dataset comes from the Italian Credit Register (CR) maintained by the Bank of Italy and other sources covering a significant sample of Italian banks and firms. There are at least four advantages in focusing on Italy. First, from Italy's perspective the global financial crisis was largely an unexpected (exogenous) event, which had a sizable impact especially on small and medium-sized firms that are highly dependent on bank financing. Second, although Italian banks have been hit 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). We do not consider the time-period beyond 2011, as it is affected by the European Sovereign debt crisis. Third, multiple lending is a long-standing characteristic of bank-firm relationships in Italy (Foglia et al. 1998, Detragiache et al. 2000). And fourth, the detailed data available for Italy allow us to test the main hypotheses of the theoretical model without making strong assumptions. Mainly, the availability of data at the bank-firm level on both quantity and prices allows us to overcome major identification problems encountered by the existing bank-lending-channel literature in disentangling loan demand from loan supply shifts (see e.g. Kashyap and Stein 1995, 2000).

The visual inspection of bank lending and interest rate dynamics in Figure 3 helps us select two periods that can be considered as good and bad times: We select the second quarter of 2007 as a good time-period when lending reached a peak and the interest rate spread applied to credit lines reached a minimum (see the green circles in panels (a) and (b) of Figure 3). We take the bad time-period to be the first quarter of 2010, which is characterized by a contraction in bank lending to firms and a very high intermediation spread (see the red circles in panels (a) and (b) of Figure 3). The selection of these two time-periods is also consistent with alternative indicators such as real GDP and stock market capitalization (see panel (c) in Figure 3).

Our second challenge is to distinguish between $T-$banks and $R-$banks. One of the distinguishing characteristics of $R-$banks in our theory and other relationship-banking models (Boot 2000; Berger and Udell 2006) is that

$R-$banks gather information about the firms they lend to on an ongoing basis to be able to provide the flexible financing their client firms value. Thus, to identify relationship banking we rely on the informational distance between the lender and the borrower.[14] The empirical banking literature has suggested that the physical distance between a bank and a firm affects the ability of the bank to gather soft information (that is, information that is difficult to codify), which in turn affects the bank's ability to act as a relationship lender (see Agarwal and Hauswald, 2010).

On the theoretical side, Hauswald and Marquez (2006) developed a model arguing that the ability of banks to assess the quality of borrowers is lower when they lend to customers that are far away. This is in line with Stein (2002) who has shown that when the production of soft information is decentralized, incentives to gather it crucially depend on the ability of the agent to convey information to the principal. Indeed, for loan officers who are typically in charge of gathering soft information and passing it through the bank's hierarchical layers, it might be difficult to harden soft information when they are distant from their headquarters.[15] Following Cremer, Garicano and Prat (2007), it may be argued that distance affects the transmission of informa-

[14] There is no clear consensus in the literature on how to identify relationship-lending characteristics. Therefore we have checked the robustness of our results by including as additional controls alternative measures for relationship lending (such as a dummy for the main bank or the length of the bank-firm relationship).

[15] Soft information is gathered through repeated interaction with the borrower and requires proximity. Banks in order to save on transportation costs delegate the production of soft information to branch loan officers since they are the ones within the bank organization which are closest to borrowers.

tion within banks (that is, the ability of branch loan officers to harden soft information), since bank headquarters may be less able to interpret the information they receive from distant branch loan officers than from closer ones. Thus, there exists a trade-off between the efficiency of communication and the breadth of activities covered by an organization, so that communication is more difficult when headquarters and branches are farther apart.

We therefore divide $R-$banks and $T-$banks according to the geographical distance between the lending banks' headquarters and firm headquarters, which we take as a proxy for informational distance.[16],[17] This way a bank can act both as an $R-$bank for a firm headquartered in the same province, and a $T-$bank for firms that are far away. More precisely, we assume that a bank is acting as an $R-$bank if it is headquartered in the province where the firm is headquartered, and as a $T-$bank otherwise.

Our third challenge is to measure credit risk and to distinguish it from asymmetric information. One basic assumption of our theoretical model is that ex ante all banks know that some firms are more risky than others. The measure of firms' credit risk observed ex ante by all banks is given by $(1-p)$ in our model, to which corresponds the firm's $Z-$score in the empirical analysis. [18] The $Z-$scores can be mapped into four levels of risk: 1) safe; 2) solvent;

[16] 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.

[17] Accordingly, branches of foreign banks are treated as $T-$banks.

[18] The Z-score is an indicator of the probability of default which is computed annually by CERVED (see http://www.cerved.com/xportal/web/eng/aboutCerved/aboutCerved.jsp) on balance sheet variables. The methodology is described in Altman et al. (1994).

3) vulnerable; and 4) risky. To match with the empirical model we have inverted the scale in the charts: $Z = 4$ is a low probability, and $Z = 1$ a high probability. Measuring asymmetric information and the role of relationship banks in gathering additional information is obviously more complex. We are clearly not able to observe directly the production of soft information. As a consequence, we can only verify ex post whether relationship banks are really better able than transaction banks to refinance the good firms and liquidate the bad ones. This is why we look at the occurrence of defaults to distinguish $H-$firms from $L-$firms.

Table 1 gives some basic information on the dataset after dropping outliers (for more information see Appendix B). The database includes around 72,500 firms tracked before and after the crisis (a total of around 174,000 bank-firm observations). The table is divided horizontally into three panels: i) all firms, ii) $H-$firms (i.e. firms that have not defaulted during the financial crisis) and iii) $L-$firms (i.e. firms that have defaulted on at least one of their loans). In the rows we divide bank-firm relationships into: i) pure relationship lending: firms which have business relationship with $R-$banks only; ii) mixed banking relationships: firms which have business relationships with both $R-$banks and $T-$banks; iii) pure transactional lending: firms which have business relationships with $T-$banks only.

Several patterns emerge. First, firms who have only relationships with $R-$banks (9% of the cases) or $T-$banks (43% of the cases) are numerous, but the majority of firms borrow from both kinds of banks (48%). Second, the percentage of defaulted firms that received lending only from $T-$banks is relatively high (64% of the total). Third, in the case of pure $R-$banking, or combined RT $-$banking, firms experience a lower increase in the spread in the crisis. Fourth, $R-$banking is associated with a higher level of bank equity-capital ratios, so that $R-$banks have a buffer against contingencies in bad times. The equity-capital slack depends on the business cycle and is depleted in bad times.

It is worth stressing, however, that capital ratios in Table 1 refer to the bank-firm relationship: we compare how much equity a hypothetical bank that supplies a $T-$loan has with respect to one that supplies an $R-$loan. To get a sense of what the capital ratios are for (real) banks specialized in different types of lending, we have divided intermediaries in three groups with a different proportions of transactional loans ($T-$share). The average capital ratio for $R-$banks (those in the first third of the distribution, with a $T-$share of 0.5%) is equal to 9.0%, half a percentage point higher than $T-$banks (those in the last third, with a $T-$share of 94%). Interestingly, the size of the average $T-$bank is more than six times that of the average $R-$bank (165 vs 22 billion). This is consistent with Stein (2002), who points out that the organizational complexity of very large intermediaries may induce them to rely mostly on hard information in order to keep the incentives of the local branch managers and those of their headquarters better aligned.

6 Empirical Findings

The patterns discussed above are broadly in line with the predictions of our theoretical model. However, these findings can only be suggestive as the differences in means reported in Table 1 are never statistical significant given the heterogeneity in the sample. The bank-lending relationship is influenced by many factors that are not controlled for in the sample descriptive statistics. This section econometrically analyses one at a time the four qualitative predictions of the model discussed at the end of Section 4.

6.1 Hypothesis 1: $R-$banks have better information than $T-$banks about firms' credit risk

To verify whether $R-$banks are better able to learn firms' types than $T-$banks we look at the relationship between the probability that a firm k defaults and the firm's relative share of *transactional vs relationship* financing. If $R-$banks have superior information than $T-$banks in a crisis then the rate of default of firms financed through transaction loans will be higher than for firms financed by $R-$banks.

Our baseline cross-sectional equation estimates the marginal probability of default of firm k in the six quarters that follow the Lehman Brothers' default (2008:q3-2010:q1) as a function of the share of loans of firm k from a $T-$bank in 2008:q2. In particular, we estimate the following marginal probit model:

$$MP(\textit{Firm k's default=1}) = \alpha + \zeta + \pi(T - share)_k + \varepsilon_k \qquad (12)$$

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 2 indicate that a firm with more $T-$bank loans has a higher probability of default.[19] This marginal effect increases with the share of $T-$bank financing and reaches a maximum of around 0.3% when $(T - share)_k$ is equal to 1. This effect is not only statistically significant but also important from an economic point of view, as the average default rate for the whole sample in the period of investigation was around 1%. We checked the robustness of this finding by enriching the set of controls with additional firm-specific characteristics: i) the Z-score; ii) a dummy that takes the value of 1 if the firm is a limited liability corporation, and zero elsewhere (LTD); iii) a dummy that takes the value of 1 for firms

[19] The reliability of this test may be biased by the possible presence of "evergreening", that is, postponing the reporting of losses on the balance sheet by rolling over non-performing loans. 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 cannot postpone the reporting of losses for too long a time. We consider the period 2008:Q3-2010:Q1 that is 18 months after the Lehman default, so that there is a higher chance that banks have been reporting losses. Second, both types of banks may have a similar incentive to postpone the reporting of losses (however, this does not rule out the possibility that R-banks evergreen firms by taking over loans from T-banks). Third, should R-banks have a greater incentive to evergreen loans, the definition of default we use limits this problem. Specifically, we consider a firm 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 an R-bank cannot effectively postpone a loss on a non-performing loan if a T-bank (or another R-bank with no incentive to evergreen) will report it.

with less than 20 employees (SMALL_FIRM), and zero elsewhere; iv) 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 last variable tells us how much information has been shared among lenders through the Credit Register over time and is a proxy for firms' reputation building (Diamond, 1989). It is also a proxy for the length of the relationship.

