Macroprudential and Monetary Policy: Loan-Level Evidence from Reserve Requirements

Work in Progress

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June, 2014

Abstract

We analyze the impact of liquidity and reserve requirements on credit supply. For identification, we exploit a change in regulation in Uruguay – an increase of the requirements for short-term funding, especially from (retail and interbank market) foreign funds – using the credit register that follows all loans granted to non-financial firms. Following a difference-in-difference approach, we compare lending to the same firm before and after the policy change among banks with different exposure to the funds targeted by the policies. We find that restrictions to short-term deposits for banks imply a reduction of credit supply; more affected banks increase their exposure into riskier firms; and larger banks mitigate the effects. Our results suggest that foreign short-term capital inflows and liquidity requirements affect credit supply and risk-taking of banks.

*We are extremely grateful to the Central Bank of Uruguay for providing the data for this study. We thank Stephane Bonhomme, Marco Lombardi, Javier Suarez, Rafael Repullo, participants at The French Prudential Supervisory Authority conference on "Risk Taking in Financial Institutions, Regulation and the Real Economy", and seminar participants at the Federal Reserve Board, Central Bank of Uruguay and CEMFI for very helpful comments and suggestions.

†The views expressed in this article are the sole responsibility of their authors and do not compromise the institutional position of the Central Bank of Uruguay.

1 Introduction

According to Bernanke and Blinder's (1988) theory about the *bank lending channel of monetary policy*, imperfections in the banking sector may enable monetary policy to have an effective impact on economic activity through changes on banks' lending behavior. This is a consequence of a violation of Modigliani and Miller Theorem on the banking sector: monetary policy affects economic activity because banks are not indifferent to the composition of the liability side of their balance sheets. For example, if the funds that are not subject to reserve requirements are also not covered by deposit insurance, banks will face an adverse selection problem that will disable their ability to fully substitute one unit of insured funds with one unit of non-reservable funds, hence their lending behavior can be affected.[1] In particular, a shock to banks' insured deposit base (for example, through higher reserve requirements) cannot be frictionlessly offset with other sources of funding. Although several studies have attempted to test the bank lending channel of monetary policy, they have faced identification problems due to the aggregated data they use.

One lesson we have learned from the recent financial crisis is the increasing reliance of banks on short-term funding. When this is the case, banks don't fully internalize the costs associated with the maturity mismatch between assets and liabilities. Although short-term funding has the advantage of flexibility (that contributes to the ability of a bank to quickly respond to an increase in the demand for loans), it also introduces refinancing risk.[2] This opens the case for macroprudential policies which, by focusing on the common exposures among banks, complement the microprudential dimension of financial regulation.

Despite the recent development of the economic debate on macroprudential policies, there is little empirical evidence on their impact (some exceptions will be discussed on Section 2). This paper sheds new light on how monetary policy can influence bank lending and real activity and contributes to the empirical discussion on the effectiveness and use of macroprudential tools to contain imbalances in the banking markets.[3] Following a difference-in-difference approach, we compare lending before and after the introduction of the policy changes among banks with different degrees of exposition to the funds targeted by the policies.

During the last decades, the monetary authorities of Latin American economies have been very active in the use of reserve requirements with a macroprudential objetive, mainly because of their counter-cyclical role for smoothing the credit cycle and their ability to contain systemic risk. Uruguay offers an excellent setup to study these effects for two main reasons: the policy changes introduced on reserve and

[1] When monetary policy tightens, reservable deposits decrease and banks' capacity to supply loans may be affected if they are not capable of issuing non-reservable debt. The adverse selection problem arises because these non-reservable funding is typically uninsured: institutions perceived as more risky by the market may find it more difficult to issue debt.

[2] Suppliers of short-term funding have less incentives to monitor the bank, so they are more prone to withdrawing the funds at the first negative market signal about the financial health of the institution.

[3] A central bank has mainly two possible means to influence the money supply: it may change the target interest rate or it can change the reserve requirement applied to banks' deposits and hence the money multiplier (when a loan is extended, new money is created in the system through commercial banks, so the total money supply is usually a multiple larger than the money originally issued by the Central Bank).

liquidity requirements in 2008, and the exhaustive credit registry of all granted loans in the system. On June 2008, the monetary authority of Uruguay introduced the following changes in the regulation associated to the percentage of funds that banks must keep as reserves on the Central Bank: an increase in reserve requirements for short-term deposits in both foreign and domestic currencies (10 and 8 percentage points respectively), an increase in the requirements for deposits from the non-financial non-resident sector (5 percentage points), and the introduction of a reserve requirement for funds from foreign banks (the same rate as for funds from non-residents).[4] These changes were implemented under a context of economic prosperity, a strong domestic demand, and threats of inflationary pressures derived from the high prices of the most relevant commodities for the Uruguayan economy. We have access to the Credit Registry of the Central Bank of Uruguay, which is an exhaustive dataset of all the loans granted by each bank. This dataset is complemented with bank balance-sheet information from all the institutions that report to the Central Bank of Uruguay in its role as regulator and supervisor of the banking system.

To study the effects on credit availability, we first match each loan with the relevant bank balance-sheet variables and then aggregate all the different loans between a bank-firm pair in each month in order to construct a measure of total committed lending from January 2007 to December 2008 (the sample starts on January 2007 in order to be able to perform placebo tests). By focusing on firms' borrowing from multiple banks, we follow a difference-in-difference approach which compares lending to the same firm before (May, 2008) and after (July, 2008) the policy change among banks with different degrees of exposition to the sources of funds targeted by the policies (Jiménez, Ongena, Peydró, Saurina, 2013). This will allow us to identify the effects of the new reserve requirements on the average supply of loans, both on the intensive and the extensive margins, and the heterogenous effects of these changes among different firm and bank characteristics.

The results on the intensive margin suggest that the higher reserve and liquidity requirements had a negative impact on non-financial firms through a cut in banks' loan supply. These effects are statistically and economically significant: a 10 percentage points increase on total reserve requirements translates into a cut in committed lending of 2 pps. When we analyze the impact of the introduced policies across different firm and bank characteristics we find that the cut in committed lending is lower for riskier firms and that larger banks are more capable of mitigating the effects of the policy. Moreover, we find that higher reserve requirements have a positive effect on the probability that a firm ends a relationship with a (more affected) bank and starts a new relationship with a different banking institution.

