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JEL Classification: E51, E52, E58, G21, G28

Keywords: liquidity, reserve requirements, Credit cycles, macroprudential and monetary policy

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Countercyclical Liquidity Policy and Credit Cycles: Evidence from Macroprudential and Monetary Policy in Brazil

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1. Introduction

Credit cycles are key for financial crises, and hence for systemic risk. Credit booms are the best predictors of financial crises throughout history, including in the 2008 global financial crisis (GFC); and once the crisis arrives, a credit crunch follows (Bernanke and Lown, 1991; Schularick and Taylor, 2012; Gourinchas and Obstfeld, 2012; Jordà, Shularick and Taylor, 2013). Macroprudential policy targets this time-varying determinant of systemic risk by tightening policy in the boom—and hence potentially reducing credit booms—and softening in the bust, thereby supporting credit (Brunnermeier et al., 2009; BCBS, 2010; Hanson, Kashyap and Stein, 2011; Freixas, Laeven and Peydró, 2015).[1] Similarly, expansive monetary policy has been supportive in crisis times (Bernanke, 2018), and some academics and policy-makers even argue that it should lean against the wind in booms (Stein, 2012; Borio, 2014). Since the 2008 GFC, countercyclical policies gained attention worldwide across policy-makers (e.g. Bernanke, 2011; Yellen, 2011; Trichet, 2011; Tombini, 2012; Draghi, 2018) and academics (e.g. Lorenzoni, 2008; Farhi, Golosov and Tsyvinski, 2009; Hanson, Kashyap and Stein, 2011; Stein, 2012, Kashyap and Stein, 2012; Gertler, Kiyotaki, and Queralto, 2012; Jeanne and Korinek, 2019).

We analyze the effects of countercyclical liquidity requirements, via reserve requirements (RR) –i.e., higher requirements in booms, while more liquidity in crises. RR serve as a monetary and a prudential policy purpose (see e.g. Stein, 1998, 2012). Especially in emerging markets, local monetary policies through setting interest rates may be ineffective, as e.g. higher policy rates may attract more capital inflows, thereby exacerbating local credit booms and inflationary pressures (Blanchard, 2013; Rey, 2015). Not surprisingly, many emerging countries use RR counter-cyclically (Montoro and Moreno, 2011; Cordella et al., 2014, Federico, Vegh, and Vuletin, 2014). As a monetary policy instrument, RR may control money supply and credit growth. On the prudential side, RR try to ensure that banks have sufficient liquidity both to meet unexpected levels of deposit withdrawals (bank fragility), and to control credit growth and risk-taking. We take liquidity and RR as interchangeable expressions throughout this paper, though a key difference between RR and liquidity requirements is whether the liquid assets are deposited at the central bank or not, respectively. After the GFC, the need for stronger liquidity requirements gained attention and is addressed in Basel III bank regulation (BCBS, 2013; Berger and Bouwman, 2016), with the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR).

[1] For excessive cycles in credit, see e.g. Kiyotaki and Moore (1997), Dell'Ariccia and Marquez (2006), Benmelech and Bergman (2012), Jeanne and Korinek (2019). The use of time-varying macroprudential policy is part of Basel III (BCBS, 2010) and of policymakers' toolkit worldwide (see e.g. Drehmann and Gambacorta, 2012; Galati and Moessner, 2013 and 2018; Borio, 2014; Claessens, 2015; Cerutti, Claessens, and Laeven, 2017).

To evaluate countercyclical liquidity policy on credit supply cycles, we exploit the exhaustive, supervisory credit register and policy changes on RR in Brazil. The policy changes happened during the GFC (a reduction of RR, i.e., easing), and in a following boom in 2010 (an increase in RR, i.e., tightening). As RR target different bank liabilities, banks are differentially affected by the policy, and some banks were even exempted from the RR policy.

Briefly summarized, our robust results show that the liquidity policy strongly attenuates both the credit crunch in bad times and the credit supply boom in good times. Economic effects are both strong at the loan-level (key for identification of credit supply) and also aggregated at the firm-level. Moreover, comparing the estimates with highest set of unobservables and observed (bank, firm, loan) controls to those lacking of any controls, despite a very large increase of the R-square, the estimates either remain with the same coefficient (or increase in absolute value), thereby suggesting lack of self-selection and omitted variables problems (following Altonji, Elder, and Taber, 2005; Oster, 2019).

Importantly, the quantitative effects are two times larger during the crisis easing than during the boom tightening: firms exposed to a 1 percentage point (p.p.) decrease in RR in the GFC through their ex-ante bankers experience a 1.03 p.p. higher total credit availability in one quarter, while firms exposed to a 1 p.p. increase in RR have 0.50 p.p. less credit availability in 2010.[2] Finally, in crisis times, liquidity policy easing: (i) supports less credit supply by more financially constrained banks; and (ii) collateral requirements increase substantially, especially by banks that provide higher credit supply. That is, effects of RR easing are stronger in crisis times (than in booms), but banks compensate the higher risk in the crisis by requiring higher collateral, and weaker banks (that tend to be risky) support less lending via RR.

Despite the large academic and policy interest on macroprudential policy, as well as its interactions with monetary policy, and despite the increased use of macroprudential policies, as far as we are aware, this is the first empirical paper to identify the effects of countercyclical liquidity policies on credit cycles. Our results show that the transmission of RR to credit supply is *asymmetric in good versus bad times*. In particular, countercyclical liquidity policy smooths credit supply cycles but with stronger quantitative effects in crises –i.e., providing higher liquidity to banks in crises stimulates credit supply more than withdrawing liquidity in good times with the associated reduction in credit supply. The remaining part of this Introduction is divided into two parts. First, we provide a detailed preview of the different parts of the paper. Second, we discuss at some length the related literature and its contrast with our paper.

[2] Economic effects are substantially higher for 1 standard deviation of RR (instead of 1 p.p.), but we prefer to report the main results for the *same change of RR in both periods*, so that the results in boom vs. bust are not driven by a different RR change.

Preview of the paper. In November of 2008, the Central Bank of Brazil (BCB) released RR with the purpose of alleviating a credit crunch during the GFC. This policy change was economically relevant with an almost immediate release of liquidity into the financial system worth 3.27% of total banks' assets, or 2.8% of GDP (BCB, 2008; Barbosa, 2010; Mesquita and Torós, 2010). Moreover, in March 2010, the BCB reversed this policy by substantially increasing RR to try to offset exuberant credit growth, particularly stemming from the previous six months (BCB, 2010; Pereira da Silva and Harris, 2012). This tightening is also economically significant and worth 2.2% of total banks' assets and 1.9% of GDP.

Therefore, the central bank reduced RR during the crisis in an attempt to sustain credit supply. Differently, in the good times, the central bank increased the requirements to try to soften the boom. In other terms, the pro-cyclical liquidity requirements (via RR) try to lean against the credit cycle and, in this sense, it is a countercyclical policy.

As many other central banks around the world, the BCB manages different RR components, most importantly on demand deposits, savings deposits, and on term deposits. RR affect mostly banks with large core liabilities, which are also the larger and more representative in terms of credit provided to firms (e.g. 84% in our sample), and, to a lesser extent, smaller banks (in Brazil some small banks are not subject to RR). In November 2008, the BCB reduced certain RR components related to demand and term deposits, and reversed this policy in March 2010. The policy not only had a time-varying nature over the cycle, but also cross-sectional bank heterogeneities, because banks differed (ex-ante) with respect to their mixture of liabilities at the policy announcement.

During easing, there is an average -3.5 p.p. change in the RR to total liabilities ratio in our sample, but banks' exposure to these policy changes (and related cash injection) varied from 0 p.p. to -9.9 p.p.. During tightening, there is an average +2 p.p. change in RR, but banks vary in their exposure from 0 p.p. to 25.3 p.p.. This implies that we can exploit not only time variation but also cross-sectional variation for each of these two policy changes. The intensity of the treatment policy variable is calculated for every bank as the difference between the reserve requirements under the pre-policy rules and under the new rules, and it is expressed as a percentage of bank's total liabilities at the time of the announcement of each policy, which happens few days before the implementation.

We exploit the credit register of the Central Bank of Brazil (SCR) in conjunction with the policy changes. The SCR contains exhaustive detailed information on firms' loans at the *firm-bank-time* level. We match this dataset with bank balance-sheet variables from the BCB. Our dataset comprises 801,260 (1,041,106) loans, extended from 99 banks to 489,297 (608,437) firms during the easing (tightening).

In the first part of this paper, by using loan-level data, we saturate cross-sectional regressions of loan growth (after vs. before the policy change) with firm fixed effects, thereby controlling for firm-level observed and unobserved fundamentals, including a proxy of firm-level credit demand (Khwaja and Mian, 2008). This identification strategy, however, can be applied only to firms with multiple bank relationships. We go beyond it and extend the analysis to a more comprehensive sample, including firms with single bank relationships. In this case, we augment the model with relevant firm observable characteristics and including sector*location fixed effects – an approach which has been found to proxy reasonably well for firm (including credit demand) shocks (Degryse et al., 2019). In addition, we present the results without any (or a weaker set of) controls to check whether the results change depending on the type of controls. We also analyze heterogeneous results depending on ex-ante bank financial constraints and other loan margins. In the second part of the paper, we aggregate the results at the firm level, where we allow for adjustment across different lenders. In this case, we cannot control for firm fixed effects, but the analysis at the loan level will show that they are not relevant for identifying credit availability.

In the loan-level analysis, we find that, relatively to the same firm, a release of RR of 1 p.p. (easing) is associated with a credit supply increase of 1.38 p.p. Moreover, an increase in RR of 1 p.p. (tightening) is associated with a decrease of credit supply of 0.73 p.p. in the post policy quarter.

Controlling for unobservable firm characteristics (e.g. via firm fixed effects) and other variables do not reduce the economic impact of RR in easing or tightening. Comparing the results from a baseline model without any control whatsoever with those from a different specification where we control for firm fixed effects, and observed loan-level and bank controls – which increases the R^2 by 40 percentage points – we find basically no difference in the estimated coefficients. Thus, our key bank treatment variable driven by the policy changes is orthogonal to unobservables (Altonji, Elder, and Taber, 2005; Oster, 2019). This suggests that we can comfortably extend our credit supply analysis to (1) the most comprehensive sample including firms with single bank relationships, and to (2) the firm level analysis. Results on the larger sample of all firms are virtually identical. Moreover, estimated coefficients are insignificant in periods in which the policy was not changed, which serve as placebo tests.

The identified credit supply at the loan level might however be smoothen out by firms – e.g. opening new relationships with least affected banks. To account for this particular general equilibrium effect, the analysis at the firm level is also relevant. Thus, we construct a treatment variable at the firm level, namely the weighted average of the bank level exposure to the RR defined before, with weights given by the

average of loan volume before the policy shock of each bank to a particular firm, i.e., the more ex-ante important relationship lenders to a particular firm are, the higher their weight; for the firm-level analysis of credit we follow e.g. Jiménez et al. (2017).

We find that firms exposed to a 1 p.p. decrease in RR through their ex-ante bank relationship lenders end up with a 1.03 p.p. higher total credit availability at the end of the following quarter (1.64 p.p. for 1 standard deviation of RR). Similarly, firms exposed to a 1 p.p. increase in RR end up with 0.50 p.p. less credit availability (0.86 p.p. for 1 standard deviation of RR). For the sample of all firms, including the ones with only 1 banking relationships (pre-policy), not surprisingly results are stronger (for 1 p.p. of RR, 1.57 in crisis softening and 0.72 in boom tightening), as for these firms, substitution across different lenders is more difficult.

