Credit Supply Responses to Reserve Requirement: Evidence from credit registry and policy shocks

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Abstract

The paper estimates the impact of reserve requirements (RR) on credit supply in Brazil, exploring a large dataset with policy shocks from tightening and loosening cycles. We explore different identification strategies. We use either a long panel or cross-sections around large policy events. We use either a simple index of RR policy or a treatment variable definition based on bank-level change in RR filtered out of variation that would occur independently of the policy. The evidence suggests that RR policy affects credit in the expected direction, that is, RR easing increases credit, while RR tightening decreases credit. Higher liquidity and capital ratios appear to reduce the impact of RR policy. Monetary policy is possibly a complement to RR policy in the sense that tightening one policy increases the effect of the other on credit. On the risk-taking channel, we find that banks avoid riskier firms in the aftermath of policy changes. During tightening phases, when there is credit contraction, riskier firms receive less credit. On the easing phases, when there is credit expansion, riskier firms also receive less credit. Results are broadly consistent across identification strategies, except for the first policy shock, just after the global financial crisis, which appears to have some distinct features.

Keywords: Reserve requirement, credit supply, capital ratio, liquidity ratio, monetary policy, macroprudential policy

JEL Classification:

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1. Introduction

Reserve requirements (RR) operate directly on the narrow credit channel defined by the supply reaction of bank credit to a change in funding composition (Kashyap and Stein (2000)). This reaction may depend on the state of the macroeconomy, such as on monetary policy, and on bank characteristics, such as liquidity or capital (Kashyap and Stein (2000), Holmstrom and Tirole (1997)). It may also have implications for the composition of credit along the riskiness of borrowers (Borio and Zhu (2008)). In this paper, we estimate the impact of reserve requirements on credit supply in Brazil.

Quantitative estimates of the supply effect, as well as its complementarity or substitution relations with other variables, is important for emerging markets that traditionally use RR policy to smooth the credit cycle (Cordella et al. (2014)). Yet, with the exception of Camors and Peydró (2013), there is little loan level evidence of the impact of such policies in these markets. We build on their work, but exploring a larger and longer dataset with policy shocks from tightening and loosening cycles. Additionally, we provide a long-term analysis through a long panel to capture macroeconomic and monetary policy interactions.

We use quarterly data from 2008Q1 to 2015Q2 from "Sistema de Informações de Crédito" (SCR), Central Bank of Brazil (BCB) credit register dataset covering virtually all loans to non-financial corporations[1]. During this time spam, a loosening and tightening cycles has been observed, leading to four policy shocks: (i) the release of reserves requirements in November, 2008 in response to the liquidity squeeze following the global financial crisis; (ii) the macroprudential reversal of this loosening cycle between March and June of 2010, followed by a longer tightening cycle, (iii) starting in December, 2010,

[1] Up to December 2011 it covered all loans greater than BRL 5,000 (USD 3,000 in 2011), and, after that, all loans greater than BRL 1,000 (USD 425 in 2014).

in the context of high capital inflows and credit growth[2]; and (iv) the reversal of this tightening, along 2012. Before and after the policy shocks, reserve requirement ratios were mostly flat and revolving around the long-term average of 23% of total liabilities subject to reserve requirements (TLRR).

The measurement of reserve requirement innovation is a central piece in the identification strategy. We evaluate two different approaches. First, we build an index, adding or subtracting one unit to the index upon the tightening or easing of RR policy. The change in this index helps assess long-term effects across RR policy shocks. Second, we define a treatment variable, as the difference between quarterly changes in current RR and quarterly changes in a counterfactual RR, both relative to TLRR. Counterfactuals refer to RR parameters fixed before September 2008, more closely reflecting RR ratio long-term average, (or beginning of 2010 in some exercises). Counterfactuals are contemporaneously calculated over the current liabilities of each bank so that the treatment variable "filter out" determinants of RR other than the regulatory changes.

We identify the complementarity or substitution relations with RR policy by introducing interaction terms in our models. Similar to Camors and Peydró (2013), we explore interactions with bank control variables such as size, liquidity, capital ratio and risk proxies. In particular, the risk proxies assess the effect on risk composition, or the risk-taking channel. In the long panel, we also explore interactions with monetary policy and macroeconomic conditions.

Following Khwaja and Mian(2008) and Jiménez et al. (2014)[3], we focus on firms with multiple bank relationships and firm (or firm*time) fixed effects to control for credit demand. To explore interactions of the treatment variable with firm or firm-bank

[2] See Barroso et.al (2015) for evidence on the link between capital inflows and credit growth.
[3] In contrast with Jiménez el al (2014), we can study the risk-taking channel without the triple interaction proposed in that paper. That is, the capital ratio is not a source of identification.

characteristics such as credit risk of a particular firm, we also include bank (or bank*time) fixed effects.   .

This paper contributes to the scarce literature estimating the effects of RR policy shocks on credit supply. It also addresses RR complementarity or mitigating relation with monetary policy, macroeconomic conditions, bank features and borrower characteristics, covering a very large dataset of firm loans and time spam. The dynamics of the Brazilian case, allows the study episodes of both macroprudential loosening and tightening separately. The dataset also allows us to explore different identification strategies. We compare results using the full sample or subsamples around policy shocks. We assess the robustness of the results obtained with simpler indicators of the policy innovation, as opposed to more precise bank specific treatment variables.[4]

The evidence is suggestive that RR policy impact credit supply in the expected direction, that is RR easing increases credit, while RR tightening decreases credit supply. The exact quantitative impact depends on the specification, but the short run elasticity of credit to reserve innovation (in p.p. of reservable liabilities) is around unit and it is stronger in tightening cycles than in loosening ones. On the risk-taking channel, we find that banks avoid riskier firms in the aftermath of policy changes. During tightening phases, when there is credit contraction, riskier firms receive less credit. On the easing phases, when there is credit expansion, riskier firms also receive less credit.

Bank interaction results are more sensitive to specification, but more generally: (i) banks with higher liquidity and capital ratios appear to sterilize RR policy impacts; (ii) monetary policy is possibly a complement to RR policy in the sense that tightening one policy increases the effect of the other on credit; (iii) during economic expansions the

[4] This paper was developed in the context of a working group sponsored by the BIS/Americas Office. The working group adopted a common protocol similar to equation (2) below, with the innovation to a macroprudential policy index in place of the reserve requirement index. It is interesting to check the robustness of the protocols to alternative definitions.

impact of RR policy is possibly weaker. Cross-section results after large events are broadly consistent with the full sample analysis, with the noticeable exception of the first policy shock, just after the global financial crisis, when most results are non-significant.

2. Literature review

The rationale for reserve requirements effects on credit supply follows Stein (1998) and Kashyap and Stein (2000). They explore imperfect substitution between insured and reservable bank liabilities on one side, and noninsured and non-reservable bank liabilities on the other. The risk-taking channel on monetary policy follows mostly Adrian and Shin (2009) and Dell'Ariccia et al. (2009). They show that changing the cost of liabilities affects banks' leverage and therefore the incentives for banks to monitor. The interaction with banks' liquidity and capital follows Kashyap and Stein (2000) and Holmstrom and Tirole (1997), respectively. In passing, the effect of typical monetary policy on credit supply and risk taking could be, in theory, similar to reserve requirements, although operating through other channels.

Tovar and Mora et al. (2012) highlight the use of reserve requirements with macroprudential purposes, especially to foster financial stability. First, it can serve as a countercyclical tool to manage the credit cycle in a broad context, limiting the excessive leverage of borrowers in the upswing and operating as a liquidity buffer in the downswing. Second, it can help to contain systemic risk accumulation by improving the funding structure of the banking system. Third, RR can target specific sectors to ease (or impose) liquidity constraints. Fourth, it can be a complementary tool for capital requirements.

Cerutti et al. (2015) document that macroprudential policies are more effective and used more broadly in less developed and more closed economies, with effectiveness measured by the correlation with credit aggregates. Cordella et al. (2014) argue that developing countries use reserve requirements for stabilizing capital flows and the credit cycle when there are severe limits on the typical monetary policy ability to smooth the level of credit and/or economic activity. According to these authors, the financial stability and business cycle-driven uses of reserve requirements cannot be separated one from the other. When reserve requirements are used to prevent financial instability, they can contribute to macroeconomic stabilization, whereas when they are used to smooth activity, they also smooth the credit cycle and promote financial stability. Similarly, Montoro and Moreno (2011) survey the reserve requirements policy use in Latin America, including its use as a macroprudential tool in face of risky capital flows and liquidity shocks.