The loan-level results suggest that the increase in reserve requirements tightened the supply of bank loans. However, some firms could have mitigated the negative effects of the lending channel by resorting to loans from banks less affected by the policy changes. In order to address this, we analyze the change in committed lending by all banks to a given firm between July and May, 2008. The results from the

[4] All these reserve requirements were not remunerated.

firm-level analysis suggest that firms with a higher credit rating are more able to mitigate the negative impact of the policy changes by changing banks.

To summarize, the evidence presented in this paper is consistent with a scenario in which the main assumptions of the bank lending channel hold: Modigliani and Miller propositions are not satisfied for banks. Given the strong reliance of banks on short-term funding, one relevant policy question is whether the new standards on liquidity regulation proposed by Basel III will be associated with higher costs.

The rest of the paper proceeds as follows: Section 2 discusses the related literature, Section 3 introduces the data and the empirical strategy, Section 4 presents the results and Section 5 concludes with a discussion on some policy implications.

2 Literature Review

The Lending View of Monetary Policy

In 1988, Bernanke and Blinder developed a three asset model in order to prove that monetary policy may have a real impact through effects on the supply of bank loans. This "bank lending view" of monetary policy, hinges upon the notion that changes in the stance of monetary policy may be followed by movements in aggregate bank lending. The adverse selection problem that lies beneath the difference between insured and uninsured financing implies that banks' different degree of access to non-deposit funding has an important role on the effectiveness of this mechanism, hence, differences in the balance-sheet structure of banks should translate into different reactions to the monetary policy.

The two main ingredients of the lending channel of monetary policy are the failures of Modigliani-Miller's Theorem for banks and non-financial firms. On the banks side, this implies that banking institutions are not indifferent between different sources of funding. Stein (1998) developes the following argument: if the bank is not able to fully finance itself with insured deposits, this introduces an adverse selection problem. For example, if the funds that are not subject to reserve requirements are also not covered by deposit insurance, banks will face an adverse selection problem that will disable their ability to fully substitute one unit of insured funds with one unit of non-reservable funds. As a result, the lending behavior of banks can be affected through constraints on their ability to issue insured deposits. On the other side, another key ingredient for monetary policy to have an effect on the supply of loans is the failure of Modigliani-Miller's Theorem for non-financial firms, that is, some firms must be unable to frictionlessly substitute bank loans with alternative sources of funds. To be more precise, if some firms do not have access to the capital market and depend on bank loans to finance their projects, bonds and loans are not perfect substitutes. As a result, changes in the composition of banks' financing may have an effect on firms' investment decisions.

Although there are several studies that empirically address the implications of the lending channel of monetary policy, the debate is not fully settled. The common feature of all these studies is that they base their analysis on aggregated data, which poses problems at the moment of disentangling loan-supply from loan-demand effects.

Naturally, one response was to advance one more step using disaggregated data in order to take into account the cross-sectional implications of the lending channel of monetary policy. The hypothesis beneath this approach is that some bank characteristics (such as size, liquidity and capitalization) have an impact only on the supply of loans, leaving unchanged the demand. Kashyap and Stein (1994), for instance, find results in line with the predictions of the lending view of monetary policy but, unfortunetely, this evidence also admits other interpretations. In particular, they find that a monetary contraction reduces the supply of bank loans while it increases the volume of commercial papers. However, although these results can be interpreted as evidence of the lending channel of monetary policy, they could also imply changes in the composition of loan demand: larger firms, with a better access to the capital market, could be demanding more credit. On a later study, Kashyap and Stein (1997), address the question of the transmission of monetary policy with a 20-year panel from US banks and find that the reaction to a contractionary monetary policy is stronger if banks have a less liquid balance sheet.

Finally, more recent studies, such as the one performed by Kwhaja and Mian (2008), explore on new methodologies in order to achieve a better identification of the bank lending channel: they focus on firms that borrow from more than one bank in order to have different degrees of exposition to the policy change (e.g. a firm may have a loan with two different banks: one with a bank with a high exposition to the policy change and one with a bank not exposed to it, hence one would expect the loan supply of the former to decline). They apply this methodology for a four-year panel on banks from Pakistan and find that a decline on banks' liquidity has a negative impact on the supply of loans both on the intensive and the extensive margins.

Macroprudential Policy

The recent financial crisis in Europe and the United States has called for the need to address systemic risk in financial markets. As Borio (2003) points out, in contrast to the microprudential policies that focus on individual institutions, the macroprudential approach of financial stability takes into account the interconnections and common exposures among institutions. Under this interpretation, the rationale for a macroprudential approach of financial regulation is to correct the market failures that may have a negative impact on the real sector.

The real and financial imbalances that accumulate during the so-called *build-up phase* of a financial crises carry with them negative implications when the process goes into reverse. A well-known example of these episodes are the banking crisis experienced in Latin America during the eighties and nineties.

Goodhart and Perotti (2012) apply a historical analogy with the "Great Fire of London" that emphasizes in a very proper way the importance of assessing systemic risk: *"preventing fire propagation is more important than focusing on how to fight large fires once started"*. Given the propagation role of liquidity crises, the new features of financial regulation embodied into Basel III Accord aim to contribute to increase confidence on banks' ability to withstand liquidity shocks.

According to Blanchard (2013), the existing empirical evidence about the impact of macroprudential tools is still limited and mixed, being mainly represented by studies of the impact of dynamic provisions in Spain (Saurina, 2009; Jiménez, Ongena, Peydró, Saurina, 2013) and studies about the impact of LTV regulation (Crowe, Dell'Ariccia Igan, Rabanal, 2011). This opens the case for this study since it provides empirical evidence on the impact of reserve requirements as a macroprudential tools.

Credit Supply and Deposits

Finally, the different nature of the funds that banks manage on the liability side of their balance-sheets plays a role on the configuration of an incentive scheme that helps discipline the behavior of the banker. In particular, as Calomiris and Kahn emphasize (1991), depositors' right of early withdrawal and the eventual run on banks gives them the ability to monitor the behavior of the financial institutions. The rigid nature of deposits as a source of financing (based on the threat of a run by depositors, which refrains the bank from renegotiating) is the one that helps discipline the banker and enable him to comit to pay. However, as Rajan and Diamond (2000, 2001) stress, although short-term funding may increase the vulnerability to a financial crisis, banks need this type of funding in order to provide liquidity and credit. That is, it is the illiquid nature associtated to credit to problematic borrowers (with illiquid investment projects) and banks' ability to transform illiquid assets into liquid ones, what induce banks' reliance on short-term funding. One testable hypothesis from these teories, and for which there is no empirical evidence, is that restrictions to short-term funding of banks (deposits) imply a decrease in the supply of credit.