In sum, countercyclical liquidity policy smooths credit supply cycles but with stronger quantitative effects in crisis times. This is interesting and somewhat unexpected as many scholars and commentators argue that monetary policy is more effective in slowing economic activity than it is in stimulating economic activity (Cover, 1992; Angrist, Jordá and Kuersteiner, 2018) and, in general, less powerful during recessions (Tenreyro and Thwaites, 2016).

We analyze further heterogeneous effects across banks and across other loan characteristics. The results suggest that the stronger effects during crisis times as compared to good times are mitigated by two additional results.

First, the impact of the liquidity injection in crisis times on credit supply is weaker for more financially constrained banks (which needed more the expansive policy). In particular, smaller banks (that suffered more during the crisis due to a market freeze),[3] foreign banks (which directly suffered from the GFC), and banks with more exposure to the tradable sector (which also suffered more from the GFC and global trade collapse associated) not only provide less credit supply on average during the crisis, but their credit supply increase less by the additional liquidity injection from the RR than credit supply from larger domestic banks.

Second, collateral requirements increase substantially for banks more benefited by the easing of RR, i.e. by banks that provide higher credit supply due to RR. A 1 p.p. decrease in RR is associated with a 3.1 p.p. increase in the number of bank-firm credit relationships to which new collateral is posted. Note also that, from a risk-taking channel perspective, the higher credit volume supplied is compensated with

[3] In Brazil, Oliveira et al. (2015) describe a fly-to-quality from small banks' depositors to bigger banks during the GFC.

higher collateral requirements in crisis times during the liquidity easing. Differently, though statistically significant, effects are very small in the boom.

Contribution to the Literature. Despite the large academic and policy interest on macroprudential policy, as well as its interactions with monetary policy, and despite the increased use of macroprudential policies (see e.g. Brunnermeier, Crocket, Goodhart, Persaud and Shin, 2009; Freixas, Laeven and Peydró, 2015; Cerutti, Claessens, and Laeven, 2017; Akinci and Olmstead-Rumsey, 2018; Alam et al., 2019), as far as we know, this is the first empirical paper to identify the effects of countercyclical liquidity policies on credit supply cycles.

On the theoretical front, Stein (2012) introduces a Pigouvian Tax (e.g. RR) in the context of a central bank whose only purpose is financial stability. He finds that this instrument addresses "an externality in which (financial) intermediaries issue too much short-term debt and leave the system excessively vulnerable to costly financial crises". Kashyap and Stein (2012) builds on this framework and present a model where central banks can change short-term interest rates on reserves. Their integrated framework has direct implications for financial stability: "by broadening the scope of reserve requirements, the central bank can simultaneously pursue two objectives: it can manage the inflation-output tradeoff using a Taylor-type rule, and it can regulate the externalities created by socially excessive short-term debt issuance on the part of financial intermediaries". This later result has important implications: in the context of a central bank with a dual-mandate, reserve requirements become a useful tool to face "credit bubbles" (Kashyap and Stein, 2012). Bustamante and Hamann (2015) and Agénor, Alper, and Pereira da Silva (2018) introduce in this framework specific countercyclical rules for RR. The implications are similar though and countercyclical RR address financial assets' volatility as well as credit cycles. Moreover, Jeanne and Korinek (2019) show how a Pigouvian taxation can help manage credit booms and busts and that the optimal policy is a countercyclical "tax".

On the empirical front and exploring countercyclical policy, Jiménez et al. (2017) show that countercyclical *capital* policy allows banks to support credit supply in crisis times but are ineffective in reducing firm-level credit supply in booms. We instead show that countercyclical *liquidity* policy not only attenuate the credit crunch in crises but smooth the credit supply boom. In this sense, liquidity requirements are stronger than capital requirements in booms and we provide empirical evidence of the aforementioned theoretical channels. While capital requirements operate through changes in banks' capital and opportunity costs (Morrison and White, 2005) and have several lags into implementation

(BCBS, 2010), countercyclical RR policy operates through a liquidity channel, with potentially stronger effects than capital and are implemented almost immediately after announcement.

In general, reserve requirements have been analyzed from the monetary policy perspective (e.g., Bernanke and Blinder, 1988; Stein, 1998). There are more recent papers analyzing reserve requirements in this context with *aggregate data* (e.g. Glocker and Towbin, 2012; Areosa and Coelho, 2013; Tovar, Garcia-Escribano, and Martin, 2012; Mora, 2014). One recent exception is Camors, Peydró, and Tous (2019), where the liquidity requirements were increased more for foreign and wholesale liabilities. Using loan-level data, the authors find that a tightening of RR has negative effects on credit supply. While this policy (based on Uruguay before the 2008 crisis) was targeting cross-sectional risk and external vulnerabilities in particular, the RR policy that we analyze target the *time-varying dimension of risk*, i.e. the effects of the *countercyclical* liquidity policy on credit supply throughout the cycle in Brazil. That is we analyze the policy in a crisis and in a boom. Finally, there are papers that have analyzed (with loan level data) the bank lending and risk-taking channels of monetary policy (Jiménez et al., 2012 and 2014) but via monetary *rates*, while we analyze (also with loan level data) reserve requirements.

The paper proceeds as follows. Section 2 provides institutional details in Brazil regarding the policy changes and the context in 2008 and 2010. Section 3 describes the datasets and the empirical strategy. Section 4 discusses the results, and Section 5 concludes.

2. The GFC, RR, and countercyclical policy in Brazil

The first moments of the GFC started in the summer of 2007, but its effects reached Brazil and other emerging market economies (EMEs), in general, after the collapse of Lehman Brothers in September 2008. Until June of 2008, the Brazilian stock price index was rising by 20 p.p. year-over-year (yoy) in local currency and 44 p.p. in US dollars. In the third quarter of 2008, despite falling commodity prices and currency depreciation, GDP still grew 5 p.p. (between June and September of 2008, annualized growth), reflecting mostly quarterly positive consumption (2.5 pp) and gross fixed capital formation (5 p.p.), both relatively to the same quarter of the previous year (Figure 1). In that same quarter, credit grew 1 p.p. in real terms relatively to the same period of 2007.

[Insert Figure 1 about here]

FX depreciation was the strongest initial effect of the crisis and quickly turned into a dollar liquidity squeeze. Between September and October, export finance contracts fell by 30 p.p. and rollover ratio of foreign debt decreased from over a 100 p.p. to 22 p.p. in November (Mesquita and Torós, 2010). However, this initial dollar squeeze quickly turned into a dry-up in the local interbank markets, magnified by depositors' runs (particularly on the smaller banks). Finally, this situation evolved into a sudden stop on domestic credit markets (BCB, 2008). In the last quarter of 2008, quarterly (qoq) credit growth in real terms reached 0 pp, and in the following two quarters, it reached -5 p.p. (Figure 1).

During this acute phase of the crisis, the BCB created a major policy to address banks' liquidity issues and support credit through a generous release of RR (Barbosa, 2010).[4] The ratio of reserve requirements in Brazil represented on average 23% of total liabilities subject to RR (LRR) from 2008 to 2015. This ratio in Brazil was mostly flat before the GFC and the resources deposited at the BCB in September 2008 were worth BRL 253 MM or 8.2% of GDP. During the GFC, in face of a liquidity squeeze in the interbank market and the credit crunch, the BCB reduced RR to the historical low levels of 18% in November 2008, i.e. a cash release program worth 2.8% of GDP (Figure 2).

[Insert Figure 2 about here]

Consumption and Gross Fixed Capital Formation (GFCF) started improving in 2009, but credit growth only kept pace in the last quarter of 2009 (Figure 1).[5] However, this late recovery process was strong and called the attention of the BCB, not only because of its speed, but also because of lower origination standards, particularly to high debt-to-income borrowers and increased maturities on auto-loans and payroll lending (BCB, 2010).

Therefore, in March 2010, the BCB partially rebuilt RR to its pre-crisis levels. Relative to other local prudential policies implemented during the same period, RR is the only one affecting credit to firms in local currency. It was also the macroprudential tool with the broadest scope and the biggest impact (BCB, 2011; Pereira da Silva and Harris, 2012). The tightening of this policy was also economically relevant and the liquidity collected from the banks to the BCB reserve accounts corresponded to 1.9% of GDP.

[4] Because of increased expected inflation, the BCB did not resort to monetary policy rates in the last quarter of 2008. In September 11, the BCB indeed increased the overnight funds rate (SELIC) by 75bps and did not start an easing monetary policy cycle until the last week of January 2009.

[5] The GFC has particularly strong effects on investments: the ratio of GFCF decreased by 17 p.p. in the first quarter of 2009 relatively to the same period of the previous year.

As mentioned, the GFC led to a liquidity squeeze that affected initially small financial institutions but eventually evolved into a freeze of the domestic credit market. In response, the BCB eased RR ratios and increased RR deductions. Around 75% of the banks were unaffected by RR change (mostly small institutions). The remaining institutions received smaller or larger shocks depending on their exposure to the more affected core liabilities. Figure 3 presents total credit growth to firms before and after the easing policy from affected banks (subject to RR) and unaffected banks (not subject to RR). Both groups of banks had positive and constant credit growth before the end of September 2008 (i.e., prior to the crisis steep phase in EMEs), and both groups faced a sharp decline during the month of October of 2008. However, after the announcement and implementation window,[6] the affected group faced a lower decline in credit growth. The differences were quite substantial in our evaluating window, comprising the three months of November to January (Figure 3, Panel A).

[Insert Figure 3 about here]

The BCB manages mainly four RR components: RR on demand deposits (unremunerated), on savings (remunerated according to the savings accounts reference rate), on term-deposits (remunerated at the overnight funds rate), and on an additional component resulting from the combination of the three aforementioned subcomponents. This additional component (and all its subcomponents) is remunerated at the overnight funds rate. The BCB also manages RR deductibles, conditional deductibles, exemption thresholds, eligible liabilities, and remuneration of RR (see BCB, 2009; and Cavalcanti and Vonbun, 2013 for more). During the easing of 2008, the RR were waived for certain small financial institutions because of an increased minimum capital threshold to compute liabilities subject to RR (i.e., an increase in RR deductions that virtually exempted certain smaller banks from this requirement).

The countercyclical measures adopted in November 2008 are the following: (i) the two additional components on demand and term deposits were reduced (-3 p.p. each);[7] (ii) reduction in RR ratios for demand deposits (-3 p.p.);[8] (iii) higher deductions for term deposits and in the additional component that

[6] Our data has monthly frequency. We take the implementation window as the month of November, because the October announcements of RR changes became effective in the very last days of October and early November.
[7] Implemented by BCB specific regulation Circular 3,408. Circular 3,426 further decreased the additional on Term Deposits by another 1 p.p.. However, the effects were only due in January, 19, 2008. This latter change lays at the end of our evaluating window and it is not reflected in the counterfactual we build.
[8] Implemented by Circular 3,413.

released some small banks from RR;[9] (iv) conditional deductibles on certain exposures acquired from small financial institutions or on interbank lending provided to these banks.[10] The amount of cash released to the average affected bank represented on average -3.5% of their total liabilities.

On February 2010, affected and unaffected banks credit growth was strong (Figure 1). Credit growth to families (particularly auto loans) was even stronger and the regulator responded reversing some of the 2008 actions with an increase in RR (BCB, 2010; Pereira da Silva and Harris, 2012). In particular, in March 2010, the BCB reversed RR policy. While credit growth stabilized for the affected banks, unaffected banks were able to increase credit to firms within the evaluating window of March to May of 2010 (Figure 3, Panel B). The impact of the tightening was on average +2% of their total liabilities.

The BCB routinely computes counterfactual RR to monitor the implementation of its policies. Considering the changes in RR, comparing current (under the new policy conditions) and counterfactual (under the previous policy conditions) is useful to summarize the impact of the RR changes in one figure., and is straightforward to calculate. We calculate the RR ratios for every bank based on the pre-policy rules and under the new rules. The difference between both RR relatively to (pre-policy) total liabilities becomes the treatment variable that we use throughout this paper. This treatment variable captures the regulatory shock at the bank level relatively to the liabilities existent close to the announcement date.