The results presented in the second column of Table 2 do not change. Our findings are also robust to calculating the proportion of transactional loans in terms of the number of banks that finance firm k instead of by the size of outstanding loans (see panel III in Table 2).

The specification in the last column of Table 2 includes as additional controls the interest rate charged by the bank on the firm's credit line prior to the Lehman default and its interaction with the dummy $T-$bank. As expected there is a positive correlation between the interest rate and the default probability. Interestingly, the coefficient on the interaction term $T-$bank*Rate is negative, suggesting that ex-post differences in borrowers' performance were priced more accurately by $R-$banks than $T-$banks.

The robustness of the above results have been checked in several ways. In particular, we have: (1) controlled for heterogeneity among Italian regions; (2) tested for alternative definitions of the relationship dummy $R-$bank; (3) considered all subsidiaries of foreign banks as $T-$banks; (4) estimated equations on a subset of "new firms"; (5) used a panel over the complete period 2007:q1-2010:q1 for a subample of 45% of firms. In all cases results are very similar. [20]

6.2 Hypotheses 2: a) $R-$banks charge higher rates in good times and lower rates in bad times. b) $R-$banks increase their supply of lending (relative to $T-$banks) in bad times.

In the second step of our empirical analysis we investigate bank lending and price setting over the business cycle. Our focus on multiple lending relations at the firm level allows us to solve potential identification issues by including both bank and firm fixed effects in the econometric model. In particular, the inclusion of fixed effects allows us to control for all (observable and unobservable) time-invariant bank and borrower characteristics, and to identify in a precise way the effects of bank-firm relationships on the interest rate charged and the loan amount.[21]

We estimate two regressions: one for the interest rate ($r_{j,k,t}$) applied by bank j on the credit line of firm k, and the other for the logarithm of

[20] For more details see Appendix C in the online annex.

[21] To highlight this point we have re-run all the models without bank and firm fixed effects. The results (not reported for the sake of brevity but available from the authors upon request) indicate that $T-$bank coefficients are often different and may even change sign. In particular, when we do not introduce fixed-effects $T-$banks are shown to supply relatively more lending but at higher prices. This is an important observation, as it clearly shows that not controlling for all unobservable bank and firm characteristics biases results; in particular, the benefits of relationship lending tend to be overestimated on prices and underestimated on quantities.

outstanding loans by bank j in real terms ($L_{j,k,t}$) on total credit lines to firm k:

$$r_{j,k,t} = \gamma T\text{-bank}_{j,k,t} + \gamma_C(T\text{-bank}_{j,k,t} * Crisis) + \nu_{j,t} + \beta_{k,t} + \varepsilon_{j,k,t}, \quad (13)$$

$$L_{j,k,t} = \mu T\text{-bank}_{j,k,t} + \mu_C(T\text{-bank}_{j,k,t} * Crisis) + \delta_{j,t} + \phi_{k,t} + \varepsilon_{j,k,t}, \quad (14)$$

where $t = 2007 : q2$, $2010 : q1$, while the dummy $Crisis$ takes the value of 1 in $2010 : q1$. The vectors ν and δ are $bank{*}Time$ fixed effects and β and ϕ are $firm * Time$ fixed effects.[22] Our variable of interest is the dummy T-bank, which takes the value 1 if the loan is granted by a transaction bank. The coefficient γ (μ) can be interpreted as the difference relative to relationship banking ($R-$banks) in interest rates (lending) in good times. The different interest rate of a T-bank relative to an $R-$bank in a crisis is given by the sum of the coefficients $\gamma + \gamma_C$ ($\mu + \mu_C$ represents, vice-versa, the difference with respect to lending).

[22] 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 how the lending relationship affects bank interest rate setting.

The results of the baseline model are reported in the first two columns of Table 3.[23] In line with the predictions of the model, the coefficients show that $T-$banks (compared to $R-$banks) provide loans at a cheaper rate (8 basis points) in good times and at a higher rate in bad times (12 basis points). The difference between the two rates is given by the coefficient $\gamma_C = .201^{***}$. As for loan quantities, other things being equal, $T-$banks always provide on average a lower amount of lending, especially in bad times. The difference $\mu_C = -0.030^{***}$ indicates that, other things equal, $R-$banks increase their supply of loans in bad times. In particular, they supply 3% more loans relative to $T-$banks.

A potential concern about the measure we use for informational distance is that it could be picking up bank size, as larger banks will have branches in several provinces other than the one in which they are headquartered. For this reason, we have re-estimated our baseline model for a sub-sample that excludes small banks (those with total assets below 25.000 billion). The results reported in the third and fourth columns of Table 3 are qualitatively the same. As there is not a clear consensus on how to identify relationship characteristics, we have also tested the robustness of the results by consider-

[23] Following Albertazzi and Marchetti (2010) and Hale and Santos (2009) we cluster standard errors ($\varepsilon_{j,k}$) at the firm level in the regressions that include bank fixed effects. Vice-versa in the 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 financial conditions of each bank in the group may depend on other banks in the group through internal capital markets. For a general discussion of different approaches used to estimate standard errors in finance panel data sets, see Petersen (2009).

ing alternative definitions for relationship banking, namely a dummy for the main bank ($Main$)[24] and the number of years of the relationship between a firm and a bank ($Duration$).[25] The results are reported in the last two columns of Table 3.

The dummy $Main$ typically captures "incentive to monitor" effects or "skin in the game" effects. Interestingly, we find that a bank with a high share of lending to a given firm tends to *always* grant lower interest rates and to reduce the cost of credit by more in the crisis. However, we also find that the main bank reduces the loan amount in the crisis. This finding is consistent with the results in Gambacorta and Mistrulli (2014) and may be interpreted as the consequence of greater bank risk-aversion and a greater need to diversify credit risk following the crisis. The results on $Duration$ are in line with the theory of relationship lending: A longer duration of the relationship better shields firms against negative shocks (Cole, 1998).

As with informational distance, banks that have established a long relationship with their clients charge higher lending rates relative to other banks in good times on the loans they roll over, but in bad times they provide a

[24] In particular, we have first calculated the share of loans granted by each bank to the firm and constructed a dummy 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 fifth of total loans.

[25] The median $Duration$ of a bank-firm relationship is 9 years (the variable is truncated at 15 years for lack of data before 1994). To compute the duration of the relationship between a firm and a bank, we take into account mergers and acquisitions among banks, so that if a bank is acquired by another bank we are able to track the original relation and correctly compute its duration.

higher amount of lending. Interestingly, the signs of the coefficient on our variable of interest ($T-$bank) continue to be in line with what is predicted by the model: $T-$banks (compared to $R-$banks) provide loans at a cheaper rate in good times and at a higher rate in bad times (see column V). As for loan quantities, other things equal, $T-$banks always provide on average a lower amount of lending, especially in bad times (see column VI).

The theoretical analysis assumes for simplicity that transactional loans are severed during the crisis and taken over by relationship loans. However, we have so far analyzed only the intensive margin, that is, the change in the amount and the cost of lending for those bank-firm relationships that are not discontinued in the crisis. We further complement the analysis by investigating the cases in which credit lines were closed or new lines were granted (the extensive margin). In Table 4 we have thus estimated the probability of discontinuing a credit line after the Lehman default as a function of the informational distance. We exploit again the multiple lending setup by focusing on around 250.000 firms that borrowed in 2007:q2 from both $R-$banks and $T-$banks. The result reported in the first panel of Table 4 indicates that credit lines of transaction banks have a 6% higher probability of being terminated in a crisis.

As termination of a credit line could also be voluntary and depend upon a switch from one bank to another, in the second panel of Table 4 we have run the same regression excluding those firms that started at least one relationship with a new bank that was not previously part of the pool of lenders in the period September 2008–March 2010 (100.000 cases). The result indicates an increase in the probability of termination from 6 to 9%.

The result could also be driven by those firms that exited the market after the Lehman default. Therefore in the third panel we have excluded all firms that went into default in the period September 2008–March 2010 (11.700 firms). In this case the probability remains stable at 9%. The last panel of Table 4 uses a different definition for relationship banking: 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 $= 0$. In this case $T-$banks are more distant from an informational point of view and the result is reinforced (the probability of termination increases from 9 to 11%), pointing to the fact that informational asymmetries increase with functional distance.

6.3 Hypothesis 3: Safe firms prefer transactional lending. Other firms prefer to combine transaction and relationship banking.