There is a growing empirical literature exploring the risk-taking channel of monetary policy. For example, Jiménez et al (2014) use credit register data from Spain to show that riskier borrowers get more credit than safe ones during a policy easing cycle. Altumbas et.al (2012) show solvency problems during the crisis were more severe for banks in jurisdictions with low interest rates for a long time and for banks with less capital. Maddaloni and Peydró (2011) show lending standards across several jurisdictions, as assessed by surveys, deteriorate in response to lower short-term interest rates. Lee et.al (2015) use syndicated loan data to show that, before the crisis, lenders invest in riskier loans in response to a decline in short-term US rates while, after it, to a decline in long-term US interest rates.

Camors and Peydro (2013) is the closest paper to ours in the literature. They show that an increase of the requirements for short-term funding in Uruguay imply a reduction of credit supply. Their results for the risk-taking channel is contradicting or non-significant in the intensive margin. However, on the extensive margin, firms with better ratings insulate from RR shocks. Tovar and Mora et al. (2012) document with macro data that RR affects credit growth, but have no implications for risk-taking. Glocker and Towbin (2012) obtain a similar result to Camors and Peydro (2013) for the case of Brazil, but using macroeconomic data and time series methodology.

3. Background and Data

3.1. Background

Reserve requirement ratio to deposits in Brazil is large by international standards. It averages around 23% of TRRL from 2008 to 2014, while Montoro and Moreno (2015) report emerging market ratios (ex. Brazil and Argentina) below 15% and developed market ratios below 5%. The ratio in Brazil is mostly flat before the global financial crisis. During the crisis, in face of a liquidity squeeze in the interbank and credit market, Central Bank of Brazil (BCB) reduces RR to the historical low levels of 18%. During the first quarter of 2010, there is a rebuild of RR (loosening cycle is complete), but followed by a tightening cycle in response to capital flows and high credit growth in the December 2010. Relative to other local macroprudential policies implemented during the same period, RR is arguably the macroprudential tool with broadest scope and biggest impact[5]. Along 2012, with growing external uncertainties, reduction of international capital flows and reduced credit supply from private banks, RR is eased again to pre-crisis levels (tightening cycle is complete). See Figure 1 and 2

Insert Figure 1 and 2 here

[5] During the post-crisis environment of large global liquidity, the Central Bank of Brazil issued many with-in sector regulations focusing financial stability, such as loan to value caps on housing loans and higher capital requirements on auto-loans. See Barroso and Sales (2012).

The Central Bank of Brazil manages mainly four RR components; RR on demand deposits (unremunerated), savings (remunerated according to savings accounts), time and term deposits (remunerated at the daily prime rate, SELIC), and an additional component comprised of three subcomponents, one for each of the previous components, (all remunerated at the daily prime rate, SELIC). It also manages deductibles, conditional deductibles, exemption thresholds, eligible liabilities and remuneration. The details of the regulatory changes in the period considered in the paper are complex. We summarize the main measures in the following subsections and present more details in Chart 1.

Insert Chart 1 here

3.1.1. Main measures

The global financial crisis leads to a liquidity squeeze in the interbank market that affected mostly small and medium-sized financial institutions and substantially impacted domestic credit growth. In response, the Central Bank of Brazil eases reserve requirements and creates conditional deductibles to stimulate larger banks to provide liquidity support to small and medium-sized ones. The main measures adopted in 2008 are the following (details in Chart 1):

(i) Reduction in RR ratios for demand deposits, term deposits and the additional rcomponent;

(ii) Higher deductions, lower remuneration and changes in eligible liabilities for time and term deposits and in the additional component that released some small banks from RR and reduced significantly RR on big banks.

(iii) Conditional deductibles on certain exposures (from mostly big banks) to small-and-medium sized financial institutions

The first measured released close to BRL 26 billion and the two remaining combined, BRL 40 billion.

In the first quarter of 2010, the BCB progressively reverses the measures adopted during the crisis[6], and, after that, tightens RR to levels higher than those prevailing before the crisis (see Figure 1 and 2). This tightening cycle starting in December 2010 is a response to high capital inflows and credit growth happening at the second half of 2010. The overall change in RR is close to BRL 70 billion.

Along 2012, BCB relax this last tightening cycle. Some new easing measures are also created to stimulate economic activity, e.g. a higher deductible for RR on term deposits and conditional deductibles for auto and motorbike loans between March and September of 2012. Credit market was feeble in this period, following two years of intense credit deepening.

3.1.4 Counterfactual RR

The Central Bank of Brazil routinely computes counterfactual RR to monitor the implementation of its policies. In light of these constant changes in RR, comparing current and counterfactual RR is useful to summarize these changes in one figure. The counterfactual is straightforward to calculate. The liabilities subject to RR (TLRR) are the same[7], but RR ratios, deductibles, conditional deductions and exemptions are calculated for every bank based on the pre-changes rule.

[6] Paradoxically, in March, 2010, BCB creates a deductible on Term Deposits and on the Additional one conditional on the capital of the banks, virtually exempting small-and-medium sized bank institutions from RR (Circular 3,485/2010)

[7] Eligible liabilities changed in 2010 for six months and comprehend the inclusion of a bond called “letra financeira” with maturities over 2 years in the eligibility list. Tracing these effects is a limitation of this study. Other changes are also untraceable. For instance, changes in remuneration of RR components (Chart 1).

In this paper, we take the pre-crisis state as the main counterfactual, because it was stable enough for a long window prior to the crisis better depicting a long-term stable state. In particular, the counterfactual RR ratios of 2008 used across all this study are those available until October 2008:

- 15% on term deposits;
- 45% for demand deposits;
- 20% for savings deposits;
- In the additional components, (8% on demand and term deposits; and 10% on savings)

In the cross-section study, we rely on the counterfactual RR of 2010, to better explore the tightening cycle starting in December, 2010. The Counterfactual in this case, reflect regulation prior to this point and is very similar to the one above, except for the Demand Deposit ratio in 43%. See Chart 1 for details in RR policy changes.

3.2. Data

3.2.1. Credit Register

The main dataset of the paper is the Brazilian Credit Register (SCR), which encompasses virtually all corporate loans in the domestic financial system. Data is quarterly from 2008Q1 to 2015Q2. The dependent variable of interest is the log change in the credit granted to a firm (f), by a bank (b) in a quarter (t), winsorized at the 2st and 98th percentile. We restrict our sample to firms with loans granted from more than one bank. This sample has over 36 million data points (27 periods, 132 banks and 478 thousand firms).

The firm risk indicator is the loan level provision to non-performing loans (PNL) weighted across all banks to which the firm has a credit exposure [8] (Firm Risk), or simply the PNL given by the bank to a particular firm (Firm-Bank Risk). . We use alternatively, the non-performing loans (NPL) to total credit exposure ratio, weighted across all banks to which the firm has a credit exposure (Firm NPL), or the NPL given by the bank to a particular firm relatively to its exposure such firm (Firm-Bank Risk).

Bank control variables are available from balance sheet data and include total assets (size), liquidity ratio (liquidity), 12 months return over assets (ROA12), Banks non-performing loans to total credit (NPL); and public, foreign or small bank dummy variables[9].

3.2.2. Reserve Requirements

We measure reserve requirements innovation with two alternative definitions. For the first measure, we build a simple index, adding or subtracting a unit on a tightening or easing policy event in a quarter – using the events in Chart 1. The change in the index is the policy innovation.

For the second measure, we use a treatment variable defined as the quarterly change in effective reserve minus the quarterly change in counterfactual reserves, both measured as a ratio to liabilities subjected to RR (TLRR). From equation (1),

$$\Delta ReservReq_t^b = 100 * \left[\Delta\left(\frac{\text{Effective}_t^b}{\text{Liabilities}_t^b}\right) - \Delta\left(\frac{\text{Counterfactual}_t^b}{\text{Liabilities}_{b,t}}\right)\right] \quad (1)$$

[8] Ratings go from "AA" (highest quality) to "H" (lowest quality), and provisioning increases nonlinearly with each step. Measured as the required provision, the ratings relate on average to expected losses and from "AA" to "H" are 0.005, 0.01, 0.03, 0.1, 0.3, 0.5, 0.7 and 1, respectively. There is a close correspondence between such provisions and the following scale of days overdue, 0, 15-30, 31-60, 61-90, 91-120, 121-150, 151-180, >180.