3 Data and Identification Strategy

Data

We have access to two datasets from the Central Bank of Uruguay in its role as banking regulator and supervisor. Both datasets cover the period from January 2007 to December 2008 and are available on a monthly frequency. The first dataset is the Credit Registry of the Central Bank of Uruguay (*Central de Riesgos*), which is an exhaustive record of all loans granted in the system with detailed information at the loan level. In particular, it contains information about the identity of the borrower, whether the borrower is a firm or a household, the country of residence, the economic sector to which it belongs, all the financial institutions with which he has a loan, the amount of the loan, the currency of the loan,

its maturity, and the rating given by the bank to the firm. On the other hand, we also have access to a dataset with balance sheet information for all the banks operating in the system during the period 2007-2008.

We focus on loans granted to non-financial private firms, making a total of 46.595 firms and 19 financial institutions for the total sample (years 2007 and 2008). Given that we focus only on loans granted to firms, this dataset is comprehensive, since the monthly reporting threshold is of approximately USD 1.500. The sample includes one public bank, 12 private commercial banks and 6 non-bank financial institutions. There is another public bank in the Uruguayan banking system, but it has been excluded from the sample since its main line of business are mortgages to households (while our focus is on loans granted to private firms) and it has experienced several restructures and recapitalizations.

During this period there were changes in the structure of the market. In particular, there was a fusion between two banks present in the Uruguayan banking system, and an acquisition of one bank by a foreign bank (not present in the country until that moment). Both cases were treated as if they were present from the beginning of the period (in order to avoid loosing the observations associated to the banks that disappeared).

Identification Strategy

Although the negative impact of the financial crisis led to a downwards revision of the projections about the performance of the developed economies, the growth figures for the emerging economies remained solid. Instead, the main concern for these economies were the inflationary pressures originated mainly by the higher prices of the commodities, context to which Uruguay was no stranger: the accumulated inflation rate for the year 2007 reached 8,50%. Under these conditions, the Uruguayan monetary authority introduced changes in the regulation of reserve requirements in order to reduce the amount of money in circulation.

We focus on the effects of the increase in the reserve requirements introduced in Uruguay on June 2008. These can be summarized in three main changes: an increase in the reserve requirements for short-term deposits, an increase in the reserve requirements for deposits from agents from abroad (deposits from non-residents), and the introduction of a reserve requirement for funds from foreign banks.[5] Hence, the different degrees of exposition of banks to these three sources of funding will determine the intensity of the impact of the policy changes.

[5]The changes where introduced through the following acts of the Central Bank of Uruguay: "Circular 1991", "Circular 1992". In particular, the requirement for short-term local currency deposits increased 8 percentage points, while that for foreign currency deposits raised 10 percentage points. As a result, the requirements for short-term deposits in local and foreign currency went up to 25% and 35% respectively. In addition, the reserve requirement for deposits from non-residents increased 5 percentage points, reaching a level of 35%. Finally, the funds from foreign banks where included in the regulation for deposits from non-residents, so the reserve requirement for these funds went from zero to a rate of 35%.

One of the purposes of this paper is to study the effects of the policy changes on the average supply of loans. To do this, we match each loan with bank balance-sheet variables and aggregate all the different loans between a bank-firm pair, obtaining a measure of total committed lending for each bank-firm pair on each of the months of the total sample.

Following a difference-in-difference approach, we compare lending for the same firm before (May, 2008) and after (July, 2008) the policy change among banks that are more and less affected by the changes in the reserve requirements. One key aspect of the identification strategy is the focus on firms with more than one bank relationship; by analyzing the change in committed lending for the same firm, we can check if the firm experiences a higher drop in lending with the bank that is more exposed to the policy change. In addition, we analyze whether the effects of the policy changes were different across different firm and bank characteristics. That is, we want to check if the policy changes had effects, not only on the average supply of loans, but on the risk-taking behavior of banks.

Next, we analyze if the changes in the reserve requirements had some effect on credit continuation (extensive margin). For this, we define a binary variable that will take the value of 1 if a bank-firm relationship is not renewed after the policy change. To be more precise, our subsample in this case will include all the bank-firm loans included in the subsample for the intensive margin analysis plus all the bank-firm loans that terminated on the month after the policy is implemented. In addition, we check whether some firms changed their bank relationships between May and July and, in case they changed, if they turned to a less affected bank.

Finally, we ask whether some firms were able to mitigate the negative impacts of the policy changes by resorting to loans from less affected banks. For this, we take exactly the same firms that are included in the loan-level analysis and study what is the impact of the policy change on their total level of debt in the system. The analysis at the firm level allows us to study the effects of the policy changes on firms' outcomes; that is, whether firms were able to substitute banks, resort to internal sources of finance or enter into financial distress.

Models

Policy Variable

We build our policy variable of interest taking into account the change in the reserve requirements for local and foreign currency deposits, deposits from foreign non-financial sector and deposits from foreign financial sector:

$$STLC = \%Additional\ Reserve\ Req * (STLClevel)$$
$$STFC = \%Additional\ Reserve\ Req * (STFClevel)$$
$$NResi = \%Additional\ Reserve\ Req * (NResilevel)$$
$$FNResi = \%Additional\ Reserve\ Req * (FNResilevel)$$

where

$STLClevel$=Deposits<30 days in local currency, both from residents and non-residents.
$STFClevel$=Deposits<181 days in foreign currency, only from residents.
$NResilevel$=Deposits<181 from Foreign Non-Financial Sector.
$FNResilevel$=Deposits<181 from Foreign Financial Sector.