A key prediction of our model is that firms with low underlying cash-flow risk (those with a probability of success in bad times that is greater than $\hat{p}_B$) prefer pure transaction banking, while those with higher cash-flow risk (with $p_B \leq \hat{p}_B$) prefer to combine transaction and relationship banking. To test this prediction we look for a $Z-$score relation such that firms with a *low*

Z score reveal their preference for pure transaction banking and those with a high Z score reveal their preference for combined T and $R-$banking. To this end, we have estimated equations (13) and (14) for firms with a different level of $Z-$score in order to explore whether $R-$banks and $T-$banks behave differently with respect to borrowers with a different degree of risk.

The results are reported in Table 5. In particular, the first row indicates the coefficient of the $T-$bank dummy in good times, while the second row indicates the additional impact for a $T-$bank with respect to a $R-$bank in a crisis period. In line with the predictions of our model, the cost of transactional lending is always lower than that of relationship banking in good times. Moreover, the difference between the interest rate paid to a $T-$bank and that paid to an $R-$bank is negatively correlated with the probability of success of the firm (positively correlated with the $Z-$score). This pattern changes in bad times when banks with a strong lending relationship ($R-$banks) offer lower rates to *risky* firms (those with a $Z-$score greater than 1). And, as predicted by our model, it is always cheaper for safe firms to use transaction banking because they obtain always a lower rate from $T-$banks. Moreover the results indicates that the roll-over effects of $R-$banks on lending is mostly present for *risky* firms, while *safe* firms always obtain a greater level of financing from $T-$banks, whether in good or bad times.[26]

[26] A graphical representation of the results is reported in the online Annex.

6.4 Hypothesis 4: $R-$banks need capital buffers to preserve the lending relationship in bad times

A final hypothesis of our model is that $R-$banks have a higher equity capital buffer than $T-$banks in good times so as to support the lending relationship in bad times. To test this hypothesis we focus on bank capital endowments: Since $T-$banks have a lower incentive of making additional loans to firms in distress in bad times, we should observe that these banks hold a lower equity-capital buffer against contingencies relative to $R-$banks prior to the crisis. In particular, we estimate the following cross-sectional equation on our sample of 179 banks:

$$CAP_j = z + \tau(T - share)_j + \Psi Y + \Phi B + \varepsilon_j, \tag{15}$$

where the dependent variable CAP_j is the regulatory capital-to-risk-weighted-assets of bank j in 2008:q2 (prior to the Lehman collapse), the variable $(T - share)_j$ is the proportion of transaction loans (in value) for bank j, z is a set of bank-zone dummies, Y a set of bank-specific controls, and B a set of bank credit portfolio-specific controls. Bank-specific characteristics include not only bank size and liquidity ratio (liquid assets over total assets), but also the retail ratio between deposits and total bank funding (excluding capital). We also include the log of the number of provinces in which each bank supplies loans, which is an additional control for the degree of transaction banking. This control is also helpful because banks with loans concentrated in their home provinces are more exposed to provincial risk than banks whose loans are spread over other provinces. All explanatory variables are taken in 2008:q1 in order to tackle endogeneity problems. The set of bank credit-portfolio characteristics B include: the average $Z-score$ and the proportions of small and LTD firms in the bank's credit portfolio. Moreover we also include 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. This dummy allows us to control for financially constrained firms.

The results reported in Table 6 indicate that, independently of the model specification chosen, a pure $T-$bank that has a credit portfolio composed exclusively of transaction loans ($T-share_j = 1$) has a capital buffer more than 3 percentage points lower than a pure $R-$bank, whose portfolio is composed exclusively of relationship loans ($T - share_j = 0$). We have also verified the effects of bank capital on interest rates and lending. Interestingly, the positive effect of bank capital in protecting the lending relationship is more important for $R-$banks than for $T-$banks.[27]

[27] During a downturn an $R-$bank (resp. $T-$bank) with a capital ratio 2 percentage points greater than another $R-$bank supplies 5% more loans at a lower interest rate of 8 bps (resp. 2% more loans and 4 bps lower rates for a $T-$bank). More details are provided in the online Annex.

7 Comparing different theories of relationship banking

The relationship banking literature distinguishes between different benefits from a long-term banking relation. Except for Berlin and Mester (1999) the other theories do not explicitly consider how relationship lending would evolve over the business cycle. Nevertheless it is instructive to briefly compare our findings with the likely predictions of the other main theories.

We have identified four different strands of relationship banking theories, which differ in their predictions of default rates, cost of credit, and credit availability over the business cycle. A first strand emphasizes the role of $R-$Banks in providing (implicit) insurance to firms towards future access to credit and future credit terms (Berger and Udell 1992, Berlin and Mester 1999). According to this (implicit) insurance theory, $R-$banks do not have better knowledge about firms' types and therefore they should experience similar default rates (in crisis times) to those of $T-$banks. Although Berlin and Mester find that banks funded more heavily with core deposits provide more loan-rate smoothing in response to exogenous changes in aggregate, it does not follow from this finding that the firms with the lowest credit risk choose this loan-rate smoothing service.

A second strand underscores the *monitoring* role of $R-$banks (Holmstrom and Tirole 1997, Boot and Thakor 2000). According to the monitoring theory, 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. Although these monitoring theories do not make any explicit predictions on default rates in a crisis, it seems plausible that these theories would predict higher probabilities of default in bad times for firms borrowing from $R-$banks.

A third strand plays up the greater *ex-ante 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 plausible prediction of these ex-ante screening theories would seem to be that $R-$banks have lower default rates in crisis times than $T-$banks. Another plausible prediction is that $R-$banks would benefit from an ex-post monopoly of information both in good and bad times, thus charging higher lending rates than $T-$banks in both states on the loans they roll over.

A fourth strand of relationship banking theories, on which our model builds, emphasizes (soft) information acquisition about borrowers' types over time. This role is closer to the one emphasized in the original contributions by Sharpe (1990), Rajan(1992) and Von Thadden (1995). This strand of theories 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. This line of theories predicts that $R-$banks charge higher lending rates in good times on the loans they roll over, and lower rates in bad times to their best clients through the crisis to protect their relationship banking investment. 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.

As a first step in the comparison among these different theoretical models, we focus on the relationship between the probability for a firm k to go into default and the composition of its *transactional* vs *relationship* financing. From our test of Proposition 1 (see equation 12) we find that $T-$banks exhibit higher default rates in bad times. This finding is consistent with the predictions of our theory as well the third strand of theories based on *ex-ante screening*. For example, we get results similar to those in Agarwal and Hauswald (2010) that distinguish between screened and unscreened loans. However, we can go one step forward by checking if the mechanism at work is pure *ex-ante screening* or banks learns about changes in borrower's creditworthiness and adapt lending terms to the evolving circumstances the firm finds itself in.

In particular, the comparison of interest rates of $R-$banks and $T-$banks in good times and in bad times provides additional insights into the likely benefits of relationship banking. In particular, our findings that $R-$banks charge higher rates than $T-$banks in good times and vice-versa in bad times are only consistent with the prediction of our theory.[28] Importantly, we

[28] The finding that transaction loans carry lower rates than relationship loans before the

do not observe an ex-post monopoly of information for $R-$banks such that $R-$banks always charge higher rates than $T-$banks on the loans they roll over.

8 Conclusion

The theoretical approach we suggest, which emphasizes the idea that relationship lending allows banks to learn firms' types, provides predictions on relative rates of default in a crisis, the behavior of interest rates, and the amount of equity capital of relationship banks that the our data broadly supports. Our empirical analysis thus provides further guidance on what relationship-lending achieves in the real economy. We have found that relationship banking is an important mitigating factor of crises. $R-$banks extend lending to their best clients in bad times to protect their relationship banking investment and, by doing so, they 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 re-

crisis, but higher rates during the crisis may in principle also be consistent with other models. For example, in a screening model, uninformed banks will charge higher rates as credit conditions worsen because this increase the Winner's Curse Effect (Rajan,1992); on the other hand, this premium may be small in normal times and the uninformed banks' rate may be lower because these banks do not sustain the cost of screening. However, such theoretical model is not able to explain why informed (relationship) banks *reduce* the level of their rates in a crisis.

sults are consistent with other empirical findings for Italy (see, among others, Albertazzi and Marchetti (2010) and Sette and Gobbi (2015)).

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.