[9] In this paper, small Banks are those with Tier 2 capital under BRL 5 billion. Definition follows the RR regulation, Circular 3,485/2010

where b refers to a bank and t to a quarter. In (1), we use the variation in counterfactual reserves to filter out the determinants of reserve requirements other than regulatory change. Figure 3 illustrate the range of the variable in the full sample and certain subsamples

Insert Figure 3 here

Notice that using equation (1) as a treatment variable implies that TLRR is not endogenously changing in response to RR shocks. This may look as a strong assumption, especially because changes are not homogenous across components and may leave room to changes towards unaffected liabilities.

We take that regulatory changes are unexpected and substitution is gradual and lags behind the regulatory change. In principle, making substantial changes in the liabilities mix is costly and takes time, but assuming no substitution across one quarter or one semester seems reasonable. Camors and Peydró (2013) also use changes between current and counterfactual RR as the treatment variable on a cross-section. Results should be comparable to the ones we present in the cross-sectional part of our results session.

4. Methodology

We present our results in two sessions. The first comprising long panel estimates both using the RR index and the treatment variable and, a second, with cross-sectional estimates around the four main policy shocks in the sample

Long Panel

The models considered in the paper are special cases of the following linear regression, where for simplicity we omitted the coefficients:

$$\Delta ln\left(\text{Credit}_{f,t}^{b}\right) * 100 = \sum_{i} \Delta ReservReq_{t-i}^{b} + \sum_{i} \Delta ReservReq_{t-i}^{b} * X_{f.t-i}^{b} + \sum_{i} X_{f.t-i}^{b} + \alpha_{f.t}^{b} \qquad (2)$$

The dependent variable is the log change in credit to a firm *f* in a specific bank *b* and period *t*. The main independent variable is the innovation in reserve requirement. We write it with a bank superscript, meaning this is not the index, but the treatment variable of equation (1).

When estimating a model with the index, the treatment variable, $eservReq$, becomes a time index reflecting the number of RR interventions in place and $\Delta ReservReq$ becomes a (+1) or (-1) indicator pending if the policy shock is a tightening or an easing in the quarter. There are several policy events happening in different periods. Since the index makes no distinction over the intensity of the shock for different periods or different banks, there is also a presumption that no single event dominates the sample. In our data, this assumption is about right, since the regulation authority implements and latter reverses the policy experiments, so that effects are more or less balanced.

We are also interested in interaction terms of the policy innovation and a vector of variables of interest denoted by X in the equation. In this interaction, we consider macro variables (indexed only by time), bank variables (indexed by both time and bank), and firm or (firm-bank) risk (indexed by time and firm or by time-firm-bank)..

The last term in the equation represent the fixed effects introduced in the model. We gradually introduce firm fixed, firm*time, bank and bank*time fixed across our model settings. . We use distributed lag model in the full sample, as well as models with a simple lag structure ranging over subsamples.

Cross section

The methodology replicates Camors and Peydro (2013), but the dependent variable in this diff-in-diff is one semester after the end of the policy shocks stated above. We use longer windows, because the regulator uses several smaller policy interventions as illustrated in Figures 4 and 5. The treatment variable is the same of equation (1) and represented in the shaded area, but $\Delta ReservReq_{t-1}^{b}$ represents the one semester change in the treatment variable, the same descripted in the four shocks. We precisely estimate on equation (2) on the following semester:

$$\Delta ln\left(\text{Credit}_{f,t+1,t}^{b}\right) = \Delta ReservReq_{t,t-1}^{b} + \Delta ReservReq_{t,t-1}^{b} * X_{f.t-1}^{b} + X_{f.t-1}^{b} + \alpha_{f.}^{b}$$

Insert Figure 4 here

Insert Figure 5 here

We consider the following four shocks: (1) A easing phase (Sept-08 to Mar-09) and a (2) tightening phase (Dec-09 Jun-10) related to the easing cycle starting in the aftermath of the 2008 crisis (Figure 4); and a (3) tightening phase (Sep-10 Mar-11) and easing phase (Mar-12 Sep-12) related to a tightening cycle (Figure 5) starting on the second half of 2010 motivated by high international capital flows and credit growth.

5. Results

We present two sets of results. The first set uses the full sample from 08Q2 to 15Q2. This allows us to compare results obtained with the somewhat naive index definition of RR innovation and the more precise treatment variable definition based on counterfactuals. As we show below, the index or treatment approach are surprisingly similar even quantitatively. This probably reflects the fact that our sample is somewhat balanced in terms of size and direction of interventions. This is the case for both short-run elasticities and long-run elasticities estimated with distributed lag models.

The second set of results uses cross-sections just after large and unexpected movements in reserve requirements. While the full sample approach measures the average elasticity across many different events, the subsample approach measures event specific elasticities.

5.1. Full Sample

The short run elasticities and interactions are in Table 1. The effect of a one p.p negative or positive innovation in reserve requirements is around 1.2 percent increase or decrease, respectively, in the stock of credit for the average firm. This is the simple average of the first row of the table. The exact absolute value of the elasticity is sensitive to the set of interactions included in the model. The short run effect is however not significant when considering all interactions. Although not significant in this case, the estimated elasticity is surprisingly similar using the index or treatment specification.

Insert Table 1 and 2 Here

The long run elasticities and interactions are in Table 2. Since there is no feedback from credit growth into the model, there is complete transmission after one year. The effect of a one p.p negative or positive innovation in reserve requirements is around 9 percent increase or decrease, respectively, in the stock of credit for the average firm. This is again the simple average of the first row of the table, with a lot of dispersion depending on the interactions included in the specification. In contrast with the short run effect, the long run effect is significant when considering all interactions and, again, the estimated elasticity is surprisingly similar using the index or treatment specification, and around the average elasticity of the columns.

Moving to the interactions. Consider the impact of the same one p.p. innovation in reserve requirement described in the last two paragraphs. The columns show the sign pattern and occasionally the point estimates are robust to the inclusion of other interaction terms. We focus on the last few columns of the table where all interactions are considered.

High capital and liquidity ratios contribute to minimize the effect from reserve requirement. Each ten p.p. increase in the capital ratio reduces the overall impact of a reserve requirement shock by 0.41 in the short run and 0.82 in the long run, while a similar ten p.p. increase in the liquidity ratio reduces the impact of the policy shock by 0.31 in the short run and 1.05 in the long run. These estimates are from the counterfactual treatment approach, that is, the last two columns of the tables. The corresponding estimates of the index approach are a bit higher and significant only for the liquidity ratio.

On the other direction, public banks reinforce the impact from reserve requirement policy, plausibly suggesting some coordination between the two actions. The fact that a bank holding company is controlled by a government entity increases the baseline effect on credit growth by 0.72 percentage points, more than half the baseline. However, the effect is short lived in that there is no significative long run impact. The short run impact estimate doubles when considering the index approach instead of the more precise treatment approach.

There is strong evidence of a risk-taking channel, in the sense that firm riskiness reinforces the impact from reserve requirement policy. We measure riskiness by the average credit rating reported by banks in the scale of required loss provisions (there is a mapping between the two given by Brazilian regulation). This essentially corresponds to an indicator of expected loss. Each one standard deviation increase in firm riskiness (or 22% in expected loss), increases the impact of a reserve requirement shock by 0.22 in the short run and .64 in the long run. The most saturated specification including bank*time fixed effects, points to an increase by 0.23 in the short run and 0.58 in the long run. The estimates using the index approach are also quantitatively close to these estimates, although a bit lower and non-significant in the long run.

Some results are noteworthy, even though not particularly robust to how we measure the policy shock. The index approach, and only it, points to a size effect, but in different directions in the short and the long run. According to treatment definition of the shock, monetary policy is complementary to reserve requirement policy in the short run, and only the short run. While according to the index approach, economic activity is complementary to reserve requirement policy in the long run, and only the long run.

5.2. Cross-sections

The cross-section models are defined around policy shocks and over semesters. Again, the first difference operator in equation (2) is measured in semesters. The policy shocks can be visually identified in Figures 4 and 5 and correspond to the easing episode in 08Q4-09Q1, the two sequential tightening episodes in 10Q1-10Q2 and 10Q4-11Q1, and the final easing episode in 12Q2-12Q3. The results from the exercise are in Tables 4 to 8.

In Table 4, we present the results for the lending channel alone. We present only the least and most saturated specifications. Results are negative, but non-significant for the first shock, on the aftermath of the crisis, when firm fixed effects and bank controls are included. Figures lay between -0.75% to -0.85% in the two tightening shocks and -2.32% in the last easing one.