During the easing, the treatment bank variable represented the change in the rules available up to October 2008: (i) RR ratio of 15% on term deposits (unchanged during easing); (ii) RR ratio of 45% for demand deposits reduced to 42% during easing; (iii) RR ratio of 20% for savings deposits unchanged during easing; (iv) the additional components, RR ratio of 8% on demand and term deposits reduced to 5%, and 10% on savings (unchanged during easing); (v) the deductible on term deposits of BRL 300M increased to BRL 2MM in the term component, and to BRL 1MM in the additional component related to term deposits.

Similarly, we also build another treatment bank variable to capture the tightening shock of March 2010, relatively to the state of RR regulation (and total liabilities per bank) until February of the same

[9] Circular 3,408 and 3,410 increase the deductible on the term deposits from BRL 300M to BRL 2 billion, and the deductible on the additional term deposit from 300M to BRL 1 billion. This has a significant effect only on smaller institutions, virtually exempting them of RR.

[10] To incentivize private liquidity support to smaller banks, the BCB allows banks buying loans, bonds, credit, and securitization funds from any bank with Tier 1 capital under BRL 7 billion to deduct these amounts from RR on term deposits. Banks can in theory deduct up to 70% on this component extending liquidity to smaller financial institutions (Circular 3,407). This regulation is further amended allowing interbank lending to the same group of small banks to be also deducted, and partially changing the nature of the additional term deposits from governments bonds to cash (Circular 3,411, Circular 3,417, and Circular 3,427).

year. The rules available until February 2010 were: (i) RR ratio of 13.5% on term deposits increased by 1.5 p.p. during tightening;[11] (ii) RR ratio of 42% for demand deposits (unchanged during tightening);[12] (iii) RR ratio of 20% for savings deposits (unchanged during tightening); (iv) the additional components, RR ratio of 5% on demand and 4% on term deposits increased to 8%, and 10% on savings (unchanged during tightening);[13] (v) The deductible on term deposits of BRL 2MM lowered to BRL 1.5MM for banks with Tier 1 capital between BRL 2MM and 5MM, and fully eliminated for banks with Tier 1 capital higher than 5MM).[14] It is worth noticing that the deductibles were not fully reversed.[15]

3. Data and Empirical Strategy

We evaluate the easing and tightening policies independently using the two policy changes, in 2008 and in 2010. For the credit analysis, we use the Brazilian credit registry ("Sistema de Informações de Crédito do Banco Central"– SCR), which encompasses virtually all corporate loans above BRL 5,000 (approximately USD 1,250 in August 2019) in the domestic financial system. This data is identified and matched by firms' social number across the different loans. Regulation requires financial institutions to provide this data to the Brazilian credit registry on a monthly basis. In turn, banks and the BCB supervision use this data to assess the riskiness of the borrowers.[16] We match the credit register with supervisory bank's balance sheet variables from the BCB ("Plano Contábil das Instituições do Sistema Financeiro Nacional – COSIF"), including the reserve requirements. Our dataset comprises 801,260 (1,041,106) loans extended by 99 banks to 489,297 (608,437) firms during the easing (tightening) periods.

[11] Between the easing and tightening, Circular 3,468 further decreased RR on term deposits from 15% to 13.5%, and Circular 3,485 reversed this last policy.
[12] Circular 3,497 created a schedule to increase this component starting in July of 2010 and ending on July of 2014. All these changes lay out of our evaluating window.
[13] Between the easing and tightening, Circular 3,426 further decreased the additional RR on term deposits to 4%. Circular 3,486 increased the additional on term and times deposits back to the pre-crisis levels.
[14] Circular 3,485 changed the deductible of the small and bigger banks.
[15] These are the banks with Tier I capital under BRL 2 billion (Circular 3,410). While they were affected by the easing, they were unaffected by the tightening. We use a balanced sample of banks in this paper. Therefore, these group of banks have a zero treatment in the tightening phase of this cycle.
[16] For firm control variables, we use the matched employer-employee database from Ministry of Labor and Employment ("Relatório de Informações Sócio-Econômicas" - RAIS) containing data on all formal job relationships in Brazil. We also use the FX system of the BCB ("Sistema Câmbio"). The FX system has identified FX transactions. Firms fulfil the system to undergo currency conversion against the BCB or any other FX dealer. The nature of these transactions is identified as fruit of exports, imports, dividends, debt services, other cash remittances etc. We use it to identify credit to trade sector firms.

We build our treatment variable relatively to the bank-level regulatory impact of changes in RR, i.e. the difference between current RR (under the new rules or requirements) and the previous RR, calculated relatively to total bank liabilities (pre-policy).

$$\Delta \text{ResReq}_{b,t} = 100 * \left(\frac{\text{Current}_t^b - \text{Previous}_t^b}{\text{Liabilities}_{t-1}^b} \right) \quad (1)$$

where *b* refers to bank and *t* to time (month). We measure this regulatory change (in equation (1)) in the announcement month *t* – i.e. in the announcement month of October 2008 (with the variables measures as of October 1st) rather than in the actual implementation in early November, so that the composition of banks' liabilities is not endogenously changing in response to RR change (though in principle, making substantial changes in the bank's liability mix is costly).

We analyze change in credit volume in this paper. For this, all individual loans to the same firm by the same bank in a period are collapsed to a *bank-firm* (total) credit exposure to build the dependent variable. Therefore, the main dependent variable represents the quarterly change (after versus before the policy) in the credit exposure of each bank-firm relationship, $\Delta \ln(\text{credit}_{b,f,t-1:t+2})$. Focusing on the quarterly (as compared to annual) changes of credit prevents introducing bias from overlapping economic shocks or other policy changes that take place in the following quarters after the easing and the tightening evaluating windows.

We also analyze new collateral posted as a dependent variable, $\text{new collateral}_{b,f,t:t+2}$, where data on collateral is available on a separate credit registry table and is linked to the credit registry by loan id. We take new collateral ids posted to each bank-firm pair between *t* and *t+2* as a risk-taking proxy. This variable takes the value of 1 if any new collateral id becomes available at a pre-existing bank-firm pair between *t* and *t+2* and 0 otherwise.

Throughout this paper, we exclude the bank relationships that are in default one month before each shock and focus on changes in the credit supply to firms that are not in arrears, though results are robust to including these defaults.

Table 1 summarizes our data. During easing (Table 1, Panel A), there is a -3.5 p.p. change in the RR to total liabilities ratio for the average firm-bank pair, but figures are smaller for bank-level data since bigger (and more affected) banks are more representative. Banks' exposure to these policy changes (and related cash injection) vary from 0 p.p. to -9.9 p.p.. During tightening (Table 1, Panel B), there is a

+2 p.p. change in RR for the average firm-bank pair, but banks vary in their exposure from 0 p.p. to 25.3 p.p..

[Insert Table 1 here]

We control for firms and banks related to the foreign sector as they were more affected by the GFC. The foreign banks ($foreign_{t-1}$) are all foreign-owned banks, but we also control for firm-bank relationships taking loans denominated in foreign currency (foreign $currency_{t-1}$) and for the *ex-ante* net exposure to the trade-related sector of each bank (net trade $share_{t-1}$). As mentioned before, trade-related sector firms,[17] exporters in particular, are more deeply affected by the GFC and its related USD liquidity squeeze. While the depreciation of the BRL against the USD could have positive outcomes to exporters rather than importers, the sharp drop in commodity prices during the GFC and the difficulties in rolling over debt in this period had far more negative outcomes to the exporters (Mesquita and Torós, 2010). Thus, banks more exposed to exporters are likely to be more affected by the crisis, facing significant capital losses. Other bank controls include: $size_{t-1}$, $capital_{t-1}$, $liquidity_{t-1}$, return-on-equity (ROE_{t-1}), and dummy variables identifying $commercial_{t-1}$, $government_{t-1}$ and $small_{t-1}$ banks.[18] We further introduce one last firm-bank control, $risk_{t-1}$, representing the average *ex-ante* provision for non-performing loans assigned by each bank to each loan and reported to the SCR (Table 1).

Most regressions in this paper include firm fixed effects, but whenever they are not introduced we augment the sample with sector*county fixed effects (α_{s*c}) and the following firm controls ($X_{f,t-1}$): *ex-ante* total firm credit (firm $credit_{t-1}$) and number of employees (n $employees_{t-1}$) to control for borrower fundamentals, both unobserved and observed variation. The average firm in our sample has close to 10 employees.

We analyze credit volume and collateral at the loan and at the firm level. The first equation assesses the credit supply channel of RR. The dependent variable is the change in the log of credit between *t-1*

[17] We take as trade sector firms those with at least USD 100 thousand net volumes registered as either exports or imports at the FX System of the BCB. In other words, we compute a dummy variable for exporters and importers. Moreover, we also use it to estimate the net trade sector exposure of each bank as total credit to exporters (minus) importers. There is a group of banks focused on trade sector credit, i.e. to both importers and exporters. We use the net trade share to differentiate across these banks based on their higher net ex ante exposure to exporters, which also proxies for possible capital losses of these more exposed banks during the GFC.

[18] We use a dummy variable to capture heterogeneous effects on the smaller banks (small). The definition is the same embedded in the regulation, i.e. banks with Tier 1 capital under BRL 5MM. Circular 3,485 also poses preferential RR treatment for these banks. Banks on top of this Tier 1 capital threshold are not eligible to any deductible.

and *t+2* (i.e., over a quarter). The treatment variable is the same presented in equation (1) and measured in *t*, the announcement month. We take all controls from *t-1* to alleviate endogeneity concerns (i.e. the liabilities reacting to the announcement) and estimate equation (2) on our most saturated regression.[19]

$$\Delta \ln\left(\text{credit}_{b,f,t-1:t+2}\right) = \beta_1 \Delta \text{ResReq}_{b,t} + X^{b}_{f,t-1} + \alpha_f + \varepsilon_{b,f,t-1:t+2} \quad (2)$$

where: $X^{b}_{f,t-1}$ is a vector of control variables at the bank and firm-bank level; α_f represents firm-fixed effects and $\varepsilon_{b,f,t-1:t+2}$ is the error term. Similar to Khwaja and Mian (2008), α_f absorbs contemporaneous observed and unobserved firm level fundamentals (including a proxy of credit demand) shifts.

Firm fixed effects in loan level analysis restrict the sample to firms with multiple bank relationships, which represent 86% of the total credit in our original sample, but less than 50% of the original number of firms. Therefore, to alleviate concerns on selection bias that this restriction possibly introduces, we also run our regressions in the comprehensive (or complete) sample relying on observed firm controls and sector*county fixed effects for credit demand proxies (see e.g. Degryse et al., 2019). Note that we focus on bank credit supply responses and the identification strategy with firm fixed effects is more conservative and, hence, we use it more broadly in this paper. Firm fixed effects address more effectively the issue of unobservable firm heterogeneity (including contemporaneous credit demand shifts, which are particularly relevant during credit booms and busts), but the downside of the strategy is a possible selection bias (Degryse et al., 2019).

However, as discussed in the Introduction, our results show that $\Delta \text{ResReq}_{b,t}$ is orthogonal to firm controls (following e.g. Oster (2019)'s test), including unobserved variation via different fixed effects (e.g. firm fixed effects), and hence our results suggest that our treatment variable is orthogonal to firm-level credit demand, which also allow us to analyze the comprehensive sample (with firms with also one bank relationship) as well as the change in firm level credit (to evaluate total firm credit availability changes) where we cannot control for firm fixed effects.

Second, we present further interactions with bank controls progressively, as in equation (3).