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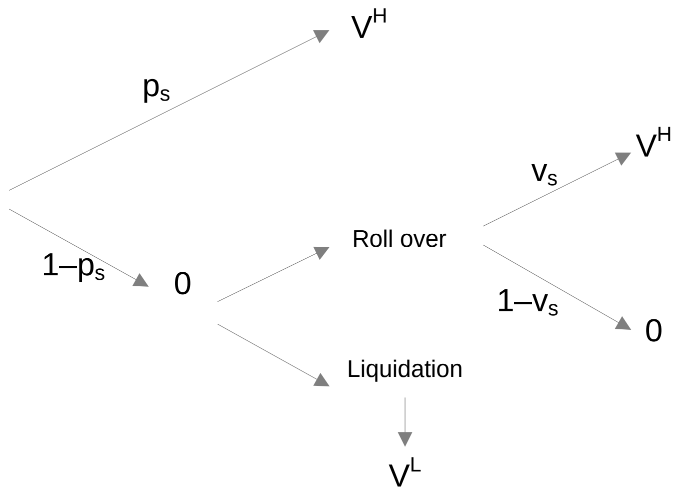
Average firm cash flows in state S

Figure 1



100% transactional banks payoff

Figure 2

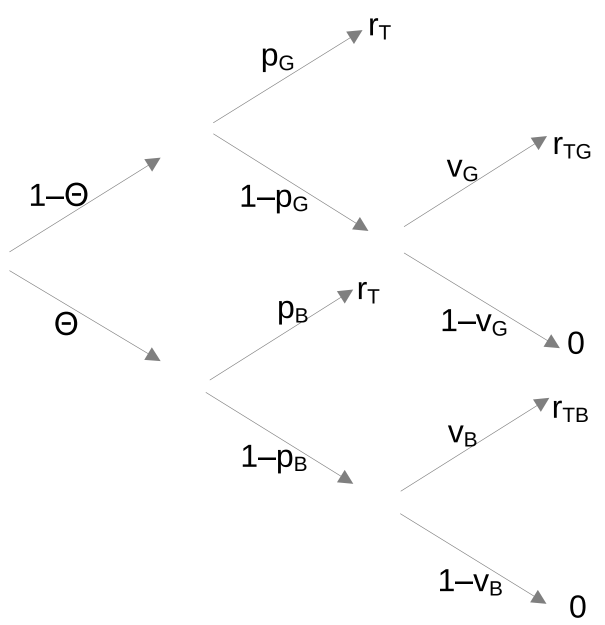
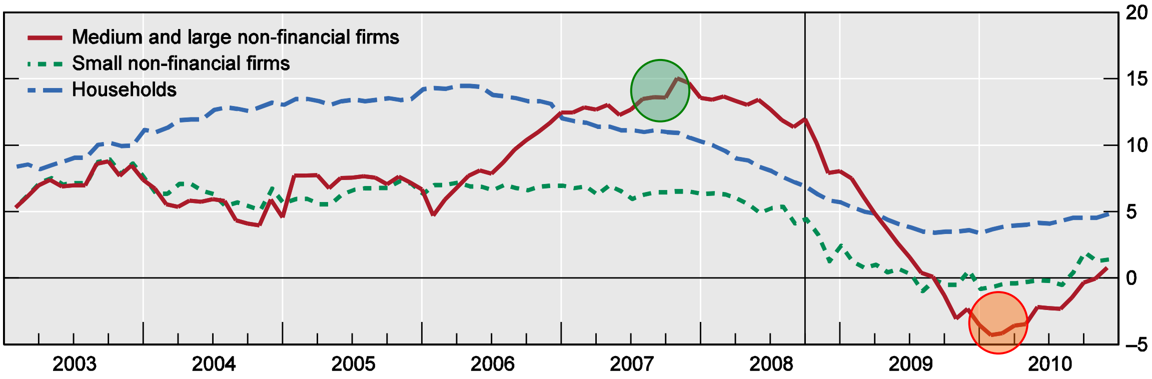


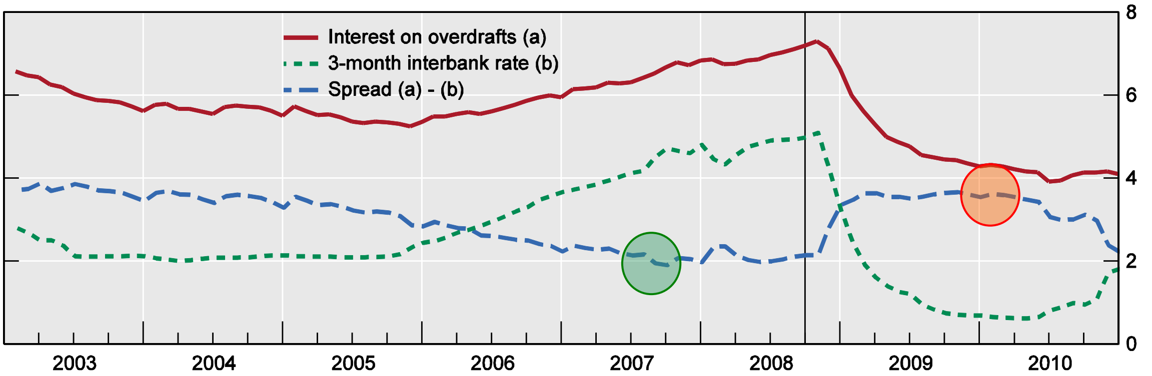
Figure 3

Bank lending, interest rates and the business cycle in Italy

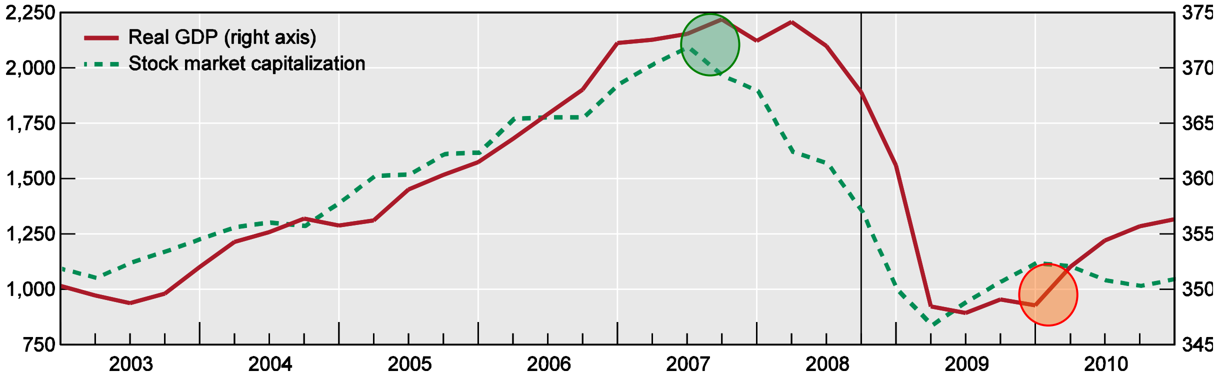
(a) Bank lending to the private sector[1, 2]



(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 Global Index, 31 Dec. 1972 = 100.

Sources: Bank of Italy; Bloomberg.

Table 1 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	15211	8.7%	4.3	6.2	1.9	7.75	7.74	-0.011	9.122	8.794	-0.33
ii) Both types	83664	48.1%	4.5	6.7	2.2	7.96	7.99	0.035	8.842	8.743	-0.10
iii) Transactional only	75004	43.1%	4.8	7.1	2.3	7.79	7.82	0.035	8.567	8.793	0.23
Total	173879	100.0%	4.6	6.9	2.2	7.87	7.90	0.031	8.748	8.769	0.02
H-FIRMS											
i) Relationship only	15040	8.7%	4.2	6.2	1.9	7.75	7.74	-0.009	9.113	8.79	-0.32
ii) Both types	83281	48.3%	4.5	6.7	2.2	7.96	7.99	0.037	8.566	8.56	-0.01
iii) Transactional only	74025	43.0%	4.8	7.1	2.3	7.78	7.82	0.037	8.840	8.79	-0.05
Total	172347	100.0%	4.6	6.8	2.2	7.86	7.90	0.033	8.731	8.68	-0.05
L-FIRMS											
i) Relationship only	170	11.1%	6.1	9.2	3.2	8.06	7.92	-0.147	8.992	8.70	-0.29
ii) Both types	387	25.2%	5.9	9.4	3.5	8.53	8.31	-0.212	8.947	9.04	0.09
iii) Transactional only	975	63.7%	6.2	9.7	3.5	8.18	8.06	-0.113	8.660	8.88	0.22
Total	1532	100.0%	6.1	9.6	3.5	8.25	8.11	-0.142	8.769	8.90	0.13

Note: L-Firms are those that went into default in the period 2008:q3-2010:q1, H-Firms are the remaining ones. The variable spread is given by the difference between the lending rate and the three month money market rate.