Insert Table 4 here

In Tables 5 to 6, we present results for the risk-taking channel including bank fixed effects. Table 5 uses the Firm $Risk_{t-1}$ definition, average provisions in the banking sector, and Table 6 uses Firm NPL_{t-1}. Both cases present similar results with positive figures and very significant figures during *easing* and negative ones during *tightening*. In other words, we find that banks avoid riskier firms in the aftermath of policy shocks. During tightening phases, when there is credit contraction, riskier firms receive less credit. On the easing phases, when there is credit expansion, riskier firms also receive less credit. Alternative firm-bank risk proxies point in the same direction. Results are available at the Appendix.

Insert Table 5 here

Insert Table 6 here

In Table 7, we explore several bank interactions jointly. Results where interactions are individually assessed are presented in the Appendix. As in Camors and Peydro(2013), we find that banks higher liquidity sterilizes RR shocks as well as higher capital. However, contrary to the authors, we find no evidence that size itself sterilizes these interventions.

Insert Table 7 here

As a robustness check, we estimate the credit channel in placebo periods and using an alternative treatment variable proxy, the change in RR to total assets (i.e. without any counterfactual). The placebos, as expected, are non-significant for counterfactual in periods when RR is stable after these shocks (Table 8). The alternative treatment variable is negative, but not significant in all shocks.

Insert Table 8 here

Results are broadly consistent with full sample analogues, except for the first easing episode. This episode corresponds to the large liquidity injection after the global financial crisis. In this case, reserve requirement is either insignificant or have apparently the opposite effect expected from theory, leading to a lower credit growth. Capital ratios and firm risk also have the opposite effects relative to the full sample. Several factors might explain this result, such as the endogeneity of the policy shock that targeted institutions differentially affected by the global financial crisis, or maybe that the policy signaled to participants that problems were more severe than expected. The divergent effect in this period might be a factor driving the lack of significance in some coefficients in the full sample.

The other episodes show a credit channel consistent with the full sample, the more so in the tightening episodes, and with coefficient point estimates close to the long run effects estimated before. Capital ratios and liquidity ratios again contribute to mitigate the effect and by similar order of magnitude as in the full sample estimates. Public banks appear to have a larger complementarity role with reserve requirement policy in the last easing cycle, the opposite being the case for bank size. The risk-taking channel appears to be particularly strong in the two tightening episodes, and the result is robust to the inclusion of bank fixed effects. The magnitude is close to the long-run full sample ones.

6. Conclusion

We addressed the credit supply effect of reserve requirement (RR) shock with different identification strategies applied to a large sample with both loosing and tightening episodes. The evidence is suggestive that RR policy impact credit in the expected direction, that is RR easing increases credit, while RR tightening decreases credit. The exact quantitative impact depends on the specification, and it is sensible higher in the medium and long run. We show that results are robust to using a simple index of reserve requirement policy *vis-a-vis* a more precise treatment variable based on bank level counterfactual reserve requirements.

This is a significant result since the index approach is less informative. The balanced sample in terms of tightening and easing episodes and their intensities contributed for this finding.

We also consider the complementarity or mitigating relation of the policy shock with monetary policy, macroeconomic conditions, bank features and firm risk. There is suggestive evidence that higher liquidity and capital ratios appear to reduce the impact of RR policy. Monetary policy is possibly a complement to RR policy in the sense that tightening one policy increases the effect of the other on credit. On the risk-taking channel, we find that banks avoid riskier firms in the aftermath of policy changes. During tightening phases, when there is credit contraction, riskier firms receive less credit.

We consider both full sample and cross-section models focusing on semesters before and after large policy shocks. Cross section results are broadly consistent with the full sample, with the noticeable exception of the first policy shock, just after the global financial crisis.

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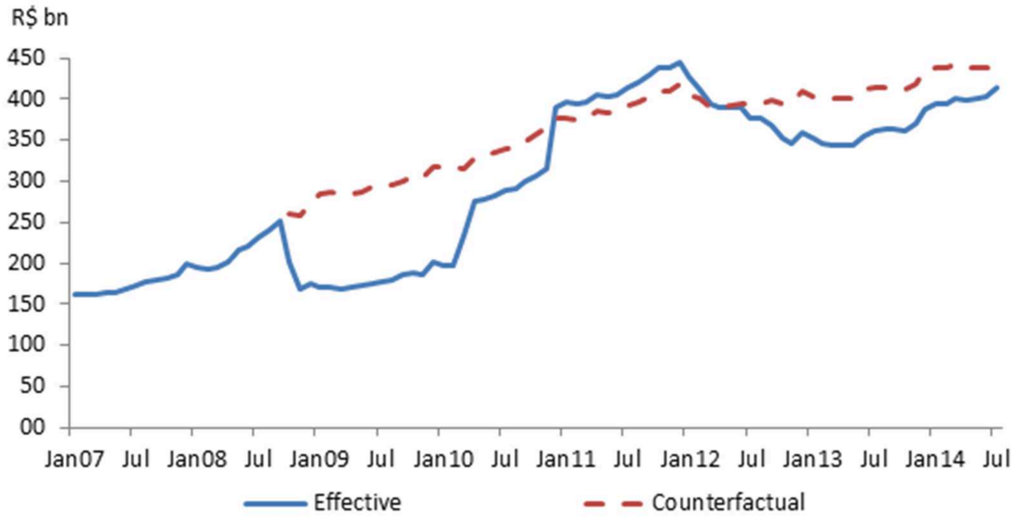
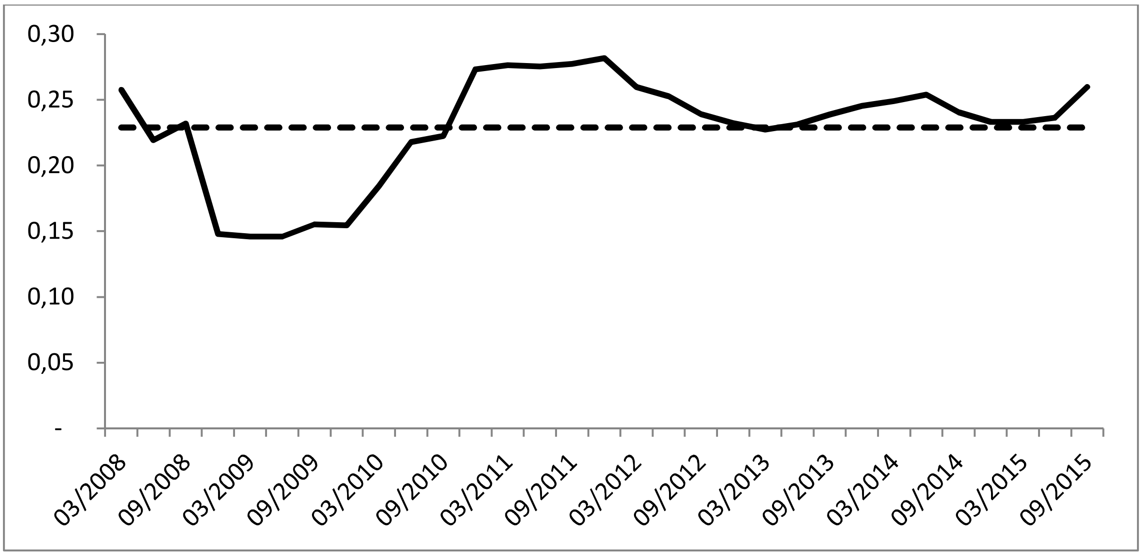
Figures, Chart and Tables

Figure 1. Total Reserve Requirements in Brazil (BRL in billions)



Notes: (i) Total includes all public, private domestic and private foreign banks operating in Brazil. (ii) Counterfactual reserve requirements are calculated based on regulation in place before September 2008.