We then add all the additional reserve requirement variables into one total variable and divide it by the total liabilities of the bank:

$$TotalAdditionalReserveRequirements = STLC + STFC + NResi + FNResi$$

$$\Delta ReserveReq_{bf,t-1} = \frac{TotalAdditionalReserveRequirements}{TotalLiabilities}$$

Intensive Margin of Lending - Average and Heterogenous Effects

For the analysis of the effects at the loan-level, we estimate two models. In Model 1, we regress the change in the log of committed credit in July 2008 with respect to May 2008 (the policy change takes effect on June 2008) on industry, firm-debt and firm-risk dummies, the already mentioned bank balance-sheet variables, and the policy variable of interest.

$$\Delta logL_{bf,t+1} = \delta_i + \delta_s + \delta_r + \alpha_1 controls_{bf,t-1} + \alpha_2 \Delta ReserveReq_{bf,t-1} + \varepsilon_{bf,t+1} \quad (1)$$

where $\Delta logL_{bf,t+1}$ is the change in the logarithm of (strictly positive) committed credit by bank b to firm f.[6] δ_i are industry dummies, δ_s are size-debt dummies and δ_r are risk-type dummies. [7] The $controls_{bf,t-1}$ include bank characteristics, such as Size, Liquidity Ratio and Solvency Ratio, while $\Delta ReserveReq$ is our policy variable of interest (which stands for the ratio of total additional reserve requirements of the bank over total liabilities).

The second model we estimate (Model 2) includes firms fixed effects:

$$\Delta logL_{bf,t+1} = \delta_f + \alpha_1 controls_{bf,t-1} + \alpha_2 \Delta ReserveReq_{bf,t-1} + \varepsilon_{bf,t+1} \quad (2)$$

Both models are estimated for the sample of firms with more than one bank relationship (we also estimate the models for the sample of all bank-firm loans in order to check the external validity of the results).[8] In addition, given that the number of banks is low, clustering standard errors only at the bank level would introduce a downwards bias in their calculation, hence we decided to cluster standard errors at the bank*industry level (were we group industries into three main groups: Agriculture and Manufactures, Trade, and Rest) in order to have a greater number of clusters. The intuition behind this decision is that, while our policy variable varies across banks, it is also very likely that residuals will be correlated within firms belonging to the same industry group.

To check the robustness of our results we will perform: placebo tests for months previous to the introduction of the policies and for the months after June 2008.[9] We also estimate both models for a sample excluding the public bank (given its nature and the fact that it represents almost 50% of the total banking system).

In addition to the analysis of the change in committed credit (average effects), we study whether these effects vary across different firm and bank characteristics. In particular, we add interactions of the policy variables with firm characteristics associated to the rating given by the bank and their classification according to the size of their debt.[10] Moreover, we also estimate the heterogenous effects of the policy change across different bank characteristics, interacting the policy variable with the three bank controls

[6] We winsorize the dependent variable of both specifications at the 1^{st} and 99^{th} percentile.

[7] According to the uruguayan regulation, a borrower will be classified into different categories according to the size of his debt. The borrower is a "highdebt borrower" if he has a debt with the bank that represents at least 10% of the minimum capital set by the regulation for banking institutions and the debt with the total system represents at least 15% of the minimum regulatory capital. Then, highdebt is a dummy that takes the value of one when the bank has reported the firm as a "highdebt borrower" and 0 if it is a "lowdebt borrower". On the other hand, the indicator for "highrisk" equals 1 if the firm has a rating of 3, 4 or 5, which are the categories for "compromised ability to pay", "very compromised ability to pay" and "irrecoverable debt".

[8] Given that the estimations are based on the sample of firms with more than one bank relationship (30% of the total sample), the results we obtain could be specific to these type of firms. In order to see the extent to which the results can be generalized to all the firms included in the sample, we estimate both models for the sample of all loans granted.

[9] The idea of the placebo tests is to check that the effect is indeed attributable to the policy changes introduced on June 2008, so we estimate the models with different time windows. If the effects on the supply of credit are attributable only to the changes on the reserve requirements of 2008, the estimated effects under the placebo tests should be insignificant.

[10] We group risk rating into 5 categories with 1 being the best and 5 the worst. On the other hand, *Highdebt* is a dummy that takes the value of one when the bank has reported the firm as a *"highdebt borrower"* and 0 if it is a *"lowdebt borrower"*.

included in the models for the analysis of the average effects and also for a dummy variable that indicates if the bank is organized as a branch of a foreign institution.

Extensive Margin - Average and Heterogenous Effects:

Next, we analyze if the policy changes had some effect on the likelihood that a bank-firm pair is not renewed (extensive margin), as well as in the probability that a firm changes banks. Under a linear probability model, we study the average effects of the policy change on the probability that a loan that existed in period t-1 ends before period t+1. The model we estimate in this case is:

$$LEnd_{bf,t+1} = \delta_f + \alpha_1 controls_{bf,t-1} + \alpha_2 \Delta ReserveReq_{bf,t-1} + \varepsilon_{bf,t+1} \quad (3)$$

where:

$$LEnd_{t+1} = \begin{cases} 1, & \text{if a loan granted by bank b to firm f in period } s < t \text{ is ended in t} \\ 0, & \text{otherwise} \end{cases}$$

δ_f are firm fixed effects, $controls_{bf,t-1}$ includes bank variables (Size, Liquidity Ratio and Solvency Ratio) and $\Delta ReserveReq_{bf,t-1}$ is our policy variable.

In addition, the model we estimate for the likelihood of a firm changing its bank relationship between May and July is the following (that is, it starts a new relationship with a different bank on July and it doesn't continue the relationship with the bank from May):

$$LChange_{bf,t+1} = \delta_f + \alpha_1 controls_{bf,t-1} + \alpha_2 \Delta ReserveReq_{bf,t-1} + \varepsilon_{bf,t+1} \quad (4)$$

where:

$$LChange_{t+1} = \begin{cases} 1, & \text{if a firm changes bank between periods t and t+1} \\ 0, & \text{otherwise} \end{cases}$$

δ_f are firm fixed effects, $controls_{bf,t-1}$ includes bank variables (Size, Liquidity Ratio and Solvency Ratio) and $\Delta ReserveReq_{bf,t-1}$ is our policy variable.

Standard errors are again clustered at the bank and bank*industrygroup level for both extensive margin models.