Table 2 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		(IV) Loan pricing	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
T-share (in value)	0.0032	***	0.0029	***			0.0052	***
	(0.0008)		*(0.0007)*				(0.0017)	
T-share (number of banks)					0.0028	***		
					(0.0007)			
Z			0.0051	***	0.0051	***	0.0040	***
			(0.0005)		*(0.0001)*		(0.0004)	
LTD			-0.0002		-0.0002		0.0006	
			(0.0018)		*(0.0018)*		(0.0014)	
Small firm			-0.0021		-0.0021		0.0000	
			(0.0034)		*(0.0034)*		(0.0044)	
Credit history			-0.0002	***	-0.0001	***	-0.0001	
			(0.0000)		*(0.0000)*		(0.0001)	
Rate							0.0018	***
							(0.0002)	
Rate* T-share (in value)							-0.0003	*
							(0.0002)	
Bank fixed effects	yes		yes		yes		yes	
Industry-province dummies	yes		yes		yes		yes	
Number of obs.	72,489		72,489		72,489		72,489	
Pseudo R2	0.0597		0.0997		0.0995		0.129	

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. 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 3 T-banking and R-banking: alternative measures of the firm-bank relationship

Variables	Informational distance		Excluding small banks		All relationship variables	
	Dep. variable: Interest rate (I)	Dep. variable: Log Loans (II)	Dep. variable: Interest rate (III)	Dep. variable: Log Loans (IV)	Dep. variable: Interest rate (VII)	Dep. variable: Log Loans (VIII)
T-Bank	-0.0812***	-0.2707***	-0.0828***	-0.2692***	-0.0284**	-0.0940***
	(0.0121)	(0.0071)	(0.0208)	(0.0117)	(0.0124)	(0.0062)
T-Bank*Crisis	0.2012***	-0.0300***	0.1943***	-0.0507***	0.1139***	-0.0543***
	(0.0170)	(0.0099)	(0.0287)	(0.0161)	(0.0174)	(0.0087)
Main					-0.1467***	1.1536***
					(0.0085)	(0.0042)
Main*Crisis					-0.0542***	-0.3047***
					(0.0118)	(0.0059)
Duration					0.0590***	0.0218***
					(0.0014)	(0.0007)
Duration*Crisis					-0.0377***	0.0042***
					(0.0019)	(0.0010)
Bank*Time fixed effects	yes	yes	yes	yes	yes	yes
Firm*Time fixed effects	yes	yes	yes	yes	yes	yes
Number of obs.	347,758	347,758	162,856	160,998	347,758	347,758
Adjusted R-squared	0.5828	0.4463	0.5614	0.4911	0.5859	0.5949

Notes: The dummy T-Bank takes the value of 1 if the loan is granted by 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. The variable Duration represents the number of years of the relationship between a firm and a bank. 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 4 Analysis of the extensive margin

Variables	Panel A: Baseline Dep. variable: Dummy termination of credit line (I)	Panel B: Excluding firms with new bank relationships (1) Dep. variable: Dummy termination of credit line (II)	Panel C: Excluding defaulted firms (2) Dep. variable: Dummy termination of credit line (III)	Panel D: Changing definition of the T-bank dummy, from province to region (3) Dep. variable: Dummy termination of credit line (IV)
T-Bank	0.0567***	0.0858***	0.0875***	0.1096***
	(0.0024)	(0.0038)	(0.0041)	(0.0037)
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Number of obs.	450,925	173,319	148,125	148,125
Adjusted R-squared	0.2416	0.3051	0.3089	0.3125

Notes: The left hand side variable is a dummy that is equal to 1 if the credit line of firm j has been closed by bank k in the period September 2008-March 2010. The dummy T-Bank takes the value of 1 if the loan is granted by a transactional bank. The coefficients represent the difference relative to relationship banking (R-banks). (1) The sample excludes those firms that started at least one relationship with a new bank that was not previously part of the pool of lenders in the period September 2008–March 2010. (2) The sample excludes also all firms that went into default in the period September 2008–March 2010. (3) In this panel we use a different definition for relationship banking: 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. 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	Safe firms (Z=1)		Solvent firms (Z=2)		Vulnerable firms (Z=3)		Risky firms (Z=4)	
	Dep. variable: Interest rate (I)	Dep. variable: Log Loans (II)	Dep. variable: Interest rate (I)	Dep. variable: Log Loans (II)	Dep. variable: Interest rate (I)	Dep. variable: Log Loans (II)	Dep. variable: Interest rate (III)	Dep. variable: Log Loans (IV)
T-Bank	-0.2066*	0.0214*	-0.1318*	-0.1242	-0.0523*	-0.2657***	-0.0159	-0.2753***
	(0.1076)	(0.012)	(0.0744)	(0.0542)	(0.0302)	(0.0203)	(0.0191)	(0.0156)
T-Bank*Crisis	0.0810	0.00291	0.1531*	0.0163*	0.2071***	-0.0255*	0.2637***	-0.0469**
	(0.1660)	(0.1136)	(0.067)	(0.0066)	(0.0434)	(0.0144)	(0.0220)	(0.0201)
Bank*Time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Firm*Time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Number of obs.	7,554	7,554	14,870	14,870	126,194	126,194	199,140	199,140
Adjusted R-squared	0.6345	0.4149	0.6171	0.4103	0.5795	0.4336	0.5438	0.4362

Notes: The dummy T-Bank takes the value of 1 if the loan is granted by 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 6 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*** (0.890)	-2.992** (1.344)	-3.154** (1.307)	-3.231** (1.308)
Bank size		0.181 (0.402)	0.038 (0.390)	0.068 (0.375)
Bank liquidity ratio		-0.015 (0.018)	-0.010 (0.019)	-0.003 (0.018)
Retail ratio		0.054*** (0.018)	0.030* (0.017)	0.029* (0.017)
Number of provinces in which each bank operates (logs)		-0.601 (0.725)	-0.149 (0.741)	-0.071 (0.727)
Proportion of small firms in the bank's credit portfolio			6.239 (4.158)	6.008 (4.062)
Proportion of LTD firms in the bank's credit portfolio			-2.693 (3.942)	-2.273 (3.889)
Average Z-score of the bank's credit portfolio			-1.7139 (2.440)	-1.388 (2.538)
Proportion of financially constrained firms (US>GR)				5.328 (6.668)
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. The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for bank zone dummies are not reported.

On line Annex

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 (**??**) 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 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:

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

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[1]

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

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 either with only one type of 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:

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

The LHS represents what the $R-$bank obtains by rolling over all the period

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

$t = 1$ 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 (1) 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. After simplifying L_T,the corresponding rate is therefore:

$$r_T^{RT} = \frac{(1+\rho_T) - (1-p)(1-\overline{\nu})V^L}{p + (1-p)\overline{\nu}}. \tag{2}$$

As intuition suggests, constraint (1) 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 (1) can be rewritten as:

$$\beta(1-m)V^H - V^L \geq L_T(r_T^{RT} - V^L). \tag{3}$$

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

$$L_T\left[\frac{(1+\rho_T)-(1-p)(1-\overline{\nu})V^L}{p+(1-p)\overline{\nu}}-V^L\right]\leq \beta V^H(1-m)-V^L, \tag{4}$$

which simplifies to:

$$L_T\left[\frac{(1+\rho_T)-V^L}{p+(1-p)\overline{\nu}}\right]\leq \beta V^H(1-m)-V^L \tag{5}$$

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 (1) 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:

$$p\ r_R^{RT}(1-L_T)+ \tag{6}$$

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

$$= (1 + \rho_R)(1 - L_T)$$

or,

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

$$(1 + \rho_R)(1 - L_T) - (1 - p)\left[\overline{\nu}((1 - m)\beta V^H - r_T^{RT} L_T) + (1 - \overline{\nu})(1 - L_T)V^L\right] \tag{7}$$

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

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

$$L_T[-(1 + \rho_R) + (1 - p)(\overline{\nu} r_T^{RT} + (1 - \overline{\nu})V^L)] + (1 + \rho_R) \tag{8}$$

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

Replacing $pr_R^{RT}(1 - L_T)$ by its value in the total funding cost ϕ 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 ϕ is minimized for the maximum value of L_T and the condition (1) is always binding.

Since (1) is holding with equality we can replace $((1-m)\beta V^H - r_T^{RT}L_T) = (1-L_T)V^L$ in (7) and simplify by $1-L_T$, thus obtaining

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

To see that $r_R^{RT}>r_T^{RT}$, notice that by substracting V^L from both sides we obtain $\frac{1+\rho_R-V^L}{p}>\frac{1+\rho_T-V^L}{p+(1-p)\overline{\nu}}$ where in the left hand side the numerator is larger and the denominator is lower.

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:

$$\begin{aligned} \Delta\Pi(p) \quad = \quad & p(r_R^{RT}(p)(1 - L_T) + r_T^{RT}(p)L_T - r_T(p)) \\ & +(1 - \theta)(1 - p_G)[\beta V^H - \frac{r_T(p)}{\nu_G}] + \\ & +\theta(1 - p_B)(\beta V^H - \frac{r_T(p)}{\nu_B}) \end{aligned} \tag{9}$$

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 (6) we then obtain that

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

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:

$$\Sigma=(1+\rho_R)-(\rho_R-\rho_T)L_T-(1-p)\left[\overline{\nu}(1-m)\beta V^H+(1-\overline{\nu})(1-L_T)V^L\right]-(1-p)(1-\overline{\nu})L_TV^L \tag{10}$$

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:

$$\begin{aligned}\Delta\Pi(p) &= (1+\rho_R) - (\rho_R - \rho_T)L_T^* - \qquad (11) \\ &\quad (1-p)\left[\overline{\nu}(1-m)\beta V^H + (1-\overline{\nu})V^L\right] - p(1+\rho_T) + (1-p)\beta V^H \\ &\quad -(1+\rho_T)[\frac{(1-\theta)(1-p_G)}{\nu_G} + \frac{\theta(1-p_B)}{\nu_B}]\end{aligned}$$

Differentiating with respect to p_B and noting that

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

and that:

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

$$
\begin{aligned}
\frac{d\Delta\Pi(p)}{dp_B} &= -(\rho_R - \rho_T)\frac{dL_T^*}{dp_B} - \frac{d(1-p)\overline{\nu}}{dp_B}\left[(1-m)\beta V^H - V_L\right] \qquad (12)\\
&+V_L - (1+\rho_T) - \beta_M V^H\\
&+(1+\rho_T)[\frac{(1-\theta)}{\nu_G} + \frac{\theta}{\nu_B}]
\end{aligned}
$$

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:

$$
\begin{aligned}
\frac{d\Delta\Pi(p)}{dp_B} &= -(\rho_R-\rho_T)\frac{\left[(1-m)\beta V^H - V^L\right]}{1+\rho_T}(1-[(1-\theta)\nu_G+\theta\nu_B]) \qquad (13)\\
&+ [(1-\theta)\nu_G+\theta\nu_B]\left[(1-m)\beta V^H - V^L\right]\\
&+V^L-(1+\rho_T)-\beta V^H\\
&+(1+\rho_T)[\frac{(1-\theta)}{\nu_G}+\frac{\theta}{\nu_B}]
\end{aligned}
$$

Or, equivalently,

$$
\begin{aligned}
\frac{d\Delta\Pi(p)}{dp_B} &= -(\rho_R-\rho_T)\frac{\left[(1-m)\beta V^H - V^L\right]}{1+\rho_T}(1-[(1-\theta)\nu_G+\theta\nu_B]) \qquad (14)\\
&- [(1-\theta)\nu_G+\theta\nu_B]\, m\beta V^H\\
&-(\beta V^H-V^L)(1-[(1-\theta)\nu_G+\theta\nu_B])\\
&+(1+\rho_T)[\frac{(1-\theta)}{\nu_G}+\frac{\theta}{\nu_B}-1]
\end{aligned}
$$

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:

$$\begin{aligned} \Delta\Pi(p) &= p(r_R^{RT}(p)(1-L_T) + r_T^{RT}(p)L_T - r_T(p)) \\ &\quad +(1-\theta)(1-p_G)[\beta V^H - \frac{r_T(p)}{\nu_G}] + \\ &\quad -\theta(1-p_B)(1-\beta)V^H \end{aligned} \tag{15}$$

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 (6) 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:

$$\Sigma=(1+\rho_R)-(\rho_R-\rho_T)L_T-(1-p)\left[\overline{\nu}(1-m)\beta V^H+(1-\overline{\nu})V^L\right] \quad (16)$$

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

$$\begin{aligned}\Delta\Pi(p) &< (\rho_R - \rho_T)(1-L_T^*) \\ &-(1-p)\left[\overline{\nu}(1-m)\beta V^H + (1-\overline{\nu})V^L\right] + (1-p)\beta V^H \\ &+\theta(1-p_B)V^L - \theta(1-p_B)V^H\end{aligned} \tag{17}$$

Rearranging terms this expression becomes:

$$\begin{aligned}\Delta\Pi(p) &< (\rho_R - \rho_T)(1-L_T^*) + (1-p)m\beta V^H \\ &-(1-p)\left[\overline{\nu}\beta V^H + (1-\overline{\nu})V^L\right] + (1-p)\beta V^H \\ &-\theta(1-p_B)(V^H - V^L)\end{aligned} \tag{18}$$

that is

$$\begin{aligned}\Delta\Pi(p) &< (\rho_R - \rho_T)(1 - L_T^*) + (1-p)m\beta V^H \\ &+(1-p)(1-\overline{\nu})\left[\beta V^H - V^L\right] \\ &-\theta(1-p_B)(V^H - V^L)\end{aligned} \tag{19}$$

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 on 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 179 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 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.[2]

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

[2] 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).

relationships. 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 around 200,000 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 174,000 observations (72,500 firms), which we use for the empirical analysis. The sectorial composition of the firms in the database is the following: 45% services; 38% manufacture; 15% constructions; 2% agriculture. The database is composed of relatively large firms (the median size of firm total assets is about 500 million euros); only 0.2% of the firms in the database have less than 20 employees.

Table B1 and B2 give some basic information on firms and banks. Table B3 provides summary statistics of the main variables used in the regressions.

Appendix C. Robustness checks

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

(1) *Heterogeneity among Italian regions.* The analysis presented so

far treats the impact of the Lehman Brothers' shock similarly across Italian regions and firm's sector of economic activity. The inclusion of fixed effects allows us to control for all (observable and unobservable) time-invariant bank and borrower characteristics, and to identify in a precise way the effects of bank-firm relationships on the interest rate charged and the loan amount. However, there could be interesting forms of heterogeneity that could be analyzed if for example some Italian regions have been more negatively impacted than others. To this end, following the referee's suggestion we have analyzed, the impact of relationship lending on interest rates and loan amounts splitting the Italian regions with respect to: a) the market share of the first five banks; b) the level of export orientation; c) different reaction to the cycle of firms' sectors of economic activity.

Panel A in Table C1 presents the results of the models (14) and (15) splitting the sample between regions with a low and high degree of credit market concentration. In particular, we have first calculated the share of the first 5 banking groups in each region and then divided the sample based on the median share (60%). The main results of our paper hold in both groups but the beneficial effects of relationship lending in a crisis are relatively higher in those regions with a lower degree of bank concentration, in line with Petersen and Rajan (1995).

The second test aims at investigating whether relationship lending had a different impact on firms depending on the export orientation of Italian regions. To this end we have first calculated the ratio of export over GDP in each region and then divided our sample based in 2 sets of regions, those that are more export oriented (with a median export share above 27%) and those less export oriented. Even in this case results are qualitatively similar but the beneficial effects of relationship lending on interest rates in a crisis are relatively higher in those regions more export oriented. This is consistent with the theoretical model predictions, showing that everything being equal, the benefits are stronger for those firms which are more exposed to the business cycle. Indeed, more export oriented regions were more exposed to the global financial crisis (see Panel B of Table C1).

Another test analyzed the nature of relationship banking among different sectors of economic activity. In particular, following Boudoukh et al (1994) and Bassanetti et al (2009) we divided firms operating in highly cyclical sectors (those that are particularly reactive to changes in the business cycle, such as, primary metals, transportation, equipment, electrical machinery, etc.) from those operating in low cyclical sectors (utilities, food and beverages, tobacco, etc.). The results reported in panel C of table C1 indicate that the beneficial effects of relationship lending are slightly higher in highly cyclical sectors but the difference is not statistically significant.

(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 the first panel of Table 3 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 Panel A of Table C2 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 the first panel of Table 3 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 Panel B of Table C2).

(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 one we have therefore estimated equations (2)-(3) on a subset of around 9,000 "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 Panel C of Table C2).

(5) *Panel analysis.* The econometric strategy used in the paper compares two periods (pre and after Lehman's default) that identify two states of the world: bad and good. The two quarters for the analysis has been carefully selected having this in mind and represent the pre-crisis peak and the crisis trough (see Figure 3).[3] However, to verify that the results are independent of the specific date selected we have run a panel over the period 2007:q1-2010:q1– the timespan for which we have the data. To keep the analysis

[3]This approach has been widely used. See; amongst others, Khwaja and Mian (2008) who examine the impact of liquidity shocks by exploiting cross-bank liquidity variation induced by unanticipated nuclear tests in Pakistan (pre– and post–nuclear test period); see also Gobbi and Sette (2015) who analyze the effects of the global financial crisis on the growth rate of lending comparing two dates around Lehmann's default (September 2008 and September 2009).

econometrically feasible we have restricted the sample to around 1,000,000 observations (around 45% of the full sample). The results are very similar to that obtained from the baseline equations (see Table C3).

(6) *Lending relationship and bank capital.* Finally, we also test the effects of bank capital endowments on interest rates and lending. We thus include in our baseline equations (13) and (14) in the main text, the regulatory capital-to-risk weighted assets ratio (CAP, lagged one period to mitigate endogeneity problems), a set of bank-zone dummies (z), and other bank-specific controls (Y):

$$\begin{aligned} r_{j,k,t} &= \gamma T\text{-bank}_{j,k} + \gamma_C(T\text{-bank}_{j,k} * Crisis) + \nu CAP_{j,k,t-1} + \\ &\quad \upsilon_C(CAP_{j,k,t-1} * Crisis) + \Psi Y + \Psi_C(Y * Crisis) + \beta + \varepsilon_{j,k,t} \end{aligned} \tag{20}$$

$$\begin{aligned} L_{j,k,t} &= \mu T\text{-bank}_{j,k} + \mu_C(T\text{-bank}_{j,k} * Crisis) + \lambda CAP_{j.k.t-1} + \\ &\quad \lambda_C(CAP_{j,k,t-1} * Crisis) + \Xi Y + \Xi_C(Y * Crisis) + \phi + \varepsilon_{j,k,t} \end{aligned} \tag{21}$$

The vector Y contains in particular the dummy $US > GR$, a dummy for mutual banks ($MUTUAL$), which are subject to a special regulatory regime (Angelini et al., 1998) and a dummy equal to 1 if a bank has received government assistance and 0 elsewhere.