Figure 2. Reserve requirement ratios, i.e. total RR to total liabilities subjected to Reserve Requirements (TLRR)

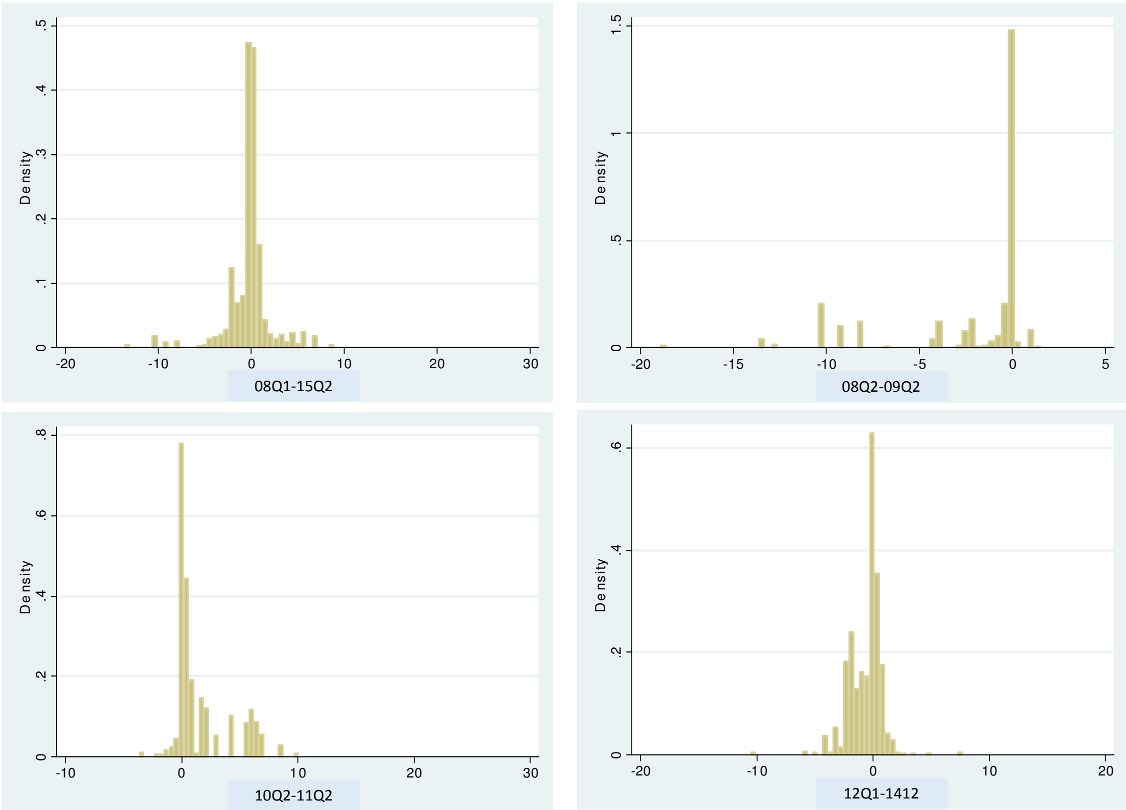


Notes: (i) Total includes all public, private domestic and private foreign banks operating in Brazil. (ii) Dashed line is the long-term average, 23% .

Chart 1: Changes in RR

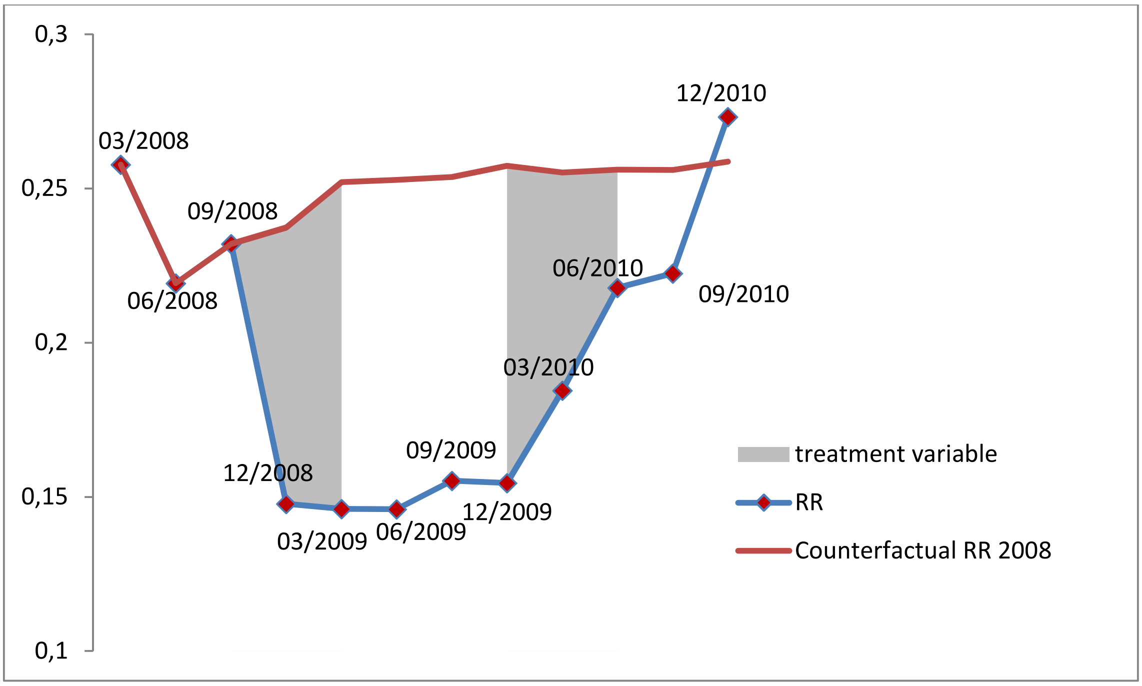
out-08	Both the Term and the Demand components of the Additional RR are reduced from 8% to 5%. From October, 8, 2008 (circ 3408)
out-08	The Demand Deposits RR is reduced from 45% to 42% (Circ 3413)
jan-09	The Term Components of the Additional RR is reduced again to 4%(Circ 3426)
set-09	Reduces the Term RR from 15% to 13.5%. From Sep, 28, 2009 (Circ 3.468)
abr-10	The Additional RR is pretty much reversed to its original condition pre-crisis, i.e., 8% for Term and Demand Deposits (Circ 3486). The Term RR itself is also reverted to 15%. A particular Bond with minimum 2 years of maturity (named Letra Financeira) was introduced as an instrument eligible to RR (for six months). From Feb, 24, 2010. (Circ. 3485)
jun-10	Demand Deposits are gradually rebuilt from 42 to 45% (circ 3497). On latter July, a 1% increase is expected. In July, 2012, 44% and In July, 2014, 45%,
dez-10	The Additional RR is increase from 8% to 12% on both Demand and Term Deposits. The Term RR is also increased from 15% to 20%. From Dec, 12, 2010 (Circ 3514) . LF is again exempted from RR.
fev-12	Reduces the remuneration on Term Deposits to 80% of the exigibility. A deduction in RR was previously created for banks to support liquidity of smaller banks either using the interbank or buying loan portfolios (until 21 of may). Certain resistance from the part of the banks to engage in these operatios made the Central Bank of Brazil create other incentives. From February, 10, 2012 (circ 3576)
jul-12	Additional RR on Savings is Reduced to 6% (Circ 3603)
out-12	The Additional RR on Demand Deposits is reduced to 0%, but the one on Term deposits is incresed from 10 to 11%. From October, 1, 2012 (circ 3609)
abr-13	The Additional RR on Term is reduced to 11%. The Additional on Savings is increased to 10% and the Demand term is set to 0%. From March, 27, 2013 (circ 3655)
jul-14	Reduces again remuneration of the Term Deposits to 50% the exigibility to further incentivizes liquidity support to banks in need. From, July, 24, 2014 (Circular 3.712)
mai-15	The Savings Component is increased from 15% to 24.5% for typical Savings accounts, with a deduction of 200M to banks with Tier 1 below BRL 5bi (circ 3757) . For rural saving accounts, the RR is reduced from 20% 15.5% for rural savings. New deductions apply for new (subsidized) housing loans. From May, 28, 2015.
jun-15	Additional RR on Savings id reduced to 5.5% (circ 3755)
jul-15	Term RR is Increased to 25% (Circ 3756). Remuneration on 100% of exigilibilities is reinstated
dez-15	Circular nº 3.755, de 16/12/2015 A new Deduction of BRL 70M is applied to the Demand Deposits RR. This should produce liquidity flow. The additional Component of Savings is reduced from 10% to 5.5%..