[19] Measuring the results relatively to *t+2* is necessary, because *t+1* may still be part of the implementation lag pending on the RR subcomponents that are affected by the regulatory change. Moreover, *t+2* allows to analyze one quarter.

$$\Delta \ln(\text{credit}_{b,f,t-1:t+2}) = \beta_1 \Delta \text{ResReq}_{b,t} + \beta_2 \Delta \text{ResReq}_{b,t} * X^b_{t-1} + X^b_{f,t-1} + \alpha_f + \varepsilon_{b,f,t-1:t+2} \quad (3)$$

where X^b_{t-1} includes bank capital$_{t-1}$, ROE$_{t-1}$, net trade share$_{t-1}$, and dummy variables identifying foreign$_{t-1}$, government$_{t-1}$, and small$_{t-1}$ banks.

Third, we focus on a risk-taking channel of the RR policy using new collateral posted between *t* and *t+2* as a dependent binary variable (4).

$$\text{new collateral}_{b,f,t:t+2} = \beta_1 \Delta \text{ResReq}_{b,t} + \beta_2 \Delta \text{ResReq}_{b,t} * X^b_{t-1} + X^b_{f,t-1} + \alpha_f + \varepsilon_{b,f,t:t+2} \quad (4)$$

We analyze the firm level effects in equations (5) and (6). To assess (aggregate) firm level effects of the policy changes, we weight each bank treatment variable by the weights of each bank-firm share of *ex-ante* credit exposures to construct a change in RR variable at the firm level.

The firm-level related estimates could be of lower magnitude than the loan-level ones, as firms could possibly mitigate the policy by resorting to less affected or unaffected banks. To address this general equilibrium adjustment, we use as dependent variable the changes in total firm credit, i.e. not only the changes in the bank-firm relationships in our sample but also credit from new bank-firm relationships (the extensive margin) as well as credit to firms with only one bank relationship (see e.g. Jiménez et al., 2017; Iyer et al., 2014).

$$\Delta \ln(\text{total credit}_{f,t-1,t+2}) = \beta_1 \Delta \text{ResReq}_{f,\text{t}} + wX^b_{f,t-1} + X_{f,t-1} + \alpha_{s*c} + \varepsilon_{f,t-1:t+2} \quad (5)$$

$$\text{new collateral}_{f,t:t+2} = \beta_1 \Delta \text{ResReq}_{f,t} + wX^b_{f,t-1} + X_{f,t-1} + \alpha_{s*c} + \varepsilon_{f,t:t+2} \quad (6)$$

where $X_{f,t-1}$ represent a vector of firm level observables, $wX^b_{f,t-1}$ are the firm-level controls related to banks (bank's or bank-firm's controls weighted by ex-ante firm-bank credit exposures), $\Delta \text{ResReq}_{f,t}$ is the (weighted bank) treatment variable (at the firm level), α_{s*c} are sector*county fixed effects that proxy for firm-level fundamentals, including a proxy of credit demand.

In the robustness section, we present placebo regressions using the same RR variables one year after each shock. In addition, to capture the effects of a fly-to-quality from smaller to bigger banks in the

evaluating window (especially during the crisis), we add in some regressions the contemporaneous changes in banks' core liabilities, i.e. the changes in both total deposits and total savings accounts of each bank. Moreover, we control for other related policies, in particular a policy incentivizing liquidity support from bigger to smaller banks was also in place, so we introduce a control variable for the volumes of liquidity support provided by each (big) bank during our two evaluating windows.

4. Results

In Table 2, we present the results at the loan level. We use the same identification strategy and controls to both the easing (November 2008) and the tightening (March 2010) phases of the countercyclical RR policy. For identification, we initially focus on firms with multiple bank relationships.

The results for the treatment RR bank variable are statistically and economically significant. During the easing (in the crisis), we find that, on average, the more (vs. less) affected banks (in response to a decrease of 1 p.p. in RR) increase credit supply by 1.38 p.p. (column 5) more relatively to the same firm (which is high given the average change in credit).

[Insert Table 2 here]

Comparing columns (1) with (5), we observe identical estimates in our treatment variable despite the 40 p.p. increase in R^2 after introducing firm fixed effects, bank and firm-bank controls (the estimated coefficients of column 1 and 5 are -1.379 and -1.375 respectively). Following Altonji, Elder and Taber (2005) and Oster (2019), this suggests that our treatment variable is orthogonal to observable and unobservable variables related to firm-level credit demand and other firm and bank fundamentals.

In 2010, in the boom, we find that an increase of 1 p.p. in RR decreases credit supply by 0.73 p.p. in our most saturated model, column 10 (Table 2). Note also that comparing column (9) with (10), we observe identical estimates in our treatment variable (-0.745 vs. -0.729) despite the 34 p.p. increase in R^2 after introducing firm fixed effects; in addition, the estimated coefficient increases in absolute value from the regression without any control.

In sum, all these results imply that the tightening phase of countercyclical policy affects the credit supply channel of RR on average less than the easing one. In other words, bank credit supply is more reactive to the easing than to the tightening of countercyclical liquidity policy.

The point estimates of our control variables capture other effects. In particular, during the crisis, foreign banks contract credit supply by 6.09 p.p. and smaller banks by 11 p.p. relatively to the same firm (column 5). Additionally, a 1 p.p. ex-ante higher share of foreign liabilities is associated with a decrease in credit supply of 3.2 pp. In 2010, we do not find these results. However, we find that government banks, that typically respond counter-cyclically (Bonomo, Brito, and Martins, 2015, Coleman and Feler, 2015) contract lending on average by 5.4 p.p. during the credit boom (column 10). Banks with higher *ex-ante* exposure to the exporters expand relatively more credit supply in this period when commodity prices are in upward trend.

As firm fixed effects (i.e. comparing column (4) with (5) and (9) with (10)) do not change the estimated coefficients (despite that the very strong increase in R^2), following Altonji, Elder, and Taber (2005) and Oster (2019), we conclude that there is no self-selection into the treatment variable. Hence, in Table 3 we replicate Table 2 but in the comprehensive sample (with all firms) and just use sector*county fixed effects instead of firm fixed effects to control for credit demand shifts. The results are very much in line with those of Table 2, though a bit stronger in absolute value (but not different statistically as those from Table 2).

[Insert Table 3 here]

In Tables 4 and 5, we explore heterogeneous effects of the easing and tightening of countercyclical policy, respectively. During the easing phase of the policy, we find that larger private domestic banks are those that mostly respond to the easing policy. That is, the impact of higher liquidity via a release of reserve requirements on credit supply is smaller for foreign and small affected banks. Results are similar for affected banks that are more exposed to the trade sector. The estimates in Table 4 suggest that on average small and foreign banks are less reactive to the easing liquidity policy as they suffer a local and global liquidity squeeze in the aftermath of the crisis.[20]

[Insert Tables 4 and 5 here]

[20] The small banks' depositors run to the big banks in a fly-to-quality movement (Oliveira, Schiozer, and Barros, 2015). Hence, our results suggest that these small banks rebuild their liquidity using the RR liquidity release policy, without fully extending credit. Results suggest that foreign banks have a similar response, probably due to the negative effects for global banks during the 2008-09 GFC.

During easing and tightening, larger domestic private banks are the main conduits of RR policy. They extend credit by 3.11 p.p. in response to a decrease of 1 p.p. in RR (Table 4), and they decrease credit by 1.75 p.p. in response to an increase in RR of 1 p.p. (Table 5).

The late-2009 and early-2010 are recovery periods for most emerging countries. Brazil as several other emerging markets received high capital inflows from developed countries. Foreign banks, in particular, operate as conduits of foreign monetary policy (Morais, Ruiz, and Peydró, 2019). In Table 5, we observe that foreign banks extend credit supply by an additional 12.3 p.p. in response to a 1 p.p. increase in RR whereas private domestic banks contract credit supply by 1.75 p.p. more relatively to the same firm. This result suggests that foreign banks bypass local macroprudential policy tightening and increase market share in this period. In the last columns of Tables 4 and 5, we show similar responses for the comprehensive sample.

In Tables 6 and 7, we present results for the collateral channel of the easing and the tightening of countercyclical policy respectively. We use the new collateral posted (1/0) variable in case a new collateral is posted to the bank-firm credit relationship during the evaluating window.

[Insert Table 6 and 7 here]

We find that a decrease in RR of 1 p.p. is associated with an increase of 3.1 p.p. in new-collateral during bad times (which is large given the summary statistics in Table 1). Moreover, smaller, government, and foreign banks are less responsive in increasing collateral requirements (Table 6). Moreover, effects are over and above change in credit volume (i.e., to address this, we directly introduce the contemporaneous changes in the credit exposure of the same bank-firm relationship as a control variable). During tightening in 2010, we observe a 0.8 p.p. decrease in new collateral posted after an increase of 1 p.p. in RR, which is substantially lower than in the crisis easing. Government affected banks ask for less collateral requirements than private domestic banks (Table 7).

In sum, we find that more affected banks extend more credit to firms during the easing phase (Table 2) while they simultaneously increase their collateral requirements (Table 6). During tightening, we find the opposite behavior, i.e. banks decrease credit supply while demanding less collateral requirements. These results are both statistically and economically significant, and corroborate a credit supply and collateral channel of macroprudential policy. All effects are economically stronger in the crisis easing than in the boom tightening.

As a last step, we present our firm-level analysis to assess effects for firms (Table 8). As we explained in the empirical strategy, we regress the weighted bank, risk controls, and the treatment variable as well as firm controls against changes on firms' total credit.

[Insert Table 8 here]

We find that the easing and tightening have binding effects at the firm level. In Panel A, a decrease of 1 p.p. in RR of the *ex-ante* bank relationship lenders of a firm is associated with a positive increase of 1.03 p.p. (for firms with multiple banks) to 1.57 p.p. (for the comprehensive sample with all firms) on total firm credit availability at the end of the first post policy quarter. During tightening, an increase in RR of 1 p.p. is associated with an average decrease of 0.50 p.p. (for firms with multiple banks) to 0.72 p.p. (for the comprehensive sample with all firms) in credit availability at the firm level. These results suggest that firms are not able to insulate from the policy changes resorting to non-affected or less affected lenders. In Panel B, the results for new collateral posted are qualitatively and quantitatively similar to those of the loan-level regression, thereby also suggesting that firms cannot mitigate banks' changes in collateral requirements after policy changes.

As a robustness check, we re-estimate our main loan-level results in two placebo periods, one year after each shock (i.e., in the same quarter for seasonal effects but in a different year). The results for the placebo are insignificant and with an opposite sign of the estimated coefficients (Table A1 of the Appendix). Moreover, in Table A2 of the Appendix (Panels A and B), columns (2) and (6), we control for liquidity extended by big to small banks in an overlapping private liquidity stimulus policy.[21] We find that private liquidity support do not qualitatively affect our main results, but larger banks extending liquidity (mostly in the interbank market) to small banks lend on average 0.45 p.p. less. Controlling for this particular policy increases our treatment variable estimate, but the difference between columns (1) and (2) is not statistically significant.[22] In columns (3) and (7), we introduce changes in deposits possibly associated with a fly-to-quality run from small banks' depositors to bigger banks. The deposit variable is insignificant during the crisis and controlling for this dimension does not affect at all our main results, neither during easing (Panel A) nor during tightening (Panel B). In columns (4) and (8), we re-introduce

[21] See Section 2 and 3 for further details.

[22] Notice that our treatment variable is computed in *t* and liquidity support (mostly as repos and credit to small banks) is extended contemporaneously.

firm-bank relationships in default at *t-1*. These loans are associated with less credit increases, but do not change the main estimates of our treatment variable.