The results reported in the first panel of Table C4 indicate that banks with larger capital ratios are better able to protect the lending relationship with their clients. Well-capitalized banks have a higher capacity to insulate their credit portfolio from the effects of an economic downturn by granting a 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 2 percentage points greater than another bank supplies 4% more loans at a lower interest rate of 7 bps. 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 event of a monetary policy shock (Kishan and Opiela 2000, Gambacorta and Mistrulli, 2004, Jimenez et al. 2012). The effects are qualitatively similar when we consider a different measure of bank capital, the excess capital ratio, that is given by the difference between regulatory capital (TIER1 plus TIER2) minus minimum capital requirements over risk weighted assets (see the second panel of Table C4).

Interestingly, the positive effect of bank capital in protecting the lending relationship is more important for $R-$banks than for $T-$banks. This can be tested by replacing $\nu CAP_{j,k,t-1} + v_C(CAP_{j,k,t-1} * Crisis)$ in equation (20) with

$$v^T(T - bank) * CAP_{j,k,t-1} + v_C^T(CAP_{j,k,t-1} * Crisis)(T - bank) +$$
$$v^R(R - bank) * CAP_{j,k,t-1} + v_C^R(CAP_{j,k,t-1} * Crisis)(R - bank)$$

and $\lambda CAP_{j.k.t-1} + \lambda_C(CAP_{j,k,t-1} * Crisis)$ in equation (21) with

$$\lambda^T(T - bank) * CAP_{j,k,t-1} + \lambda_C^T(CAP_{j,k,t-1} * Crisis)(T - bank) +$$
$$\lambda^R(R - bank) * CAP_{j,k,t-1} + \lambda_C^R(CAP_{j,k,t-1} * Crisis)(R - bank)$$

In particular, the coefficients v_C^T and v_C^R take the values of -0.020*** (s.e. 0.004) and -0.042*** (s.e. 0.003), respectively, and are statistically different. A similar result is obtained in the lending equation, where λ_C^T and λ_C^R take the values of 0.010** (s.e. 0.004) and 0.025*** (s.e. 0.006) respectively, and are statistically different from one another. This means that during a downturn an $R-$bank (resp. $T-$bank) with a capital ratio 2 percentage points greater than another $R-$bank supplies 5% more loans at a lower interest rate of 8 bps (resp. 2% more loans and 4 bps lower rates for a $T-$bank).

(7) *Graphical representation of the results in Table 5.* The results reported in Table 5 of the main text are represented graphically in Figure C1. In particular, the two panels report the values of the coefficient on the $T-$bank dummy that represents the difference with respect to $R-$banks. Panel (a) on the left illustrates the effect on the interest rate applied on credit lines, while panel (b) on the right indicates the effects on the log of lending. The pre-Lehman period is represented by a solid line, while a dotted line represents the post-Lehman period. In each graph the horizontal axis reports the $Z-$score of the firms. To match with the empirical model we have inverted the scale in the charts: from $Z = 4$ (risky firms and low probability of success) to

$Z = 1$ (safe firms and high probability of success). The vertical axis of panel (a) indicates the difference in the level of the interest rate applied by the two bank types on credit lines to the four different kinds of firms; that of panel (b) reports the difference in the log of lending supplied by the two bank types.

The visual inspection of panel (a) indicates that the difference between the interest rate paid to a $T-$bank and that paid to an $R-$bank is negatively correlated with the probability of success of the firm (positively correlated with the $Z-$score). In line with the predictions of our model, the cost of transactional lending is always lower than that of relationship banking in good times: the solid line is always below zero for all $Z-$scores (see panel (a) of Figure C1). This pattern changes and the dotted line moves upward above zero in bad times when banks with a strong lending relationship ($R-$banks) offer lower rates to $risky$ firms (those with a $Z-$score greater than 1). And, as predicted by our model, it is always cheaper for safe firms to use transaction banking because they obtain always a lower rate from $T-$banks. Moreover panel (b) of Figure 4 highlights that the roll-over effects of $R-$banks on lending is mostly present for *risky* firms, while $safe$ firms always obtain a greater level of financing from $T-$banks, whether in good or bad times (both the solid and the dotted line are always above zero for $Z = 1$).

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Table B1 Summary statistics for firms

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	3777	0.68	10.92	0.991	7.48	3.81	5.38
2=Solvent	7435	0.69	10.36	0.995	7.65	3.94	5.65
3=Vulnerable	63097	0.71	10.33	0.981	7.89	4.39	6.33
4=Risky	99570	0.72	9.35	0.963	7.91	4.88	7.33
Total	173879	0.72	9.78	0.971	7.88	4.64	6.86

Notes: (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. (3) Interest rate on credit lines minus one month interbank rate.

Table B2 Summary statistics for banks

Variables	Obs	Mean	Std. Dev.	Min	Max
T-share	179	0.449	0.280	0.000	1.000
Bank size (log Total Assets)	179	8.121	1.329	6.037	12.992
Bank liquidity ratio (1)	179	25.760	15.780	3.239	89.341
Capital ratio (2)	179	8.600	3.278	0.015	18.817
Mutual bank (dummy)	179	0.263	0.441	0.000	1.000
Rescued bank	179	0.028	0.165	0.000	1.000
Average Z-score of the bank’s credit portfolio	179	3.441	0.158	2.500	4.000
Proportion od LTD firms in the bank's credit portfolio	179	0.664	0.148	0.000	1.000
Proportion of small firms in the bank's credit portfolio	179	0.285	0.136	0.000	1.000
Proportion of financially constrained firms	179	0.130	0.050	0.000	0.333
Number of provinces in which each bank operates (logs)	179	3.747	0.684	1.386	4.700

Note: All bank-specific and credit portfolio characteristics are at 2008:q1. (1) Cash and securities over total assets. (2) Regulatory capital/risk-weighted asset at 2008:q2, prior to Lehman's default.

Table B3 Summary statistics of variables used in the regressions

Variable	Description	Obs	Mean	Std Dev	Min	Max
Rate	Interest rate applied by the bank on the credit line of the firm	347,758	8.130	2.837	0.500	28.077
Spread	Difference between the interest rate charged by the bank on the credit line and the 3-month interbank rate	347,758	5.773	2.982	-1.100	23.930
Log Loans	Logarithm of outstanding loans by the bank in real terms on total credit lines to the firm	347,758	7.882	1.429	-4.549	16.880
T-bank	T-Bank takes the value of 1 if the loan is granted by a transactional bank who has the headquarter in the same province of the firm	347,758	0.720	0.449	0.000	1.000
T-bank (region)	Same as above but region instead than province	347,758	0.000	0.000	0.000	0.000
Main	The dummy Main is equal to one if that bank grants the highest share of lending to that firm.	347,758	0.422	0.494	0.000	1.000
Duration	Number of years of the relationship between a firm and a bank	347,758	9.734	3.714	2.500	15.000
US>GR	Dummy 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	347,758	0.133	0.340	0.000	1.000
Crisis	Dummy that takes the value of 1 in 2010:q1 and zero in 2007:q2	347,758	0.500	0.500	0.000	1.000
Z score	The Z-score is an indicator of the probability of default which is computed annually by CERVED on balance sheet variables	347,758	3.487	0.668	1.000	4.000
Credit history	The number of years elapsed since the first time a borrower was reported to the Credit Register	347,758	10.242	4.136	2.500	15.000
New Firms	Dummy variable for those firms that entered the credit register in the period 2005:Q2:2007:Q2	347,758	0.087	0.282	0.000	1.000
LTD	Dummy for firms organized as limited liability corporations	347,758	0.972	0.166	0.000	1.000
Small firm	Dummy that takes the value of 1 for firms with less than 20 employees and zero elsewhere	347,758	0.001	0.033	0.000	1.000
Mutual bank	Dummy for mutual banks which are subject to a special regulatory regime	347,758	0.058	0.234	0.000	1.000
Leverage ratio	Tier1 equity over total assets	347,758	8.759	2.663	2.401	21.274
Excess capital	Difference between regulatory capital (TIER1 plus TIER2) minus minimum capital requirements over risk weighted assets	347,758	5.806	4.481	-0.172	38.335
Export orientation	Export over GDP in each region	347,758	23.756	8.391	1.014	32.565
Credit market concentration	Lending market share of the largest 5 banks in each region	347,758	61.373	5.408	40.348	87.864

Table C1 T-banking and R-banking: Bank competition, export orientation and different response to the business cycle

Variables	Panel A: Credit market concentration				Panel B: Export orientation				Panel C: Sector cyclicality			
	High		Low		High		Low		High		Low	
	Dep. variable: Interest rate (I)	Dep. variable: Log Loans (II)	Dep. variable: Interest rate (III)	Dep. variable: Log Loans (IV)	Dep. variable: Interest rate (V)	Dep. variable: Log Loans (VI)	Dep. variable: Interest rate (VII)	Dep. variable: Log Loans (VIII)	Dep. variable: Interest rate (IX)	Dep. variable: Log Loans (X)	Dep. variable: Interest rate (XI)	Dep. variable: Log Loans (XII)
T-Bank	-0.094***	-0.253***	-0.041	-0.327***	-0.079***	-0.254***	-0.086***	-0.308***	-0.099***	-0.262***	-0.040*	-0.290***
	(0.013)	(0.008)	(0.026)	(0.014)	(0.014)	(0.009)	(0.022)	(0.013)	(0.015)	(0.008)	(0.022)	(0.013)
T-Bank*Crisis	0.273***	-0.037***	0.121***	0.019	0.258***	-0.028**	0.131***	-0.015	0.208***	-0.028**	0.186***	-0.035*
	(0.023)	(0.014)	(0.030)	(0.016)	(0.021)	(0.013)	(0.029)	(0.016)	(0.020)	(0.012)	(0.031)	(0.018)
Bank*Time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm*Time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Number of obs.	191,116	191,116	156,642	156,642	208,390	208,390	139,368	139,368	243,066	243,066	104,692	104,692
Adjusted R-squared	0.584	0.446	0.582	0.453	0.582	0.460	0.585	0.432	0.579	0.448	0.596	0.444