Figure 3. Innovation in reserve requirements



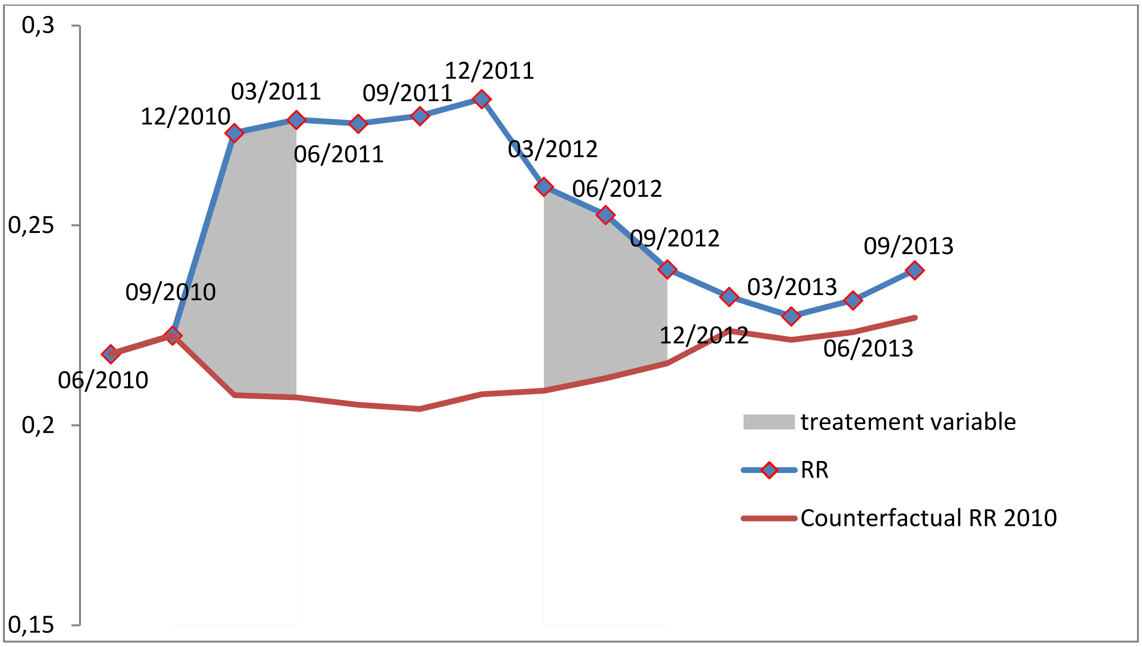
Notes: The innovation is the change in the ratio of effective reserve to liabilities minus the ratio of counterfactual reserves ratio to liabilities (in percentage points).

Figure 4: RR and Counterfactual RR of 2008 during the easing cyle.



Note: The change between RR and Counterfactual RR is the treatment variable illustrated in the shaded areas. The shock dates are (1) March-09 and (2) June-10. $\Delta ln\left(\text{Credit}_{f,t+1,t}^{b}\right)$ is the dependent variable calculated in the following semester, i.e. changes in total credit at the firm bank level between September relatively to March(2009) and December relatively to June (2010), respectively

Figure 5: RR and Counterfactual RR of 2010 during the easing cyle



Note: The change between RR and Counterfactual RR is the treatment variable illustrated in the shaded areas. The shock dates are (1) Mar-11 and (2) Sep-09. $\Delta ln\left(\text{Credit}_{f,t+1,t}^{b}\right)$ is the dependent variable calculated in the following semester, i.e. changes in total credit at the firm bank level between September, 2011 relatively to March, 2011 and from June, 2013 relatively to December, 2012, respective

Table 1. Loan level effect of reserve requirement innovation: one lag

The first row shows the credit channel effect estimate, while the other rows show complementarity or substitution patterns with macro variables, bank variables and firm variables, including firm risk. Columns (1)-(9) use as innovation the change in the reserve requirement index, with the index calculated by adding or subtracting one unit in case of tightening or easing policy events. Colum (10)-(11) use the as innovation the change in effective reserve minus the change in counterfactual reserve, both as a ratio to reservable liabilities. Models include only one lag of regressors. Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and *** is significance at 10%.

Dependent variable: $\Delta\ln(credit_{b,f,t})$											
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\Delta ResReq_{t-1}$	-1.02 ***	-2.34 ***	-3.40 ***	2.97 **	-0.42	-1.2 ***	-2.6 ***	-0.74 **	-1.63	-1.6	
	(0.37)	(0.67)	(1.20)	(1.15)	(0.32)	(0.4)	(0.81)	(0.38)	(1.28)	(1.89)	
$\Delta ResReq_{t-1}$:											
* Capital Ratio $_{t-1}$		12.58 ***							1.85	4.09 ***	
		(3.74)							(5.2)	(1.41)	
* Liquidity Ratio $_{t-1}$			11.53 **						8.86 ***	3.08 **	
			(4.68)						(3.25)	(1.83)	
* Size $_{t-1}$				-4.56 ***					-1.89 **	0.03	
				(1.52)					(0.77)	(0.06)	
* Public Bank					-1.71 ***				-1.52 ***	-0.72 ***	
					(0.42)				(0.31)	(0.09)	
* ΔPolicy Rate $_{t-1}$						-0.02			0.00	0.00	
						(0.02)			(0.02)	(0.01)	
* ΔGDP $_{t-1}$							0.30 ***		0.19 **	0.01	
							(0.11)		(0.11)	(0.04)	
* Firm Risk $_{t-1}$								-1.30 ***	-1.32 **	-0.98 ***	-1.05 ***
								(0.77)	(0.75)	(0.26)	(0.24)
Macro Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	><	><
Seasonal Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	><	><
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	><	><
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	><
Firm-Time Fixed Effects	No	No	No	No	No	No	No	No	No	Yes	Yes
Bank-Time Fixed Effects	No	No	No	No	No	No	No	No	No	No	Yes
ΔResReq	Index	Index	Index	Index	Index	Index	Index	Index	Index	Counterf.	Counterf.
R2	5%	5%	5%	5%	5%	5%	5%	5%	5%	43%	46%
N banks	134	134	134	134	134	134	134	134	134	134	126
N firms (million)	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	0.84
N (million)	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	15.4

Table 2. Loan level effect of reserve requirement innovation: contemporaneous and four lags

The first row shows the credit channel effect estimate, while the other rows show complementarity or substitution patterns with macro variables, bank variables and firm variables, including firm risk. Columns (1)-(9) use as innovation the change in the reserve requirement index, with the index calculated by adding or subtracting one unit in case of tightening or easing policy events. Colum (10)-(11) use the as innovation the change in effective reserve minus the change in counterfactual reserve, both as a ratio to reservable liabilities. Models include contemporaneous and four lags of the regressors.The table repor the sum of all five coefficientes. Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and *** is significance at 10%.

Dependent variable: $\Delta\ln(credit_{b,f,t})$											
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\Sigma_{i=0..4}\Delta ResReq_{t-i}$	-1.18	-3.01 ***	-2.93 **	-0.99	-0.43	-45.9 **	-14.9 ***	-0.24	-9.92 *	-10.2 *	
	(1.06)	(1.20)	(1.31)	(4.87)	(0.73)	(19.9)	(3.70)	(0.81)	(5.09)	(6.19)	
$\Sigma_{i=0..4}\Delta ResReq_{t-i}$											
* Capital Ratio $_{t-i}$		19.09 ***							13.52	8.21 **	
		(6.63)							(10.3)	(3.82)	
* Liquidity Ratio $_{t-i}$			11.40 *						13.33 **	10.48 ***	
			(6.33)						(5.76)	(3.92)	
* Size $_{t-i}$				0.03					0.27 *	0.30	
				(0.17)					(0.16)	(0.22)	
* Public Bank					-2.22 ***				-1.07	-0.48	
					(0.40)				(0.70)	(0.32)	
* ΔPolicy Rate $_{t-i}$						-0.54				-0.03 **	
						(0.66)				(0.02)	
* ΔGDP $_{t-i}$							1.83 ***			-0.10	
							(0.43)			(0.12)	
* Firm Risk $_{t-i}$								-1.37	-1.63	-2.92 ***	-2.64 ***
								(1.56)	(1.66)	(0.91)	(0.93)
Macro Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	><	><
Seasonal Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	><	><
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	><	><
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	><
Firm-Time Fixed Effects	No	No	No	No	No	No	No	No	No	Yes	Yes
Bank-Time Fixed Effects	No	No	No	No	No	No	No	No	No	No	Yes
ΔResReq	Index	Index	Index	Index	Index	Index	Index	Index	Index	Counterf.	Counterf.
R2	6%	6%	6%	6%	6%	6%	6%	6%	6%	46%	46%
N banks	126	126	126	126	126	126	126	126	126	126	126
N firms (million)	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
N (million)	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4