Firm-Level Models

Another question is whether some type of firms were able to mitigate the negative impacts of the policy changes by substituting the loan supply of the affected banks with loans from banks less exposed to the funds targeted by the policy change. Under the firm-level analysis, all the bank variables and the policy variable are calculated as a weighted average where the weights are given by the portion of loans granted by the banks that were lending to a given firm just before the policy reforms took place over the total loans granted to the firm. Moreover, we cluster standard errors at the mainbank level (the bank with the highest portion of loans granted to the firm over the total debt of the firm) and at the alternative cluster level (given by the interaction of the mainbank and the industry groups used for the loan-level models). The setup in this case is:

$$\Delta logL_{f,t+1} = \delta_i + \alpha_1 controlsw_{f,t-1} + \alpha_2 \Delta ReserveReqw_{f,t-1} + \varepsilon_{f,t+1} \quad (5)$$

where $\Delta logL_{f,t+1}$ is the change in the logarithm of (strictly positive) committed credit by all banks to firm f, and δ_i are industry dummies.[11] The $controlsw_{f,t-1}$ include the same bank characteristics included under the loan-level analysis, and $\Delta ReserveReqw_{f,t-1}$is our policy variables of interest.

4 Results

Tables 2 and 3 display the estimates of the loan-level specifications for the sample of firms with more than one bank relationship (intensive margin). Table 2 presents the results for the estimations of the average effects of the policy changes, while Table 3 shows the estimates for the impact of the policy changes across different firm and bank characteristics (adding interaction terms of the policy variable with indicators of firms' risk and debt size and bank characteristics). Table 4 displays the results of the estimations of both the average and heterogenous effects of the extensive margin (for the probability of firms changing the bank relationship and of ending existing ones) for the sample of firms with more than one bank relationship. Finally, Table 5 presents the estimates for the firm-level specification.

Intensive Margin

Average Effects

The estimated effects on the intensive margin suggest that the changes in the reserve requirements introduced in Uruguay during the first half of 2008 implied that, on average, banks with a higher exposition to the funds affected by the policy changes cut committed lending more than the less exposed banks.

[11] We winsorize the dependent variable of both specifications at the 1^{st} and 99^{th} percentile.

The coefficient of $\Delta ReserveReq$ is statistically significant across the different combinations of sets of characteristics and fixed effects. We first regress the dependent variable on $\Delta ReserveReq$ without including any bank or firm characteristics and find a negative and statistically significant effect (-0.307**). We then estimate our first specification without including bank characteristics obtaining also a negative and statistically significant effect (-0.342***) that is robust to the inclusion of bank characteristics (-0.277**). The estimated effect on $\Delta ReserveReq$ when we include firm fixed effects (second specification) remains statistically significant both when we don't include bank characteristics (-0.278*) as well as when we do include them (-0.166*).

The economic significance of the coefficient for the first specification with bank characteristics (column (3) of Table 2) implies that a 10pps increase in the total reserve requirements imposed on banks translates into a cut of committed lending of 3pps. If we instead estimate the second specification (including firm fixed effects), the economic significance of the effect implies a cut in committed lending of 2pps.

As a robustness check, we perform placebo tests in order to check if the estimated effects are indeed attributable to the reforms introduced in the reserve requirements. Columns (5) and (6) of Table 2 display the estimated coefficients of the policy variable by altering the time window for periods before and after the policy changes took place. We find that, although negative, the estimated coefficients are statistically not significant.

In sum, the results suggest that banks with higher exposition to the funds targeted by the policy reforms on reserve requirements cut their total committed credit to the same firm more after the reform took place.

Heterogenous Effects

Once we have analyzed the average effects of the policy changes, we ask whether these effects differ across different bank and firm characteristics. Table 3 displays the results of the analyses of the heterogenous effects on the intensive margin, where we estimate both specifications including interactions of the policy variable with firm characteristics (credit ratings and firms' size of debt) and relevant bank characteristics (size, liquidity ratio, solvency ratio and whether the bank is organized as a branch of a foreign institution).

The first three models in Table 3 estimate the heterogenous effects of the policy changes across different firm characteristics. We first estimate the effects without controlling for other firm and bank characteristics (column (1)), and we later include firm fixed effects (column (2)) and firm and bank fixed effects (column (3)). While the average effects of the policy variable remain negative, we find a positive effect for the interaction of the policy variable with the highest and lowest credit ratings.

In columns (4) to (7) we display the results of the estimations with the policy variable interacted with each bank characteristic, while in column (8) we include all interactions in one single model. We find a positive and statistically significant effect of the policy interaction with the size of the bank. As predicted by the theory, larger banks are more capable of mitigating the negative effects of higher reserve requirements on their supply of loans. We also find that banks with a lower solvency ratio (measured as the relationship between the regulatory capital and the capital requirements associated to credit and market risk) are less capable of mitigating the negative effect of the policy changes. The results found across different firm and bank characteristics are robust to the saturated specification where we interact the policy variable with both firm and bank characteristics.

Extensive Margin

Average and Heterogenous Effects

In Table 4 we analyze the average effects of the policy changes on the probability that the bank-firm relationship continues (extensive margin). That is, the question now is whether the frequency with which a bank-firm relationship is not renewed is higher for banks more exposed to the policy changes, and if a firm that is related to a bank more exposed to the policy changes is more likely to change its bank relationship.

In Panel A of Table 4 we display the results of regressing the probability of a firm changing its bank relationship after the policy change is introduced under a specification with firm fixed effects (column (1)). We find that a firm that holds a relationship with a bank more exposed to the funds targeted by the higher requirements is more likely to change to another (less affected) bank (0.037**). This result is robust to a specification in which we also include bank fixed effects and interactions of the policy variable with bank characteristics (0.064**). These results suggest that a 1% reduction in overall funding leads to a 37 basis points increase in the probability that a firm changes banking relations after the policy is implemented.

In Panel B of Table 4 we analyze the effect of the policy change on the probability that a bank-firm relationship ends after the policy change is introduced. We find a positive and statistically significant effect both under the specification including firm fixed effects (column (1)) as well as the specification with firm fixed effects and bank characteristics (column (2)). We obtain a higher effect if we further interact the policy variable with bank characteristics (column (4)). The results for this second specification imply that a 1% reduction in total funding leads to a 159 basis points increase in the probability that a bank-firm relationship ends.

Firm-Level Analysis

As was previously discussed, the results at the loan-level imply that the policy changes on reserve requirements introduced in Uruguay during the first half of 2008 tightened the supply of credit from banks. An interesting question now is whether some firms were able to mitigate these effects by resorting to loans from less affected institutions.