5. Conclusions

Since the aftermath of the 2008-09 global financial crisis, policy-makers and academics are paying great attention to macroprudential policy, including interactions with monetary policy (Claessens, 2015; Freixas, Laeven and Peydró, 2015). Despite broad interest from academics and policy-makers on the countercyclical liquidity policy (higher liquidity requirements in booms, and hence higher liquidity for banks in crises), there is scant empirical evidence of the related transmission channels. To the best of our knowledge, this is the first paper to evaluate the effects of countercyclical macroprudential liquidity tools.

To evaluate the countercyclical macroprudential liquidity policy on credit supply cycles, we exploit the Brazilian credit register and policy changes on reserve requirements, which affected banks differentially. Note that RR are both a monetary and prudential tool. We use exhaustive loan level data from Central Bank of Brazil to investigate the easing and tightening phases of this policy. The policy changes we evaluate were economically relevant and implemented in Brazil to alleviate a credit crunch in the aftermath of the 2008 crisis and latter (in 2010) reversed in light of accelerated credit growth.

Our robust evidence shows that the liquidity policy strongly attenuates both the credit crunch in bad times and the credit supply boom in good times. Moreover, effects are also strong at the firm level analysis (thereby impacting overall firm credit) and, importantly, twice larger during the (crisis) easing than the (boom) tightening. In particular, we find that firms exposed to a 1 p.p. average decrease in RR through their *ex-ante* bank relationship lenders end up (during the crisis) with higher total credit availability by 1.03 p.p. at the end of the following quarter; in 2010 (boom), firms exposed to a 1 p.p. average increase in RR end up with 0.50 p.p. less credit availability. Therefore, countercyclical liquidity policy smooths credit supply cycles, but with stronger effects in crises. Finally, in crisis times liquidity policy easing: (i) supports less credit supply from more financially constrained banks; and (ii) collateral requirements increase substantially, especially by banks that provide higher credit supply –i.e., effects of policy easing are stronger in crisis times (than in booms), but banks compensate the higher risk in the crisis by requiring higher collateral, and weaker banks (that tend to be risky) support less lending via RR. In sum, our results show that the transmission of liquidity macroprudential policy to credit supply is asymmetric in good *versus* bad times, with stronger quantitative effects in crises.

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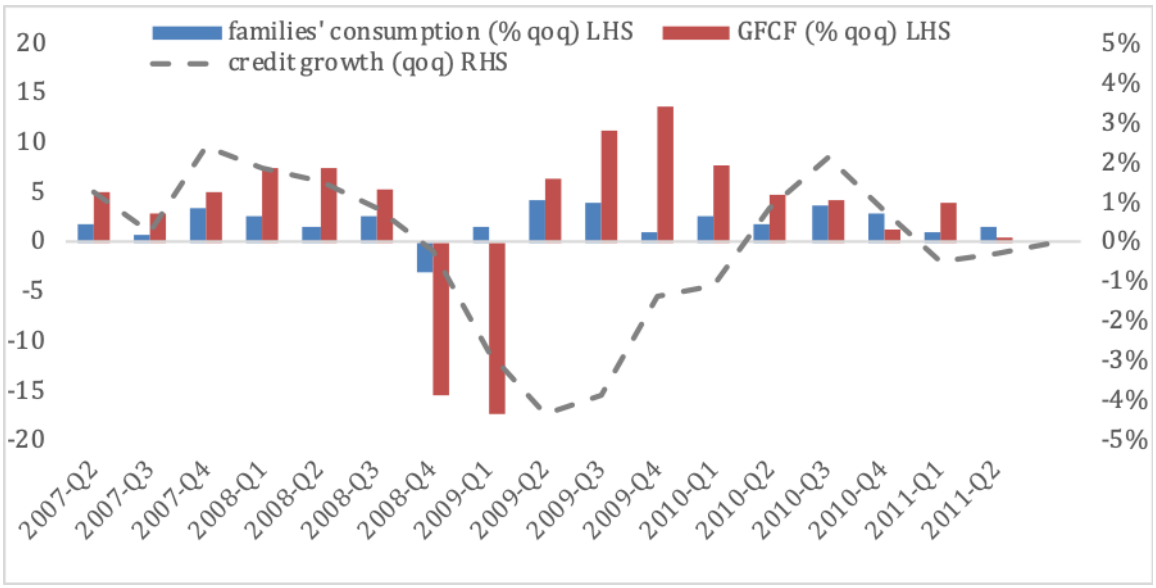
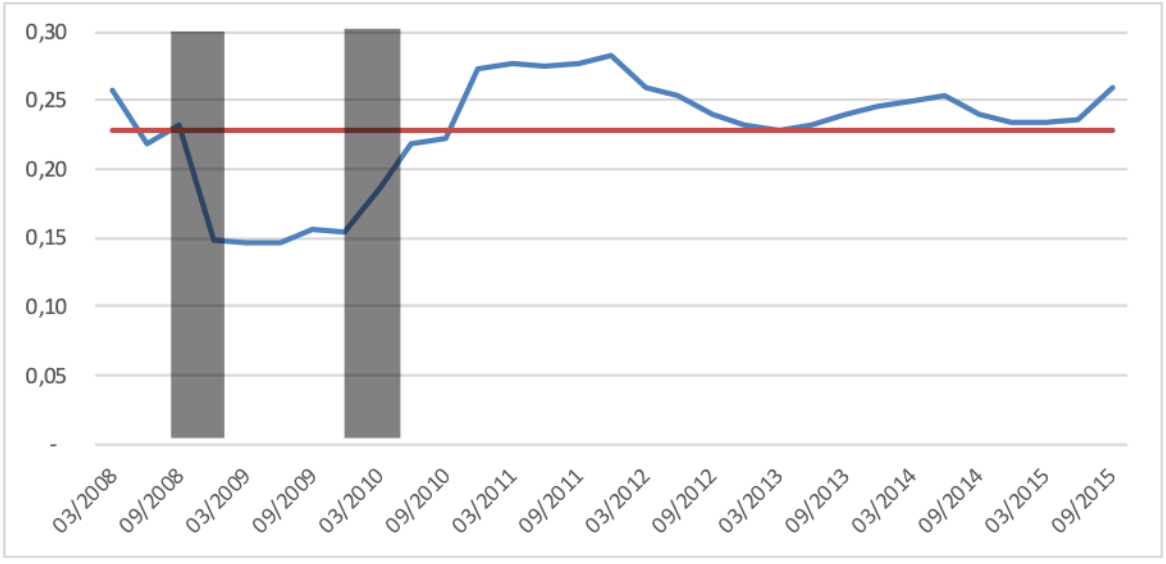
Figures and Tables

Figure 1: A credit crunch and recovery



Source: Central Bank of Brazil

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

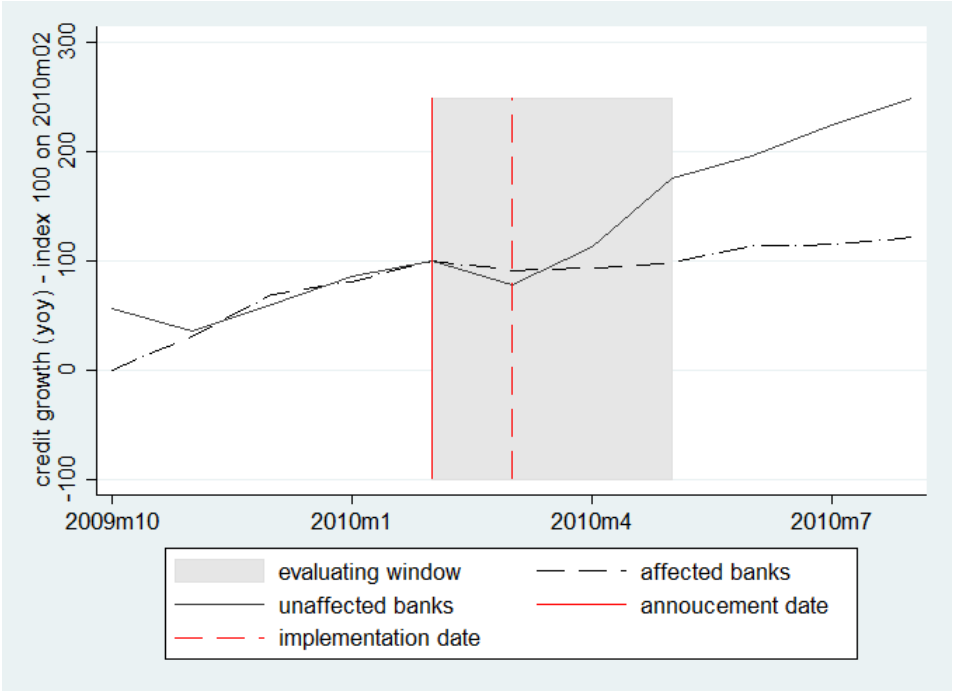


Source: Central Bank of Brazil
Notes: Red line is the average, 23%. Darker areas represent the estimating window of the easing and tightening respectively.

Figure 3

Panel A. Median bank total credit growth to firms (yoy) of affected and unaffected banks around the announcement and implementation of the November 2008 (easing policy) (top panel).

Panel B. Median bank total credit growth to firms (yoy) of affected and unaffected banks around the announcement and implementation of the March 2010 (tightening policy) (bottom panel)



TABLES

Table 1: Summary Statistics

PANEL A: Easing (2008)

	Unit	min	p10	p50	mean	p90	max	sd	N
Loan level									
Δln(credit) $_{b,f,t-1:t+2}$	%	-7.54	-0.37	-0.06	-0.03	0.37	6.68	0.45	534,754
new collateral $_{b,f,t:t+2}$	0/1	0.00	0.00	0.00	0.09	0.36	1.00	0.26	534,754
risk$_{t-1}$	Ln (1 + %)	0.00	0.10	0.55	0.70	1.39	4.62	0.66	534,754
foreign currency$_{t-1}$	0/1	0.00	0.00	0.00	0.01	0.00	1.00	0.10	534,754
ΔResReq $_{b,t}$	% of liabilities	-9.91	-6.68	-4.07	-3.53	-0.13	0.00	2.33	534,754
Firm level									
Δln(credit) $_{f,t-1:t+2}$	%	-5.92	-0.51	-0.03	0.02	0.60	6.37	0.52	204,644
new collateral $_{f,t:t+2}$	0:1	0.00	0.00	0.00	0.09	0.36	1.00	0.19	204,644
firm credit$_{t-1}$	Ln	9.62	11.77	13.91	14.08	16.54	29.74	1.95	204,644
n employees$_{t-1}$	Ln	0.69	1.10	2.20	2.41	4.08	11.66	1.28	204,644
ΔResReq $_{f,t}$	% of liabilities	-9.91	-5.86	-3.81	-3.80	-1.80	0.00	1.59	204,644
Bank level									
size$_{t-1}$	Ln (BRL Millions)	17.47	19.51	22.15	22.19	26.34	26.70	2.24	99
capital$_{t-1}$	Ln (1+ % of assets)	1.33	2.20	2.68	2.79	3.52	4.47	0.54	99
liquidity$_{t-1}$	Ln (1+ % of assets)	0.49	1.45	2.94	2.75	3.57	4.38	0.79	99
ROE$_{t-1}$	% of equity (yoy)	-144.09	0.28	17.23	15.42	35.22	58.00	21.04	99
foreign liabilities$_{t-1}$	Ln (1+ % of core-liabilities)	0.00	0.00	2.72	2.52	5.18	7.24	2.00	99
net trade share$_{t-1}$	% of credit	-28.51	-1.89	0.80	5.94	21.75	67.67	13.45	99
foreign$_{t-1}$	0/1	0.00	0.00	0.00	0.37	1.00	1.00	0.49	99
commercial$_{t-1}$	0/1	0.00	0.00	1.00	0.83	1.00	1.00	0.38	99
gov$_{t-1}$	0/1	0.00	0.00	0.00	0.08	0.00	1.00	0.27	99
small$_{t-1}$	0/1	0.00	0.00	1.00	0.86	1.00	1.00	0.35	99
Δdeposits $_{b,t-1:t+2}$	% of log changes	-977.37	-43.67	-7.97	-22.26	13.00	161.03	106.02	99
liquidity support $_{b,t:t+2}$	% of Tier 1 capital	0.00	0.00	0.00	2.82	14.03	55.92	8.22	99
ΔResReq $_{b,t}$	% of liabilities	-9.91	-3.98	0.00	-0.94	0.00	0.00	1.94	99