Table 4. Credit Channel using DiD: 4 shocks

The dependent variable is the change in the natural log of credit given by bank *b* to firm *f* (intensive margin) between *t+1* and *t*, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank *b* between *t* and *t-1* relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1. Models (1), (3), (5) and (7) present the estimates without any controls, and the remaining models, present the most saturated estimates, with firm fixed effects and bank controls.In the first two columns, models (1-2), we present DResReq *t*, measured between end of March, 2009 and end of September, 2008. Similarly, models (3-4) represent the change in RR during build-up phase of the loosening cycle, i.e. from end of December, 2009 to end of June,2010; models (5-6), represent the tightening phase of the tightening cycle from end December, 2010 to end March, 2011; and models (7-8), the latter release phase, between end of March and end of September, 2012. Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 - mar/09		dez/09 - jun/10		set/10 - mar/11		Mar-12 -	
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_t$	-0.671**	0.350	0.455	-0.746***	-0.023	-0.847*	-0.653	-2.299**
	(0.294)	(0.311)	(0.344)	(0.237)	(0.337)	(0.437)	(0.925)	(1.013)
Observations	554,088	554,088	754,839	754,837	829,596	829,596	876,181	876,181
R-squared	0.005	0.540	0.001	0.461	0.000	0.454	0.000	0.458
Firm Controls	NO	<>	NO	<>	NO	<>	NO	<>
Bank Controls	NO	YES	NO	YES	NO	YES	NO	YES
Firm FE	NO	YES	NO	YES	NO	YES	NO	YES
Bank FE	<>	<>	<>	<>	<>	<>	<>	<>
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

Table 5 Risk Channel using DiD: 4 shocks (bank-fixed effects)

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, DIn(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1. Models (1), (3), (5) and (7) are saturated with firm fixed effects and bank controls. The treatment variable is interacted with firm risk(f_risk $_{t-1}$), the bank sector average provisions against firm *f.* The remaining models are saturated with bank-fixed effects to better depict the significance of the risk interaction. Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 - mar/09		dez/09 - jun/10		set/10 - mar/11		jun/12 - Sep/12	
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_t$	0.300		-0.675***		-0.805*		-2.313**	
	(0.322)		(0.249)		(0.443)		(1.003)	
ΔResReq $_t$ * Firm Risk $_{t-1}$	1.800***	2.056***	-1.994***	-1.814***	-1.368**	-1.224**	0.397	-0.563
	(0.400)	(0.374)	(0.604)	(0.561)	(0.543)	(0.557)	(1.794)	(1.545)
Observations	554,088	554,088	754,837	754,839	829,596	829,596	876,181	876,181
R-squared	0.540	0.546	0.461	0.464	0.454	0.457	0.458	0.464
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	NO	YES	NO	YES	NO	YES	NO
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	NO	YES	NO	YES	NO	YES	NO	YES
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

Table 6 : Risk-taking channel: NPL (bank-fixed effects)

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1.All models reflect the most saturated estimatives, with firm fixed effects and bank controls. Models (1), (3), (5) and (7) are saturated with firm fixed effects and bank controls. The treatment variable is interacted with firm NPL, the amount of the exposure of firm f in arrears for over 90 days against all banking sector. The remaining models are saturated with bank-fixed effects to better depict the significance of the risk interaction. Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: $\Delta \ln(credit_{b,f,t+1})$

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 -	mar/09	dez/09 -	jun/10	set/10 -	mar/11	jun/12 -	dez/12
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta ResReq_t$	0.322		-0.688***		-0.807*		-2.338**	
	(0.312)		(0.239)		(0.433)		(1.002)	
$\Delta ResReq_t$								
* Firm NPL_{t-1}	4.150***	3.984***	-4.703***	-4.705***	-4.277***	-4.025***	3.195**	2.873*
	(0.455)	(0.429)	(0.693)	(0.678)	(0.646)	(0.634)	(1.609)	(1.610)
Observations	554,088	554,088	754,837	754,839	829,596	829,596	876,181	876,181
R-squared	0.540	0.546	0.461	0.464	0.454	0.457	0.458	0.464
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	NO	YES	NO	YES	NO	YES	NO
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	NO	YES	NO	YES	NO	YES	NO	YES
$\Delta ResReq$	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

Table 7 : All-in-All models DiD: 4 shocks

All models are estimated with firm fixed effects and bank controls. Models (1), (3), (5) and (7) present all-in-all estimates for the risk-taking proxy, Firm Risk $_{t-1}$. The remaining models use the alternative, Firm NPL $_{t-1}$. Controls variables are the same used in Table 3. Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 - mar/09		dez/09 - jun/10		set/10 - mar/11		jun/12 - dez/12	
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_t$	-1.987	-1.927	-2.837	-2.239	0.169	0.807	-17.173	-17.501
	(6.917)	(6.890)	(3.039)	(3.113)	(8.365)	(8.351)	(18.983)	(19.091)
ΔResReq $_t$								
* size $_{t-1}$	0.075	0.070	0.052	0.030	-0.138	-0.158	0.140	0.150
	(0.258)	(0.257)	(0.123)	(0.126)	(0.275)	(0.275)	(0.693)	(0.696)
* Liquidity $_{t-1}$	6.439*	6.635*	-0.344	-0.293	11.447	11.140	42.315***	42.395***
	(3.552)	(3.551)	(3.958)	(4.004)	(6.964)	(6.953)	(11.385)	(11.424)
* CAR $_{t-1}$	-10.120**	-10.026**	9.324	9.281	4.663	4.507	43.632***	43.800***
	(4.520)	(4.521)	(5.949)	(6.023)	(6.126)	(6.120)	(15.642)	(15.715)
* Firm Risk $_{t-1}$	0.732***		-2.216***		-1.094***		1.770*	
	(0.236)		(0.267)		(0.157)		(0.967)	
* Firm NPL $_{t-1}$		4.184***		-4.811***		-4.159***		3.195*
		(0.451)		(0.701)		(0.646)		(1.639)
Observations	554,088	554,088	754,837	754,837	829,596	829,596	876,181	876,181
R-squared	0.540	0.541	0.462	0.461	0.455	0.455	0.461	0.461
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank-Firm Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	<>	<>	<>	<>	<>	<>	<>	<>
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

Table 8 : Robustness: Placebo

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1. In models (1), we present the impact of the placebo change in RR measured between end of December, 2009 and end of June, 2009. In models (2 and 3), we present the impact of the placebo change in RR measured between end of June, 2011 and end of December, 2010 and in model (4), between December, 2013 and June, 2013. Model (1-2) use the counterfactual RR of 2008 and models (3) and (4) the counterfactual of 2010. Models (5-8) replicate the most saturated model of Table 1 over the same RR shocks (the same cycles and periods), but the treatment variable is calculated without any counterfactual, i.e. DResReq b,t is the first difference simply calculated over total liabilities between t and t-1. Notice that the counterfactual is calculated over Reservable Liabilitie (on average 40% of total liabilities). Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Placebo				No counterfactual			
	June-09 Dec-09	Dec-10 June-11	Dec-10 June-11	June-13 Dec-13	Sep-08 Mar-09	Dec-09 Jun-10	Sep-10 Mar-11	Jun-12 Dec-12
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	-(8)
ΔResReq $_t$	-0.218	-0.036	-0.491	0.477	0.322	-1.399***	-3.153***	-4.553
	(0.378)	(0.300)	(0.510)	(0.504)	(0.602)	(0.281)	(1.181)	(3.898)
Observations	73,008	85,228	85,228	91,242	55,397	75,114	82,877	88,358
R-squared	0.464	0.455	0.455	0.462	0.541	0.458	0.456	0.459
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	<>	<>	<>	<>	<>	<>	<>	<>
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	w/o Counterf.	w/o Counterf.	w/o Counterf.	w/o Counterf.

Appendix: Some other results.