The results from the firm-level models (Table 5) show that, on average, firms were not able to insulate form the negative impact of the policy changes (-0.280*). When we analyze the effects across different firm characteristics, we find that firms with the highest rating were the ones capable of mitigating the negative effects of the higher reserve requirements imposed on banks. In addition, when we estimate the effects across different bank characteristics, we find that firms related to larger banks were more succesful on mitigating the negative effects of the lending channel. Both results are robust to the saturated specification in which we add interactions of the policy variable with both firm and bank characteristics.

5 Conclusions

Although the use of reserve and liquidity requirements as macroprudential tools has been very popular in Latin American economies, there's little evidence about the impact of these policies. In this paper, we study the role of reserve and liquidity requirements as macroprudential tools. In particular, we analyze the effects of the increase in the reserve requirements for different sources of funding on the average supply of credit and on the risk-taking behavior of banks.

Uruguay offers an excellent setting to study these effects given the changes introduced in the regulation regarding reserve reguirements in June 2008 and the comprehensive datasets we have access to. We use a difference-in-difference approach comparing lending before and after the introduction of the policy changes among banks with different degrees of exposition to the funds targeted by the policies.

The results on the intensive margin suggest that the main assumptions of the bank lending channel of monetary policy hold: Modigliani and Miller propositions are not satisfied for banks. In particular, increases in reserve and liquidity requirements for different sources of funding (short-term funding, funds from the foreign non-financial sector and funds from foreign banks) have an impact on non-financial firms through changes in banks' lending behavior. That is, restrictions to short-term funding imply a reduction on the supply of loans. In addition, we find that more affected banks increase their exposure to riskier firms while larger banks are more capable of mitigating the effects of the lending channel.

These policies may also have real costs for corporate firms. When we analyze the effects of the higher reserve requirements at the firm level, we find that, on average, firms were not able to insulate from the

negative impact of the policy changes, although the results of the heterogenous analysis suggest that firms with a better credit rating or more related with larger banks were capable of mitigating the effects. This is a relevant conclusion for an economy like Uruguay, where the development of the capital market is in a very early stage and, as a consecuence, bank financing plays a key role in the investment decisions of firms.

The results of this study entail policy implications for macroprudential regulation. Although restrictions to short-term funding by banks may contribute to prevent threats that can later translate into risk propagation among the banking system, the strong reliance of banks on these type of funds plays an important role on the lending behavior of these institutions. As a consequence, the new standards proposed by Basel III may have a cost and, as predicted by Diamond and Rajan (JPE, 2001) and Calomiris and Kahn (AER, 1991), restrictions to short-term finance from banks imply a reduction of credit availability.

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7 Tables and Figures

Table 1: Panel A

Loan-Level Analysis	**Variable Definition**
Dependent Variables (bank-firm)	
$\Delta logL_{bf,t+1}$	Change in the logarithm of (strictly positive) committed credit granted by bank b to firm f between t-1 and t+1.
$LEnd_{bf,t+1}$	=1 if the bank-firm relationship ends during the period (t-1,t+1), =0 otherwise.
$LChange_{bf,t+1}$	=1 if the firm changes its bank relationship (and doesn't continue with the previous one) during the period (t-1,t+1), =0 otherwise.
Policy Variables	
ΔReserveReq	Ratio of bank's total additional reserve requirements over total liabilities. Banks' additional reserve requirements is the sum of the change in reserve requirements for: short-term local currency deposits, short-term foreign currency deposits, deposits from foreign non-financial sector, and deposits from foreign financial sector.
Bank-Level Variables	
Size	Logarithm of total assets of bank b at t-1.
Liquidity	Ratio of Available Liquidity over Total Assets of bank b at t-1. The Available Liquidity includes liquid assets in excess to the liquidity in the Central Bank of Uruguay plus assets portfolio (excluding the portfolio of securities that cannot be sold but held until investment).
Solvency	$=(Eligible\ Capital/RWA$ of bank b at t-1.
Branch	=1 if bank b is organized as a branch of a foreign bank, =0 otherwise.
Loan-Level Variables	
Highdebt	=1 if firm f is classified as a "highdebt" borrower, =0 otherwise.
Rating 1	=1 if firm f has a rating of 1A ("borrower with loan fully covered by warranty") and 1C ("borrower with strong capacity to pay"), =0 otherwise. Best Rating.
Rating 2	=1 if firm f has a rating of 2A ("borrower with adequate capacity to pay", delay in payment<30 days) and 2B ("borrower with potential problems to pay", delay in payment<60 days), =0 otherwise.
Rating 3	=1 if firm f has a rating of 3 ("borrower with compromised capacity to pay", delay in payment<120 days), =0 otherwise.
Rating 4	=1 if firm f has a rating of 4 ("borrower with very compromised capacity to pay", delay in payment<180 days), =0 otherwise.
Rating 5	=1 if firm f has a rating of 5 ("irrecoverable debt", delay in payment≥ 180 days), =0 otherwise. Worst Rating.
Firm-Level Analysis	**Variable Definition**
Dependent Variables (bank-firm)	
$\Delta logFL_{f,t+1}$	Change in the logarithm of (striclty positive) committed credit granted by all banks to firm f between t-1 and t+1.
Policy Variable	
ΔReserveReqw	Ratio of additional reserve requirements over assets for all the banks that were lending to the firm on May, 2008. Each bank value of the ratio is weighted by its loan volume to the firm on May, 2008 over total the total firm debt.

Table 1: Panel B

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Dependent Variables				
ΔlogLjul08	0.018	0.579	-5.659	11.889
LEndjul08	0.0975	0.297	0	1
LChangejul08	0.003	0.053	0	1
ΔlogFLjul08	0.01	0.373	-6.658	3.138
Independent Variables				
ΔReserveReq	0.071	0.03	0	0.143
Ln(Total Assets)	5.424	1.82	2.639	8.908
Liquidity Ratio	0.183	0.139	0.047	0.491
Solvency Ratio	0.315	0.247	0.104	0.999
STLCratio	0.007	0.007	0	0.026
STFCratio	0.028	0.02	0	0.055
NResiratio	0.016	0.014	0	0.04
FNResiratio	0.02	0.029	0	0.112
STLC Deposits over Total Assets	0.074	0.069	0	0.234
STFC Deposits over Total Assets	0.247	0.183	0	0.507
NResi Deposits over Total Assets	0.237	0.187	0	0.517
FNResi Deposits over Total Assets	0.042	0.058	0	0.246
Loan-Level Variables				
Ln(Loan Amount)	14.882	1.931	11.009	22.313
Rating 1	0.438	0.496	0	1
Rating 2	0.222	0.416	0	1
Rating 3	0.071	0.256	0	1
Rating 4	0.053	0.224	0	1
Rating 5	0.217	0.412	0	1
Primary and Manufacturing Sector	0.418	0.493	0	1
Trade	0.3	0.458	0	1
Others	0.281	0.45	0	1