PANEL B: Tightening (2010)

	Unit	min	p10	p50	mean	p90	max	sd	N
Loan level									
Δln(credit) $_{b,f,t-1:t+2}$	%	-7.23	-0.34	-0.06	0.00	0.44	7.59	0.45	742,716
new collateral $_{b,f,t:t+2}$	0/1	0.00	0.00	0.00	0.08	0.26	1.00	0.25	742,716
risk$_{t-1}$	Ln (1 + %)	0.00	0.19	0.45	0.72	1.39	4.62	0.70	742,716
foreign currency$_{t-1}$	0/1	0.00	0.00	0.00	0.01	0.00	1.00	0.08	742,716
ΔResReq $_{b,t}$	% of liabilities	0.00	0.00	1.35	2.00	2.06	25.32	3.71	742,716
Firm level									
Δln(credit) $_{f,t-1:t+2}$	%	-9.63	-0.45	-0.01	0.06	0.66	7.20	0.52	279,791
new collateral $_{f,t:t+2}$	0:1	0.00	0.00	0.00	0.09	0.36	1.00	0.19	279,791
firm credit$_{t-1}$	Ln	9.55	11.79	13.88	14.02	16.37	31.02	1.86	279,791
n employees$_{t-1}$	Ln	0.69	1.10	2.08	2.34	3.95	11.25	1.25	279,791
ΔResReq $_{f,t}$	% of liabilities	0.00	0.80	1.38	1.70	2.44	24.77	1.72	279,791
Bank level									
size$_{t-1}$	Ln (BRL Millions)	17.48	19.61	22.33	22.37	26.63	27.01	2.37	99
capital$_{t-1}$	Ln (1+ % of assets)	1.27	2.20	2.68	2.78	3.45	4.48	0.51	99
liquidity$_{t-1}$	Ln (1+ % of assets)	0.71	2.27	3.18	3.07	3.84	4.39	0.68	99
ROE$_{t-1}$	% of equity (yoy)	-47.23	-6.90	13.47	11.84	26.82	39.51	14.71	99
foreign liabilities$_{t-1}$	Ln (1+ % of core-liabilities)	0.00	0.00	2.16	3.84	4.64	6.69	4.86	99
net trade share$_{t-1}$	% of credit	-22.92	-5.42	0.00	3.35	17.16	48.76	11.09	99
foreign$_{t-1}$	0/1	0.00	0.00	0.00	0.36	1.00	1.00	0.48	99
commercial$_{t-1}$	0/1	0.00	0.00	1.00	0.83	1.00	1.00	0.38	99
gov$_{t-1}$	0/1	0.00	0.00	0.00	0.08	0.00	1.00	0.27	99
small$_{t-1}$	0/1	0.00	0.00	1.00	0.85	1.00	1.00	0.36	99
Δdeposits $_{b,t-1:t+2}$	% of log changes	-467.03	-9.82	2.46	-4.09	19.90	61.14	61.74	99
liquidity support $_{b,t:t+2}$	% of Tier 1 capital	0.00	0.00	0.00	2.33	9.26	44.12	6.24	99
ΔResReq $_{b,t}$	% of liabilities	0.00	0.00	0.00	0.72	1.17	25.32	3.38	99

Notes: Panel A represents summary statistics related to the easing policy implemented during the global financial crisis (bust) in 2008 and Panel B represents the tightening policy implemented during the economic recovery (boom) in 2010. We present all bank, firm and loan-level variables used in this paper. The treatment variable is ΔResReq $_{b,t}$ and it measures for each bank the difference between RR calculated under the new and the old rules relatively to total liabilities. Thus, this variable presents negative figures reflecting easing when RR are reduced (Panel A) and positive figures reflecting tightening when RR are increased (Panel B).

Table 2: Loan-level analysis - Credit channel of countercyclical policy (firms with multiple bank relationships)

Dependent variable: $\Delta\ln(\text{credit}_{b,f,t-1:t+2})$										
	Easing of countercyclical RR (Nov. 2008)					Tightening of countercyclical RR (March 2010)				
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ΔResReq $_{b,t}$	-1.379**	-1.354**	-1.291***	-1.565***	-1.375***	-0.476***	-0.489***	-0.496***	-0.745***	-0.729***
	(0.603)	(0.621)	(0.463)	(0.516)	(0.396)	(0.170)	(0.157)	(0.115)	(0.141)	(0.099)
capital$_{t-1}$				10.143***	9.754***				1.011	0.730
				(2.985)	(2.505)				(2.779)	(1.988)
liquidity$_{t-1}$				-2.389	-2.150				3.415	3.064*
				(2.240)	(1.860)				(2.087)	(1.704)
size$_{t-1}$				-0.352	-0.474				1.514	1.531
				(1.259)	(1.012)				(1.256)	(1.011)
gov$_{t-1}$				2.784	2.351				-5.216**	-5.352***
				(1.781)	(1.518)				(2.324)	(1.814)
foreign$_{t-1}$				-6.481*	-6.087**				0.412	1.208
				(3.447)	(2.672)				(3.163)	(2.490)
small$_{t-1}$				-10.496*	-10.994**				-0.318	0.300
				(6.218)	(4.916)				(5.467)	(4.285)
commercial$_{t-1}$				-0.836	-1.054				1.938	3.099
				(6.794)	(5.478)				(6.161)	(4.466)
foreign liabilities$_{t-1}$				-2.965***	-3.216***				-1.237	-1.302
				(0.963)	(0.751)				(1.565)	(1.194)
ROE$_{t-1}$				0.033	0.015				0.138	0.162*
				(0.121)	(0.100)				(0.104)	(0.089)
net trade share$_{t-1}$				0.148	0.236				0.540*	0.565***
				(0.212)	(0.152)				(0.292)	(0.197)
Observations	534,754	534,754	534,754	534,754	534,754	742,716	742,716	742,716	742,716	742,716
R-squared	0.007	0.045	0.394	0.060	0.406	0.002	0.035	0.382	0.042	0.387
Loan Controls	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Firm Controls	No	Yes	-	Yes	-	No	Yes	-	Yes	-
Firm FE	No	No	Yes	No	Yes	No	No	Yes	No	Yes
N firms	204,644	204,644	204,644	204,644	204,644	279,791	279,791	279,791	279,791	279,791
N sectors	72	72	72	72	72	72	72	72	72	72
N banks	99	99	99	99	99	99	99	99	99	99

Notes: The dependent variable is the change in the natural logarithm of bank *b* total credit exposure against firm *f* between *t-1* and *t+2*, $\Delta\ln(\text{credit}_{b,f,t-1:t+2})$, where *t* is the announcement month of the RR policy change, i.e. over a quarter. The treatment variable is $\Delta\text{ResReq}_{b,t}$ and measures the difference between RR calculated under the new and the old rules. The bank controls are the ln of total assets (size), the ln of the capital adequacy ratio or core capital to total assets (capital), the ln of the liquidity ratio or total liquid assets to total assets (liquidity), the ln of foreign debt issued to total liabilities (foreign liabilities), the one-year return on equity (ROE), and the net trade share, i.e. total credit to exporters (-) importers to total bank credit (net trade share). We also use a dummy variable for public banks (gov), foreign banks (foreign), commercial banks (commercial), and banks whose Tier 1 capital is smaller than BRL 5 billion (small). The firm controls are ln of total credit (firm debt) and the ln of the number of employees (n employees), augmented with firm sector and county dummies. The loan controls are the weighted firm-bank provisions allocated across all loans of this firm-bank relationship (risk) and a (foreign currency) dummy in case a firm-bank pair has dollar denominated loans. All controls are taken from *t-1*. Defaulted loans, those in arrears of 90 days or more in *t-1* are removed. Models (3), (5), (8) and (10) are augmented with firm fixed effects. Models (1)-(5) represent the easing of RR and models (6)-(10) represent the tightening. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 3: Loan-level analysis - Credit channel of countercyclical policy in the comprehensive sample (all firms and loans)

Dependent variable: $\Delta\ln(\text{credit}_{b,f,t-1:t+2})$										
	Easing of countercyclical RR (Nov. 2008)					Tightening of countercyclical RR (March 2010)				
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ΔResReq $_{b,t}$	-1.343**	-1.296**	-1.292**	-1.632***	-1.656***	-0.471**	-0.451**	-0.480***	-0.760***	-0.763***
	(0.627)	(0.601)	(0.603)	(0.531)	(0.524)	(0.202)	(0.192)	(0.181)	(0.135)	(0.132)
capital$_{t-1}$				10.680***	10.817***				1.222	0.989
				(3.005)	(2.944)				(3.198)	(3.033)
liquidity$_{t-1}$				-2.726	-2.821				4.320*	4.146*
				(2.302)	(2.191)				(2.503)	(2.320)
size$_{t-1}$				-0.862	-0.805				1.561	1.358
				(1.310)	(1.263)				(1.521)	(1.396)
gov$_{t-1}$				2.909*	3.070**				-6.077***	-5.792***
				(1.620)	(1.522)				(2.241)	(2.184)
foreign$_{t-1}$				-6.707*	-6.907*				1.581	1.479
				(3.622)	(3.547)				(3.488)	(3.346)
small$_{t-1}$				-11.696*	-11.542*				0.309	-0.379
				(6.304)	(6.178)				(6.727)	(6.161)
commercial$_{t-1}$				-0.420	-0.492				0.020	0.015
				(7.358)	(7.113)				(7.140)	(7.060)
foreign liabilities$_{t-1}$				-2.546**	-2.617**				-0.709	-0.602
				(1.123)	(1.049)				(1.819)	(1.721)
ROE$_{t-1}$				0.053	0.046				0.190	0.188
				(0.127)	(0.123)				(0.125)	(0.119)
net trade share$_{t-1}$				0.054	0.043				0.483	0.488
				(0.240)	(0.234)				(0.358)	(0.336)
Observations	801,260	801,260	801,260	801,260	801,260	1,041,106	1,041,106	1,041,106	1,041,106	1,041,106
R-squared	0.005	0.013	0.045	0.024	0.056	0.001	0.007	0.036	0.015	0.043
Loan and Firm Controls	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Sector*County FE	No	No	Yes	No	Yes	No	No	Yes	No	Yes
N firms	489,297	489,297	489,297	489,297	489,297	608,437	608,437	608,437	608,437	608,437
N sectors	72	72	72	72	72	74	74	74	74	74
N banks	99	99	99	99	99	99	99	99	99	99

Notes: The dependent variable is the change in the natural logarithm of bank *b* total credit exposure against firm *f* between *t-1* and *t+2*, $\Delta\ln(\text{credit}_{b,f,t-1:t+2})$, where *t* is the announcement month of the RR policy change, i.e. over a quarter. The treatment variable is ΔResReq $_{b,t}$ and measures the difference between RR calculated under the new and the old rules. The bank controls (displayed) are the ln of total assets (size), the ln of the capital adequacy ratio or core capital to total assets (capital), the ln of the liquidity ratio or total liquid assets to total assets (liquidity), the ln of foreign debt issued to total liabilities (foreign liabilities), the one-year return on equity (ROE), and the net trade share, i.e. total credit to exporters (-) importers to total bank credit (net trade share). We also use a dummy variable for public banks (gov), foreign banks (foreign), commercial banks (commercial), and banks whose Tier 1 capital is smaller than BRL 5 billion (small). The firm controls are ln of total credit (firm debt) and the ln of the number of employees (n employees), augmented with firm sector and county dummies. The loan controls are the weighted firm-bank provisions allocated across all loans of this firm-bank relationship (risk) and a (foreign currency) dummy in case a firm-bank pair has dollar denominated loans. All controls are taken from *t-1*. Defaulted loans, those in arrears of 90 days or more in *t-1* are removed. Models (3), (5), (8) and (10) are augmented with sector*county (instead of firm) fixed effects. Models (1)-(5) represent the easing of RR and models (6)-(10) represent the tightening. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 4: Loan-level analysis – Heterogeneity on banks during easing