A.1. Credit Channel: size and liquidity using DiD: 4 shocks

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1.All models reflect the most saturated estimatives, with firm fixed effects and bank controls. Models (1), (3), (5) and (7) present interactions between size and treatement variable. All others, present interactions with the control variable, banks liquity t-1, Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: $\Delta \ln(credit_{b,f,t+1})$

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 - mar/09		dez/09 - jun/10		set/10 - mar/11		jun/12 - dez/12	
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta ResReq_t$	2.191	-0.512	-0.921	0.317	16.265**	-3.003***	4.598	-9.736***
	(5.813)	(0.783)	(3.154)	(0.737)	(7.831)	(0.844)	(27.232)	(2.230)
$\Delta ResReq_t$								
* $Size_{t-1}$	-0.072		0.007		-0.649**		-0.262	
	(0.229)		(0.119)		(0.294)		(1.046)	
* $Liquidity_{t-1}$		3.508		-4.062		10.969**		37.105***
		(2.973)		(2.678)		(4.310)		(10.800)
Observations	554,088	554,088	754,837	754,837	829,596	829,596	876,181	876,181
R-squared	0.540	0.540	0.461	0.461	0.454	0.454	0.458	0.460
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	<>	<>	<>	<>	<>	<>	<>	<>
$\Delta ResReq$	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

A.2. Credit Channel: CAR and ROA12 using DiD: 4 shocks

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1.All models reflect the most saturated estimatives, with firm fixed effects and bank controls. Models (1), (3), (5) and (7) present interactions between CAR $_{t-1}$ and the treatment variable. All others, present interactions with the control variable, banks ROA12 $_{t-1}$, Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 - mar/09		dez/09 - jun/10		set/10 - mar/11		jun/12 - dez/12	
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_t$	0.589	0.421	-1.605***	-1.112***	-0.390	0.539	-3.953***	-2.924**
	(0.679)	(0.653)	(0.498)	(0.330)	(0.562)	(0.749)	(1.186)	(1.191)
ΔResReq $_t$								
* CAR $_{t-1}$	-2.058		9.277**		-5.623		26.681	
	(4.461)		(4.145)		(5.242)		(18.250)	
* ROA12 $_{t-1}$		-2.158		28.559		-70.336**		45.759
		(16.988)		(22.364)		(31.296)		(74.733)
Observations	554,088	554,088	754,837	754,837	829,596	829,596	876,181	876,181
R-squared	0.540	0.540	0.461	0.461	0.454	0.454	0.458	0.458
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	<>	<>	<>	<>	<>	<>	<>	<>
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

A.3. Credit Channel: public and foreign banks using DiD: 4 shocks

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1.All models reflect the most saturated estimatives, with firm fixed effects and bank controls. Models (1), (3), (5) and (7) present interactions between public $_{t-1}$ and the treatment variable. All others, present interactions with the control variable, Foreign $_{t-1}$, Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 -	mar/09	dez/09 -	jun/10	set/10 -	mar/11	jun/12 -	dez/12
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_t$	0.847***	0.450*	-0.712***	-0.801***	-0.913**	-1.268***	2.086	-1.489*
	(0.221)	(0.268)	(0.249)	(0.186)	(0.434)	(0.391)	(1.809)	(0.868)
ΔResReq $_t$								
* Public Bank $_{t-1}$	-1.801***		-0.425		1.020*		-7.219***	
	(0.584)		(0.545)		(0.599)		(2.114)	
* Foreign $_{t-1}$		-0.776*		0.936**		1.823***		-5.142***
		(0.463)		(0.420)		(0.514)		(1.285)
Observations	554,088	554,088	754,837	754,837	829,596	829,596	876,181	876,181
R-squared	0.541	0.540	0.461	0.461	0.454	0.454	0.459	0.459
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	<>	<>	<>	<>	<>	<>	<>	<>
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

A.4. Risk Channel using DiD: 4 shocks (using Firm Bank risk)

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1.All models reflect the most saturated estimatives, with firm fixed effects and bank controls. Models (1), (3), (5) and (7) present the estimates of the credit channel interacted with firm-bank risk (fb_risk $_{t-1}$), the average provision levels the bank *b* hold against firm *f,* and the remaining (even) models are interacted with firm risk(f_risk $_{t-1}$), the bank sector average provisions against firm *f.* Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 -	mar/09	dez/09 -	jun/10	set/10 -	mar/11	jun/12 -	dez/12
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_t$	0.300	0.330	-0.675***	-0.714***	-0.805*	-0.826*	-2.313**	-2.318**
	(0.322)	(0.310)	(0.249)	(0.226)	(0.443)	(0.434)	(1.003)	(1.004)
ΔResReq $_t$								
* Firm Risk $_{t-1}$	1.800***		-1.994***		-1.368**		0.397	
	(0.400)		(0.604)		(0.543)		(1.794)	
*Firm x Bank risk $_{t-1}$		0.799***		-2.157***		-1.139***		1.880*
		(0.272)		(0.249)		(0.149)		(1.014)
Observations	554,088	554,088	754,837	754,837	829,596	829,596	876,181	876,181
R-squared	0.540	0.540	0.461	0.461	0.454	0.454	0.458	0.458
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	<>	<>	<>	<>	<>	<>	<>	<>
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

A.5. Risk Channel using DiD: 4 shocks (using NPL Bank risk)

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1.All models reflect the saturated estimatives, with firm fixed effects and bank controls. Models (1), (3), (5) and (7) present the estimates of the credit channel interacted with firm-bank NPL, the amount of the exposure of firm *f* in arrears for over 90 days against bank *b,* and the remaining (even) models are interacted with firm NPL, the bank sector average provisions against firm *f.* Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 - mar/09		dez/09 - jun/10		set/10 - mar/11		jun/12 - dez/12	
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_t$	0.341	0.322	-0.711***	-0.688***	-0.819*	-0.807*	-2.278**	-2.338**
	(0.308)	(0.312)	(0.230)	(0.239)	(0.429)	(0.433)	(1.012)	(1.002)
ΔResReq $_t$								
*Firm x Bank NPL $_{t-1}$	5.625***		-8.413***		-6.696***		9.659***	
	(0.591)		(0.724)		(0.912)		(2.835)	
* Firm NPL $_{t-1}$		4.150***		-4.703***		-4.277***		3.195**
		(0.455)		(0.693)		(0.646)		(1.609)
Observations	554,088	554,088	754,837	754,837	829,596	829,596	876,181	876,181
R-squared	0.540	0.540	0.462	0.461	0.454	0.454	0.458	0.458
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	NO	NO	NO	NO	NO	NO	NO	NO
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10

A.6. Risk Channel using DiD: 4 shocks (other possible risk channels)

The dependent variable is the change in the natural log of credit given by bank b to firm f (intensive margin) between t+1 and t, Dln(credit b,f,t+1), i.e. one semester after a RR shock. The treatment variable is the change in RR of bank b between t and t-1 relatively to its conterfactual, DResReq b,t. The bank controls are the natural log of bank assets (size), the capital adequacy ratio - core capital to total liabilities (CAR), the liquidity ratio - total liquid assets to total assets (liquidity), banks Non-Performing-Loans to total credit ratio (NPL),the 12 months Return-on-Assets (ROA12), a dummy variable for public (public) and a dummy for foreign (foreign) banks, all in t-1.All models reflect the most saturated estimatives, with firm fixed effects and bank controls. Models (1), (3), (5) and (7) present the estimates of the credit channel interacted with High Debt Firm (High Debt Firm $_{t-1}$), the relative importante of firm *f* credit exposure to bank *b* core capital. The remaining models are interacted with Banks total NPL$_{t-1}$ relatively to his whole credit portfolio (not only firms). Standard errors are clustered at the bank level. *** is significance at 1%, ** is significance at 5% and * is significance at 10%.

Dependent variable: Δln(credit $_{b,f,t+1}$)

	Loosening cyle				Tightening cyle			
	Easing		*Tightening*		*Tightening*		*Easing*	
	set/08 -	mar/09	dez/09 -	jun/10	set/10 -	mar/11	jun/12 -	dez/12
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_t$	0.350	3.331***	-0.743***	-2.032***	-0.847*	0.406	-2.298**	-3.510***
	(0.311)	(0.609)	(0.238)	(0.685)	(0.436)	(0.546)	(1.014)	(1.237)
ΔResReq $_t$								
*High Debt Firm $_{t-1}$	-3.254		-15.730		7.536		-19.579	
	(3.304)		(10.109)		(18.007)		(33.159)	
* Bank NPL $_{t-1}$		-48.959***		13.346*		-15.083*		28.484
		(9.055)		(7.041)		(7.736)		(17.817)
Observations	554,088	554,088	754,837	754,837	829,596	829,596	876,181	876,181
R-squared	0.540	0.541	0.461	0.461	0.454	0.454	0.458	0.459
Firm Controls	<>	<>	<>	<>	<>	<>	<>	<>
Bank Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	<>	<>	<>	<>	<>	<>	<>	<>
ΔResReq	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 08	Counterf. 10	Counterf. 10	Counterf. 10	Counterf. 10