Table 2: Loan-Level Intensive Margin of Lending: Average Effects

	$\Delta logL_{bf,t+1}$ (Jul-May)				$\Delta logL_{bf,t+1}$(May-Mar)	$\Delta logL_{bf,t+1}$(Sep-Jul)	$\Delta logL_{bf,t+1}$ (Jul-May)
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta ReserveReq$	-0.307**	-0.342***	-0.277**	-0.278*	-0.018	-0.126	-0.166*
	(0.145)	(0.111)	(0.129)	(0.135)	(0.160)	(0.154)	(0.096)
Industry/debt/risk Fixed Effects	No	Yes	Yes	><	><	><	><
Firm Fixed Effects	No	No	No	Yes	Yes	Yes	Yes
Bank Controls	No	No	Yes	No	No	No	Yes
Number of Observations	9659	9659	9659	9659	9605	9957	9659

NOTE. The dependent variable is the change in the logarithm of (strictly positive) committed credit by bank b to firm f between july and may (where the policy change t is june). The policy variable $\Delta ReserveReq$ is the ratio of the change in bank's total reserve requirements (on short-term local currency deposits, short-term foreign currency deposits, deposits from foreign non-financial sector and deposits from foreign financial sector) over Total Liabilities. The estimations are performed for the sample of firms with more than one bank relationship. Standard errors are clustered at the bank*industry-group level (where the industry groups are: Primary and Manufactures, Trade, Rest). Columns (5) and (6) display the results of the estimations for the placebo tests performed for previous and posterior periods. "Yes" indicates that the set of characteristics of fixed effects is included. "No" indicates that the set of characteristics or fixed effects is not included. "><" indicates that the indicated set of characteristics or fixed effects are comprised in the wider included set of fixed effects. * Significant at 10 %,** Significant at 5 %,*** Significant at 1 %.

Table 3: Loan-Level Intensive Margin of Lending: Heterogenous Effects

Dependent Variable: $\Delta logL_{bf,t+1}$									
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta ReserveReq$	-0.275	-0.562***		-2.002***	-0.487	-0.552*	-0.134	-0.830***	-0.896**
	(0.187)	(0.160)		(0.569)	(0.497)	(0.282)	(0.105)	(0.176)	(0.357)
$\Delta ReserveReq$*Rating2	0.301	0.886***	0.643**						0.554*
	(0.300)	(0.221)	(0.254)						(0.277)
$\Delta ReserveReq$*Rating3	-0.111	0.089	0.399						0.250
	(0.214)	(0.401)	(0.650)						(0.658)
$\Delta ReserveReq$*Rating4	-0.635	-0.185	0.167						0.136
	(0.622)	(0.556)	(0.635)						(0.697)
$\Delta ReserveReq$*Rating5	0.414**	0.662***	0.557**						0.756***
	(0.189)	(0.169)	(0.257)						(0.216)
$\Delta ReserveReq$*Highdebt	0.847	1.625	2.180						2.078
	(2.148)	(2.062)	(2.605)						(2.524)
$\Delta ReserveReq$*Size				0.490***				0.228***	0.155**
				(0.159)				(0.041)	(0.070)
$\Delta ReserveReq$*Liquidity					3025			0.407	0.766
					(4.041)			(1.133)	(1.446)
$\Delta ReserveReq$*Solvency						2754		-1.281**	-2.456*
						(1.817)		(0.614)	(1.231)
$\Delta ReserveReq$*Branch							1381	1469	0.342
							(0.932)	(1.268)	(1.366)
Firm Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	No	No	Yes	−−	−−	−−	−−	−−	−−
Firm-risk Controls	Yes	><	><	><	><	><	><	><	><
Bank Controls	No	No	><	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	9659	9659	9659	9659	9659	9659	9659	9659	9659

NOTE. The dependent variable is the change in the logarithm of (strictly positive) committed credit by bank b to firm f between july and may (where the policy change t is june). The policy variable $\Delta ReserveReq$ is the ratio of the change in bank's total reserve requirements (on short-term local currency deposits, short-term foerign currency deposits, deposits from foreign non-financial sector and deposits from foreign financial sector) over total Liabilities. The estimations are performed for the sample of firms with more than one bank relationship. Standard errors are clustered at the bank*firm-risk level (where risk level is low if the firm's rating is 1 or 2, and high if the rating is 3, 4 or 5). "Yes" indicates that the set of characteristics of fixed effects is included. "No" indicates that the set of characteristics or fixed effects is not included. "><" indicates that the indicated set of characteristics or fixed effects are comprised in the wider included set of fixed effects. "−−" indicates that the set of fixed effects cannot be included. * Significant at 10 %,** Significant at 5 %,*** Significant at 1 %.

Table 4: Loan-Level Extensive Margin of New Loans - Panel A

Dependent Variable: $LChange_{bf,t+1}$					
Model	(1)	(2)	(3)	(4)	(5)
$\Delta ReserveReq$	0.037**	0.022		0.064**	0.097
	(0.013)	(0.021)		(0.024)	(0.065)
$\Delta ReserveReq$*Rating2			0.124		0.134
			(0.097)		(0.091)
$\Delta ReserveReq$*Rating3			0.011		-0.000
			(0.043)		(0.058)
$\Delta ReserveReq$*Rating4			-0.200*		-0.244**
			(0.116)		(0.120)
$\Delta ReserveReq$*Rating5			0.053		-0.059
			(0.039)		(0.053)
$\Delta ReserveReq$*Highdebt			-0.048		0.027
			(0.107)		(0.069)
$\Delta ReserveReq$*Size				-0.015*	-0.029
				(0.008)	(0.018)
$\Delta ReserveReq$*Liquidity				0.076	-0.208
				(0.197)	(0.302)
$\Delta ReserveReq$*Solvency				0.064	0.547
				(0.136)	(0.357)
$\Delta ReserveReq$*Branch				-0.280*	-0.317**
				(0.146)	(0.129)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	No	−−	Yes	Yes	−−
Firm-Risk Controls	><	><	><	><	><
Bank Controls	No	Yes	><	><	Yes
Number of Observations	9686	9686	9686	9686	9686