	Dependent variable: Δln(credit $_{b,f,t-1:t+2}$)								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ΔResReq $_{b,t}$	-1.375***	-1.322***	-1.357***	-1.409***	-1.968***	-2.235***	-2.245***	-3.113***	-3.254***
	(0.396)	(0.383)	(0.412)	(0.344)	(0.429)	(0.524)	(0.478)	(0.446)	(0.554)
ΔResReq $_{b,t}$ *capital$_{t-1}$		-1.764***						-0.608	-0.185
		(0.574)						(1.224)	(1.451)
ΔResReq $_{b,t}$ *ROE$_{t-1}$			0.013					0.025	0.032
			(0.042)					(0.071)	(0.083)
ΔResReq $_{b,t}$ *net trade share$_{t-1}$				0.150**				0.076*	0.110*
				(0.068)				(0.043)	(0.058)
ΔResReq $_{b,t}$ *foreign$_{t-1}$					3.730***			3.850***	3.847***
					(0.649)			(0.772)	(0.915)
ΔResReq $_{b,t}$ *small$_{t-1}$						2.106***		2.213***	2.488**
						(0.706)		(0.756)	(0.948)
ΔResReq $_{b,t}$ *gov$_{t-1}$							2.197***	0.645	0.176
							(0.536)	(0.647)	(0.803)
Observations	534,754	534,754	534,754	534,754	534,754	534,754	534,754	534,754	801,260
R-squared	0.406	0.406	0.406	0.406	0.407	0.406	0.407	0.408	0.055
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm Controls	-	-	-	-	-	-	-	-	Yes
Sector*County FE	-	-	-	-	-	-	-	-	Yes

Notes: This table presents effects of bank heterogeneities on credit supply. The dependent variable is the change in the natural logarithm of bank *b* total credit exposure against firm *f* between *t-1* and *t+2* (i.e. over a quarter), Δln(credit $_{b,f,t-1:t+2}$), where *t* is the announcement month of the RR policy change. The treatment variable is ΔResReq $_{b,t}$ and measures the difference between RR calculated under the new and the old rules. The bank controls are the ln of total assets (size), the ln of the capital adequacy ratio or core capital to total assets (capital), the ln of the liquidity ratio or total liquid assets to total assets (liquidity), the ln of foreign debt issued to total liabilities (foreign liabilities), the one-year return on equity (ROE), and the net trade share, i.e. total credit to exporters (-) importers to total bank credit (net trade share). We also use a dummy variable for public banks (gov), foreign banks (foreign), commercial banks (commercial), and banks whose Tier 1 capital is smaller than BRL 5 billion (small). The loan controls are the weighted firm-bank provisions allocated across all loans of this firm-bank relationship (risk) and a (foreign currency) dummy in case a firm-bank pair has dollar denominated loans. All controls are taken from *t-1*. Defaulted loans, those in arrears of 90 days or more in *t-1* are removed. Models (1)-(8) represent the most saturated regressions with Firm FE and bank controls. In model (9), we use the comprehensive sample with firm-bank, firm and bank controls augmented with sector*county FEs. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 5: Loan-level analysis – Heterogeneity on banks during tightening

	Dependent variable: Δln(credit $_{b,f,t-1:t+2}$)								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ΔResReq $_{b,t}$	-0.729***	-0.013	-0.657***	-0.652***	-0.760***	-0.729***	-0.728***	-1.749**	-1.535**
	(0.099)	(0.127)	(0.146)	(0.085)	(0.093)	(0.099)	(0.100)	(0.812)	(0.761)
ΔResReq $_{b,t}$ *capital$_{t-1}$		-6.500***						3.437	5.436
		(1.164)						(4.551)	(5.132)
ΔResReq $_{b,t}$ *ROE$_{t-1}$			-0.093					0.693*	0.999**
			(0.105)					(0.390)	(0.474)
ΔResReq $_{b,t}$ *net trade share$_{t-1}$				-0.418				0.178	0.125
				(0.278)				(0.353)	(0.447)
ΔResReq $_{b,t}$ *foreign$_{t-1}$					6.396***			12.328***	15.595***
					(0.791)			(3.538)	(4.182)
ΔResReq $_{b,t}$ *small$_{t-1}$						-0.078		6.353	10.175
						(1.337)		(6.871)	(8.353)
ΔResReq $_{b,t}$ *gov$_{t-1}$							0.759	-6.253	-10.336**
							(1.927)	(3.760)	(4.780)
Observations	742,716	742,716	742,716	742,716	742,716	742,716	742,716	742,716	1,041,106
R-squared	0.387	0.388	0.387	0.387	0.388	0.387	0.387	0.389	0.044
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm Controls	-	-	-	-	-	-	-	-	Yes
Sector*County FE	-	-	-	-	-	-	-	-	Yes

Notes: This table presents effects of bank heterogeneities on credit supply. The dependent variable is the change in the natural logarithm of bank *b* total credit exposure against firm *f* between *t-1* and *t+2* (i.e. over a quarter), Δln(credit $_{b,f,t-1:t+2}$), where *t* is the announcement month of the RR policy change. The treatment variable is ΔResReq $_{b,t}$ and measures the difference between RR calculated under the new and the old rules. The bank controls are the ln of total assets (size), the ln of the capital adequacy ratio or core capital to total assets (capital), the ln of the liquidity ratio or total liquid assets to total assets (liquidity), the ln of foreign debt issued to total liabilities (foreign liabilities), the one-year return on equity (ROE), and the net trade share, i.e. total credit to exporters (-) importers to total bank credit (net trade share). We also use a dummy variable for public banks (gov), foreign banks (foreign), commercial banks (commercial), and banks whose Tier 1 capital is smaller than BRL 5 billion (small). The loan controls are the weighted firm-bank provisions allocated across all loans of this firm-bank relationship (risk) and a (foreign currency) dummy in case a firm-bank pair has dollar denominated loans. All controls are taken from *t-1*. Defaulted loans, those in arrears of 90 days or more in *t-1* are removed. Models (1)-(8) represent the most saturated regressions with Firm FE and bank controls. In model (9), we use the comprehensive sample with firm-bank, firm and bank controls augmented with sector*county FEs. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 6: Loan-level analysis: Collateral requirements (risk-taking) during easing

	Dependent variable: new collateral $_{b,f,t:t+2}$ (1/0)								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ΔResReq $_{b,t}$	-0.031***	-0.030***	-0.032***	-0.033***	-0.042***	-0.048***	-0.055***	-0.066***	-0.068***
	(0.008)	(0.008)	(0.008)	(0.006)	(0.009)	(0.009)	(0.009)	(0.004)	(0.004)
ΔResReq $_{b,t}$ *capital$_{t-1}$		-0.029***						-0.007	-0.000
		(0.007)						(0.014)	(0.001)
ΔResReq $_{b,t}$ *ROE$_{t-1}$			-0.000					-0.001	0.004***
			(0.001)					(0.001)	(0.001)
ΔResReq $_{b,t}$ *net trade share$_{t-1}$				0.006***				0.005***	0.069***
				(0.001)				(0.001)	(0.009)
ΔResReq $_{b,t}$ *foreign$_{t-1}$					0.065***			0.061***	0.017***
					(0.011)			(0.008)	(0.005)
ΔResReq $_{b,t}$ *small$_{t-1}$						0.040***		0.020***	0.047***
						(0.010)		(0.004)	(0.008)
ΔResReq $_{b,t}$ *gov$_{t-1}$							0.059***	0.038***	0.000*
							(0.009)	(0.007)	(0.000)
Δln(credit $_{b,f,t-1:t+2}$)	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	-0.007
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.016)
Observations	534,754	534,754	534,754	534,754	534,754	534,754	534,754	534,754	801,260
R-squared	0.460	0.463	0.460	0.472	0.468	0.467	0.473	0.489	0.192
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm Controls	-	-	-	-	-	-	-	-	Yes
Sector*County FE	-	-	-	-	-	-	-	-	Yes

Notes: This table presents effects of bank heterogeneities on risk-taking. The dependent variable new collateral $_{b,f,t:t+2}$, takes the value of 1 if a new collateral is posted for the firm-bank pair between *t* and *t+2* and 0 otherwise, where *t* is the announcement month of the RR policy change (i.e. over a quarter). The treatment variable is ΔResReq $_{b,t}$ and measures the difference between RR calculated under the new and the old rules. The bank controls are the ln of total assets (size), the ln of the capital adequacy ratio or core capital to total assets (capital), the ln of the liquidity ratio or total liquid assets to total assets (liquidity), the ln of foreign debt issued to total liabilities (foreign liabilities), the one-year return on equity (ROE), and the net trade share, i.e. total credit to exporters (-) importers to total bank credit (net trade share). We also use a dummy variable for public banks (gov), foreign banks (foreign), commercial banks (commercial), and banks whose Tier 1 capital is smaller than BRL 5 billion (small). The loan controls are the weighted firm-bank provisions allocated across all loans of this firm-bank relationship (risk) and a (foreign currency) dummy in case a firm-bank pair has dollar denominated loans. All controls are taken from *t-1*. Defaulted loans, those in arrears of 90 days or more in *t-1* are removed. Models (1)-(8) represent the most saturated regressions with Firm FE and bank controls. In model (9), we use the comprehensive sample with firm-bank, firm and bank controls augmented with sector*county FEs. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 7: Loan-level analysis: Collateral requirements (risk-taking) during tightening

	Dependent variable: new collateral $_{b,f,t:t+2}$ (1/0)								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ΔResReq $_{b,t}$	-0.008***	-0.007***	-0.007***	-0.007***	-0.008***	-0.008***	-0.008***	-0.023**	-0.013
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.010)	(0.009)
ΔResReq $_{b,t}$ *capital$_{t-1}$		-0.011						0.088*	0.036
		(0.016)						(0.049)	(0.059)
ΔResReq $_{b,t}$ *ROE$_{t-1}$			-0.001					0.008*	0.004
			(0.001)					(0.005)	(0.005)
ΔResReq $_{b,t}$ *net trade share$_{t-1}$				-0.008**				-0.009**	-0.003
				(0.003)				(0.004)	(0.005)
ΔResReq $_{b,t}$ *foreign$_{t-1}$					0.006			0.066	0.030
					(0.007)			(0.043)	(0.048)
ΔResReq $_{b,t}$ *small$_{t-1}$						-0.007		0.158**	0.076
						(0.016)		(0.075)	(0.091)
ΔResReq $_{b,t}$ *gov$_{t-1}$							-0.079***	-0.122**	-0.109**
							(0.020)	(0.049)	(0.054)
Δln(credit $_{b,f,t-1:t+2}$)	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	742,716	742,716	742,716	742,716	742,716	742,716	742,716	742,716	1,041,106
R-squared	0.427	0.428	0.428	0.430	0.428	0.427	0.429	0.432	0.110
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm Controls	-	-	-	-	-	-	-	-	Yes
Sector*County FE	-	-	-	-	-	-	-	-	Yes

Notes: This table presents effects of bank heterogeneities on risk-taking. The dependent variable new collateral $_{b,f,t:t+2}$, takes the value of 1 if a new collateral is posted for the firm-bank pair between *t* and *t+2* and 0 otherwise, where *t* is the announcement month of the RR policy change (i.e. over a quarter). The treatment variable is ΔResReq $_{b,t}$ and measures the difference between RR calculated under the new and the old rules. The bank controls are the ln of total assets (size), the ln of the capital adequacy ratio or core capital to total assets (capital), the ln of the liquidity ratio or total liquid assets to total assets (liquidity), the ln of foreign debt issued to total liabilities (foreign liabilities), the one-year return on equity (ROE), and the net trade share, i.e. total credit to exporters (-) importers to total bank credit (net trade share). We also use a dummy variable for public banks (gov), foreign banks (foreign), commercial banks (commercial), and banks whose Tier 1 capital is smaller than BRL 5 billions (small). The loan controls are the weighted firm-bank provisions allocated across all loans of this firm-bank relationship (risk) and a (foreign currency) dummy in case a firm-bank pair has dollar denominated loans. All controls are taken from *t-1*. Defaulted loans, those in arrears of 90 days or more in *t-1* are removed. Models (1)-(8) represent the most saturated regressions with Firm FE and bank controls. In model (9), we use the comprehensive sample with firm-bank, firm and bank controls augmented with sector*county FEs. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5; * p< 10*.