Notes: The dummy T-Bank takes the value of 1 if the loan is granted by 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 C2 Changing definition of informational distance and analysis for new firms

Variables	Panel A: Changing definition of the T-bank dummy, from province to region		Panel B: All foreign banks are T-banks		. Panel C: New firms	
	Dep. variable: Interest rate (I)	Dep. variable: Log Loans (II)	Dep. variable: Interest rate (III)	Dep. variable: Log Loans (IV)	Dep. variable: Interest rate (V)	Dep. variable: Log Loans (VI)
T-Bank	-0.0503***	-0.2004***	-0.0996***	-0.2537***	-0.1747**	-0.1975***
	(0.0148)	(0.0085)	(0.0169)	(0.0116)	(0.0736)	(0.0434)
T-Bank*Crisis	0.1237***	-0.2134***	0.2128***	-0.0626***	0.2933***	-0.0616**
	(0.0213)	(0.0113)	(0.0260)	(0.0153)	(0.1094)	(0.0314)
Bank*Time fixed effects	yes	yes	yes	yes	yes	yes
Firm*Time fixed effects	yes	yes	yes	yes	yes	yes
Number of obs.	347,758	347,758	347,758	347,758	30,920	30,920
Adjusted R-squared	0.5808	0.4461	0.5809	0.4459	0.5480	0.4478

Notes: The dummy T-Bank takes the value of 1 if the loan is granted by 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 C3 T-banking and R-banking: panel approach

Variables	Informational distance		Excluding small banks		All relationship variables	
	Dep. variable: Interest rate (I)	Dep. variable: Log Loans (II)	Dep. variable: Interest rate (III)	Dep. variable: Log Loans (IV)	Dep. variable: Interest rate (VII)	Dep. variable: Log Loans (VIII)
T-Bank	-0.1126***	-0.3263***	-0.1690***	-0.3795***	-0.1219***	-0.1927***
	(0.0304)	(0.0120)	(0.0643)	(0.0212)	(0.0304)	(0.0108)
T-Bank*Crisis	0.1583***	-0.0375***	0.1714**	-0.0406***	0.1539***	-0.0469***
	(0.0335)	(0.0104)	(0.0715)	(0.0189)	(0.0336)	(0.0096)
Main					-0.1294***	1.4951***
					(0.0268)	(0.0071)
Main*Crisis					-0.0522**	-0.0385***
					(0.0246)	(0.0074)
Duration					0.0080*	0.0071*
					(0.0050)	(0.0041)
Duration*Crisis					-0.0011**	0.0006*
					(0.0005)	(0.0035)
Bank*Time fixed effects	yes	yes	yes	yes	yes	yes
Firm*Time fixed effects	yes	yes	yes	yes	yes	yes
Number of obs.	1,022,840	1,022,841	638,924	638,925	1,022,840	1,022,841
Estimation period	2007:q1-2010:q1	2007:q1-2010:q1	2007:q1-2010:q1	2007:q1-2010:q1	2007:q1-2010:q1	2007:q1-2010:q1
Adjusted R-squared	0.9276	0.7152	0.9404	0.7258	0.9277	0.7667

Notes: The estimation is based on a random sample 1/3 of firms of the original database. The dummy T-Bank takes the value of 1 if the loan is granted by 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. The variable Duration represents the number of years of the relationship between a firm and a bank. 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 C4 Lending relationship and bank-capital

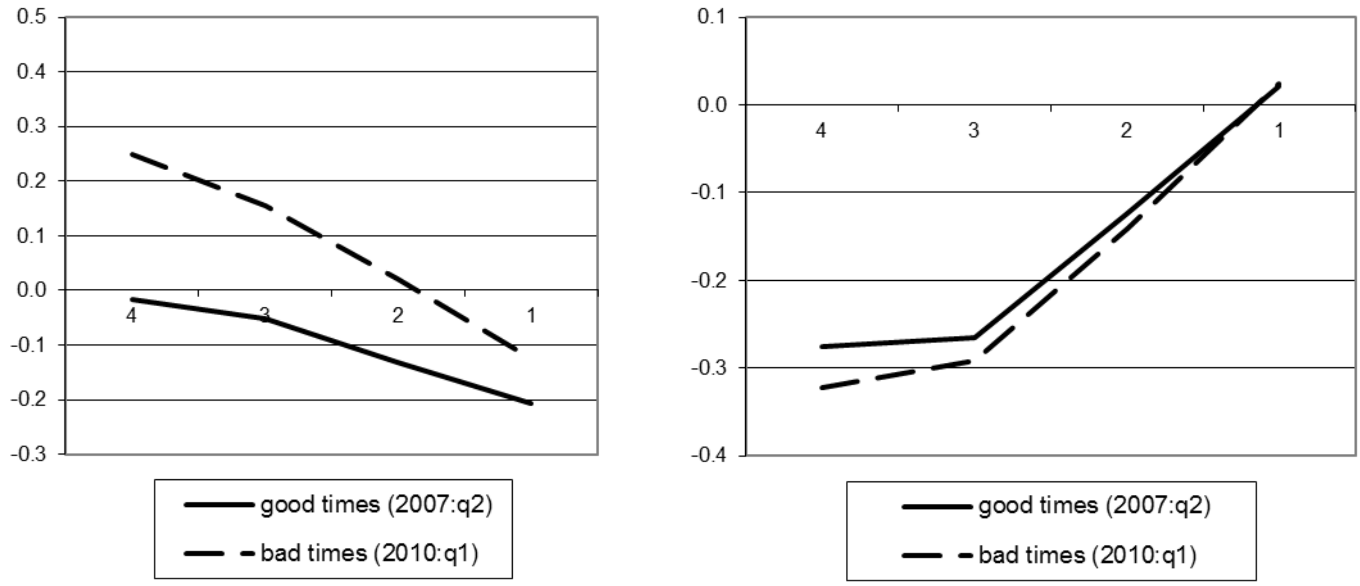
Variables	Leverage ratio (1)		Excess capital ratio (2)	
	Dep. variable: Interest rate (I)	Dep. variable: Log Loans (II)	Dep. variable: Interest rate (VII)	Dep. variable: Log Loans (VIII)
T-Bank	-0.0693***	-0.1706***	-0.0766***	-0.1609***
	(0.0173)	(0.0398)	(0.0193)	(0.0364)
T-Bank*Crisis	0.1434**	-0.0174***	0.1401**	-0.0147***
	(0.0660)	(0.0034)	(0.0682)	(0.0043)
Capital	-0.0185	-0.0108***	-0.0070	-0.0063
	(0.0160)	(0.0036)	(0.0020)	(0.0059)
Capital*Crisis	-0.0384**	0.0222**	-0.0340***	0.0222**
	(0.0170)	(0.0091)	(0.0104)	(0.0090)
Additional controls Y (3)	yes	yes	yes	yes
Additional controls Y*Crisis (3)	yes	yes	yes	yes
Bank zone dummies *Time fixed effects	yes	yes	yes	yes
Firm*Time fixed effects	yes	yes	yes	yes
Number of obs.	347,758	347,758	347,758	347,758
Adjusted R-squared	0.5361	0.4266	0.5408	0.4348

Notes: The dummy T-Bank takes the value of 1 if the loan is granted by 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. (1) The leverage ratio is defined as bank equity and reserves over total assets. (2) Excess capital ratio is given by Regulatory capital in excess of minimum capital requirement over risk-weighted assets. (3) The vector Y includes the 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; and a dummy for mutual banks (MUTUAL), which are subject to a special regulatory regime.

Figure C1

Lending supply and interest rate setting of T-banks vs R-banks by state of the world[1]

(a) Interest rate	(b) Lending



[1] This figure reports a graphical representation of the results in Table 5. In particular, the two panels report the values of the coefficient on the T-bank dummy that represents the difference with respect to R-banks. Panel (a) on the left illustrates the effect on the interest rate applied on credit lines, while panel (b) on the right indicates the effects on the log of lending. The pre-Lehman period is represented by a solid line, while a dotted line represents the post-Lehman period. In each graph the horizontal axis reports the Z-score of the firms. To match with the empirical model we have inverted the scale in the charts: from Z=4 (risky firm and low probability of success) to Z=1 (safe firm and high probability of success).The vertical axis of panel (a) indicates the difference in the level of the interest rate applied by the two bank types on credit lines to the 4 different kinds of firms; that of panel (b) reports the difference in the log of lending supplied by the two bank types.