Note: the dependent variable takes the value of 1 if a firm changes bank between period $t-1$ and period $t+1$ (and doesn't continue the relationship with the bank from May), and 0 otherwise (where the policy change t is june). The policy variable $\Delta ReserveReq$ is the ratio of the change in bank's total reserve requirements (on short-term local currency deposits, short-term foreign currency deposits, deposits from foreign non-financial sector and deposits from foreign financial sector) over total Liabilities. The estimations are performed for the sample of firms with more than one bank relationship. Standard errors are clustered at the bank*firm-risk level (where risk level is low if the firm's rating is 1 or 2, and high if the rating is 3, 4 or 5). "Yes" indicates that the set of characteristics of fixed effects is included. "No" indicates that the set of characteristics or fixed effects is not included. "><" indicates that the indicated set of characteristics or fixed effects are comprised in the wider included set of fixed effects. "−−" indicates that the set of fixed effects cannot be included. * Significant at 10 %,** Significant at 5 %,*** Significant at 1 %.

Table 4: Loan-Level Extensive Margin of Ending Loans - Panel B

Dependent Variable: $LEnd_{bf,t+1}$					
Model	(1)	(2)	(3)	(4)	(5)
$\Delta ReserveReq$	0.159***	0.090**		0.283***	0.190
	(0.022)	(0.037)		(0.084)	(0.124)
$\Delta ReserveReq$*Rating2			0.334**		0.355**
			(0.150)		(0.168)
$\Delta ReserveReq$*Rating3			0.260		0.279
			(0.245)		(0.251)
$\Delta ReserveReq$*Rating4			0.546**		0.493*
			(0.262)		(0.250)
$\Delta ReserveReq$*Rating5			0.171		0.022
			(0.123)		(0.086)
$\Delta ReserveReq$*Highdebt			1.310		1.379
			(1.064)		(1.050)
$\Delta ReserveReq$*Size				-0.041	-0.067*
				(0.024)	(0.035)
$\Delta ReserveReq$*Liquidity				-0.040	0.645
				(0.291)	(0.494)
$\Delta ReserveReq$*Solvency				-0.060	-0.080
				(0.168)	(0.390)
$\Delta ReserveReq$*Branch				-0.812	-1.160*
				(0.553)	(0.671)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	No	−−	Yes	Yes	−−
Firm-Risk Controls	><	><	><	><	><
Bank Controls	No	Yes	><	><	Yes
Number of Observations	10703	10703	10703	10703	10703

Note: the dependent variable takes the value of 1 if a a bank-firm relationship that existed in period $t-1$ ends in period $t+1$ and 0 otherwise (where the policy change t is june). The policy variable $\Delta ReserveReq$ is the ratio of the change in bank's total reserve requirements (on short-term local currency deposits, short-term foerign currency deposits, deposits from foreign non-financial sector and deposits from foreign financial sector) over total Liabilities. The estimations are performed for the sample of firms with more than one bank relationship. Standard errors are clustered at the bank*firm-risk level (where risk level is low if the firm's rating is 1 or 2, and high if the rating is 3, 4 or 5). "Yes" indicates that the set of characteristics of fixed effects is included. "No" indicates that the set of characteristics or fixed effects is not included. "><" indicates that the indicated set of characteristics or fixed effects are comprised in the wider included set of fixed effects. "−−" indicates that the set of fixed effects cannot be included. * Significant at 10 %,** Significant at 5 %,*** Significant at 1 %.

Table 5: Firm-Level Analysis

Dependent Variable: $\Delta logFL_{f,t+1}$					
Model	(1)	(2)	(3)	(4)	(5)
$\Delta ReserveReq$	-0.280*	-0.302	-0.308	-0.338	-0.491
	(0.150)	(0.524)	(0.349)	(1.659)	(2.010)
$\Delta ReserveReq$*Rating2		1.067**	0.793*		0.982**
		(0.459)	(0.412)		(0.390)
$\Delta ReserveReq$*Rating3		-0.159	-0.464		-0.134
		(0.805)	(0.639)		(0.549)
$\Delta ReserveReq$*Rating4		-0.767	0.259		-0.714
		(0.948)	(0.572)		(0.547)
$\Delta ReserveReq$*Rating5		0.408	0.535		0.460
		(0.563)	(0.369)		(0.364)
$\Delta ReserveReq$*Highdebt		0.947	-0.351		0.612
		(0.828)	(1.419)		(0.868)
$\Delta ReserveReq$*Size				0.155***	0.081**
				(0.041)	(0.038)
$\Delta ReserveReq$*Liquidity				0.167	0.022
				(1.078)	(0.813)
$\Delta ReserveReq$*Solvency				-0.266	0.029
				(0.949)	(0.660)
$\Delta ReserveReq$*Branch				-0.357	-0.061
				(1.582)	(1.674)
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Bank Controls	No	No	Yes	Yes	Yes
Number of Observations	4288	4288	4288	4288	4288

Note: the dependent variable is the change in the logarithm of (strictly positive) committed cedit by all banks to firm f between july and may (where the policy change t is june). The estimations are performed for the same firms that are included in the loan-level analysis. Under the firm-level specification, all the bank variables are calculated as a weighted average where the weights are given by the portion of loans granted by the banks that were lending to a given firm just before the policy reforms took place (May, 2008) over the total loans granted to the firm. Standard errors are clustered at the bank*firm-risk level (where risk level is low if the firm's rating is 1 or 2, and high if the rating is 3, 4 or 5). The policy variable $\Delta ReserveReqw$ is the weighted average of the ratio of the change in bank's total reserve requirements (on short-term local currency deposits, short-term foerign currency deposits, deposits from foreign non-financial sector and deposits from foreign financial sector) over total Liabilities. Standard errors are clustered at the mainbank*firm-risk level (where the risk level is low if the firm's rating is 1 or 2, and high if the rating is 3, 4 or 5 and the mainbank is the bank with the highest portion of loans granted to the firm on May, 2008). "Yes" indicates that the set of characteristics of fixed effects is included. "No" indicates that the set of characteristics or fixed effects is not included. * Significant at 10 %,** Significant at 5 %,*** Significant at 1 %.