Table 8: Firm-level analysis: estimates on credit supply and risk-taking

PANEL A. Dependent variable: $\Delta\ln(\text{credit}_{f,t-1:t+2})$

	Easing (November 2008)		Tightening (March 2010)	
Model	(1)	(2)	(3)	(4)
$\Delta\text{ResReq}_{f,t}$	-1.029***	-1.569**	-0.502***	-0.719***
	(0.352)	(0.618)	(0.093)	(0.175)
Observations	204,644	489,297	279,791	608,437
R-squared	0.120	0.083	0.101	0.071
Sector*County FE	Yes	Yes	Yes	Yes
N sectors	72	72	72	74
N counties	3311	3998	3680	4250
N main banks	92	95	93	95
Sample of firms	Multi-loan firms	All firms	Multi-loan firms	All firms

PANEL B. Dependent variable: new collateral $_{f,t:t+2}$ (1/0)

	Easing (November 2008)		Tightening (March 2010)	
Model	(1)	(2)	(3)	(4)
$\Delta\text{ResReq}_{f,t}$	-0.034***	-0.037***	-0.006***	-0.009***
	(0.008)	(0.010)	(0.001)	(0.001)
$\Delta\ln(\text{credit}_{f,t-1:t+2})$	0.000***	-0.000	0.000***	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	204,644	489,297	279,791	608,437
R-squared	0.199	0.201	0.149	0.130
Sector*County FE	Yes	Yes	Yes	Yes
N sectors	72	72	72	74
N counties	3311	3998	3680	4250
N main banks	92	95	93	95
Sample of firms	Multi-loan firms	All firms	Multi-loan firms	All firms

Notes: In Panel A, the dependent variable is the changein the natural logarithm of the total credit exposure of firm *f* between *t-1* and *t+2* $\Delta\ln(\text{credit}_{f,t-1:t+2})$; and, in panel B, the weighted new collateral variable, new collateral $_{f,t:t+2}$,where *t* is the announcement month of the RR policy change. The treatment variable, $\Delta\text{ResReq}_{f,t}$,the bank, and the firm-bank controls are all weighted average to the firm-level using the *ex-ante* firm-bank credit exposures. All models have firm-bank, bank, firm-level controls and sector*county FEs. Models (2) and (4) represent the comprehensive sample. Standard errors are clustered at the main bank, i.e. the bank extending more credit *ex-ante* to firm *f* and (2 digit) firm sector level *** p< 1%; ** p<5%; and * p<10%.

APPENDIX

Table A1: Placebo test

Dependent variable: $\Delta\ln(\text{credit}_{b,f,t-1:t+2})$										
	Easing of countercyclical RR (Nov. 2009 shock)					Tightening of countercyclical RR (March, 2011 shock)				
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ΔResReq $_{b,t}$	0.000	0.042	0.079	0.408	0.415	0.388*	0.373*	0.285*	0.419	0.285
	(0.491)	(0.471)	(0.346)	(0.533)	(0.389)	(0.221)	(0.205)	(0.150)	(0.421)	(0.311)
capital$_{t-1}$				-1.128	-1.543				2.526	1.798
				(2.245)	(1.755)				(2.237)	(1.740)
liquidity$_{t-1}$				0.527	0.386				0.936	0.950
				(1.823)	(1.494)				(1.946)	(1.470)
size$_{t-1}$				0.656	0.584				0.212	0.118
				(1.058)	(0.837)				(0.865)	(0.660)
gov$_{t-1}$				-1.311	-1.220				3.608*	3.704**
				(2.994)	(2.262)				(2.144)	(1.687)
foreign$_{t-1}$				-0.040	-0.272				-0.129	-0.124
				(3.077)	(2.355)				(3.131)	(2.684)
small$_{t-1}$				-2.667	-2.731				-3.456	-4.492
				(4.627)	(3.769)				(6.251)	(4.881)
commercial$_{t-1}$				4.041	2.846				0.234	-0.859
				(6.059)	(4.633)				(5.884)	(4.202)
foreign liabilities$_{t-1}$				-0.506	-0.321				0.248	0.423
				(1.466)	(1.097)				(0.830)	(0.643)
ROE$_{t-1}$				0.114	0.114				0.157	0.178
				(0.154)	(0.117)				(0.170)	(0.144)
net trade share$_{t-1}$				0.826**	0.828***				0.695**	0.703***
				(0.335)	(0.229)				(0.281)	(0.238)
Observations	703,433	703,433	703,433	703,433	703,433	865,970	865,970	865,970	865,970	865,970
R-squared	0.000	0.035	0.380	0.042	0.385	0.001	0.033	0.375	0.038	0.379
Loan Controls	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Firm Controls	No	Yes	-	Yes	-	No	Yes	-	Yes	-
Firm FE	No	No	Yes	No	Yes	No	No	Yes	No	Yes
N firms	265,023	265,024	265,025	265,026	265,027	320,856	320,857	320,858	320,859	320,860
N sectors	72	72	72	72	72	72	72	72	72	72
N banks	99	99	99	99	99	99	99	99	99	99

Notes: The dependent variable is the change in the natural log of bank *b* total credit to firm *f* between *t-1* and *t+2*, $\Delta\ln(\text{credit}_{b,f,t-1:t+2})$, where *t* is the (fake) announcement month of the RR policy change. The (placebo) treatment variable is $\Delta\text{ResReq}_{b,t}$ and measures the difference between RR calculated under the new and the old rules. Bank controls are total assets (size), the capital adequacy ratio (capital), the total liquid assets to total assets ratio (liquidity), foreign debt issued to total liabilities ratio (foreign liabilities) – all expressed in ln - and the one-year return on equity (ROE), and the net trade share, i.e. total credit to exporters (-) importers to total bank credit (net trade share). We use a dummy variable for public banks (gov), foreign banks (foreign), commercial banks (commercial), and banks with smaller Tier 1 capital than BRL 5 billion (small). Firm controls are ln of total credit (firm debt) and the ln of the number of employees (n employees), augmented with firm sector and county dummies. Loan controls are the weighted firm-bank provisions allocated across all loans of this firm-bank relationship (risk) and a (foreign currency) dummy in case a firm-bank pair has dollar denominated loans. All controls are taken from *t-1*. Defaulted loans, those in arrears of 90 days or more in *t-1* are removed. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table A2: Other robustness

Panel A: Easing

	$\Delta\ln(\text{credit}_{b,f,t-1:t+2})$				new collateral $_{b,f,t:t+2}$ (1/0)			
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_{b,t}$	-1.375***	-1.726***	-1.346***	-1.296***	-0.031***	-0.040***	-0.030***	-0.030***
	(0.396)	(0.400)	(0.428)	(0.376)	(0.008)	(0.008)	(0.008)	(0.008)
liquidity support$_{b,t:t+2}$		-0.456***				-0.011***		
		(0.156)				(0.002)		
Δdeposits $_{b,t-1:t+2}$			-0.007				-0.000	
			(0.020)				(0.000)	
default$_{t-1}$				-1.233				0.016***
				(0.894)				(0.006)
$\Delta\ln(\text{credit}_{b,f,t-1:t+2})$					0.000***	0.000***	0.000***	0.000***
					(0.000)	(0.000)	(0.000)	(0.000)
Observations	534,754	534,754	534,754	577,577	534,754	534,754	534,754	577,577
R-squared	0.406	0.406	0.406	0.403	0.46	0.468	0.460	0.454
Firm-Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N firms	204,644	204,644	204,644	218,902	204,644	204,644	204,644	218,902
N sectors	72	72	72	72	72	72	72	72
N banks	99	99	99	99	99	99	99	99

Notes: This table presents robustness tests for the easing cycle. All models are saturated with firm FE and all firm-bank and bank controls used insofar. In models (2) and (6), liquidity support $_{b,t:t+2}$ represents liquidity extended as credit and bond acquisition, credit extensions, or repo lending against banks with Tier I capital under BRL 7 billions; this variable controls for a contemporaneous RR policy that provides RR deductibles to (big banks) willing to extend liquidity to smaller banks. In models (3) and (7), Δdeposits $_{b,t-1:t+2}$ represents each bank contemporaneous change in deposits; this variable controls for fly-to-quality behavior in 2008 and 2009. In models (4) and (8), defaulted loans, i.e. those in arrears of 90 days or more in *t-1* are introduced in the regressions and their effects are captured with a dummy variable, default$_{t-1}$. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table B: Tightening

	Δln(credit $_{b,f,t-1:t+2}$)				new collateral $_{b,f,t:t+2}$ (1/0)			
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔResReq $_{b,t}$	-0.729***	-0.709***	-0.722***	-0.678***	-0.008***	-0.009***	-0.008***	-0.008***
	(0.099)	(0.115)	(0.101)	(0.093)	(0.002)	(0.002)	(0.002)	(0.002)
liquidity support $_{b,t:t+2}$		0.101				-0.007**		
		(0.284)				(0.003)		
Δdeposits $_{b,t-1:t+2}$			0.170**				-0.001*	
			(0.081)				(0.001)	
default$_{t-1}$				-1.546*				-0.003
				(0.917)				(0.004)
Δln(credit $_{b,f,t-1:t+2}$)					0.001***	0.001***	0.001***	0.001***
					(0.000)	(0.000)	(0.000)	(0.000)
Observations	742,716	742,716	742,716	832,172	742,716	742,716	742,716	832,172
R-squared	0.387	0.387	0.387	0.386	0.423	0.426	0.423	0.418
Firm-Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N firms	279,791	279,791	279,791	309,067	279,791	279791	279791	309,067
N sectors	72	72	72	72	72	72	72	72
N banks	99	99	99	99	99	99	99	99

Notes: This table presents robustness tests for the tightening cycle. All models are saturated with Firm FE and all firm-bank and bank controls used insofar. In models (2) and (6), liquidity support $_{b,t:t+2}$ represents liquidity extended as credit and bond acquisition, credit extensions, or repo lending against banks with Tier I capital under BRL 7 billions; this variable controls for a contemporaneous RR policy that provides RR deductibles to (big banks) willing to extend liquidity to smaller banks. In models (3) and (7), Δdeposits $_{b,t-1:t+2}$ represents each bank contemporaneous change in deposits; this variable controls for potential fly-to-quality behavior in 2010. In models (4) and (8), defaulted loans, i.e. those in arrears of 90 days or more in *t-1* are introduced in the regressions and their effects are captured with a dummy variable, default$_{t-1}$. Standard errors are double clustered at the bank and (2 digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.