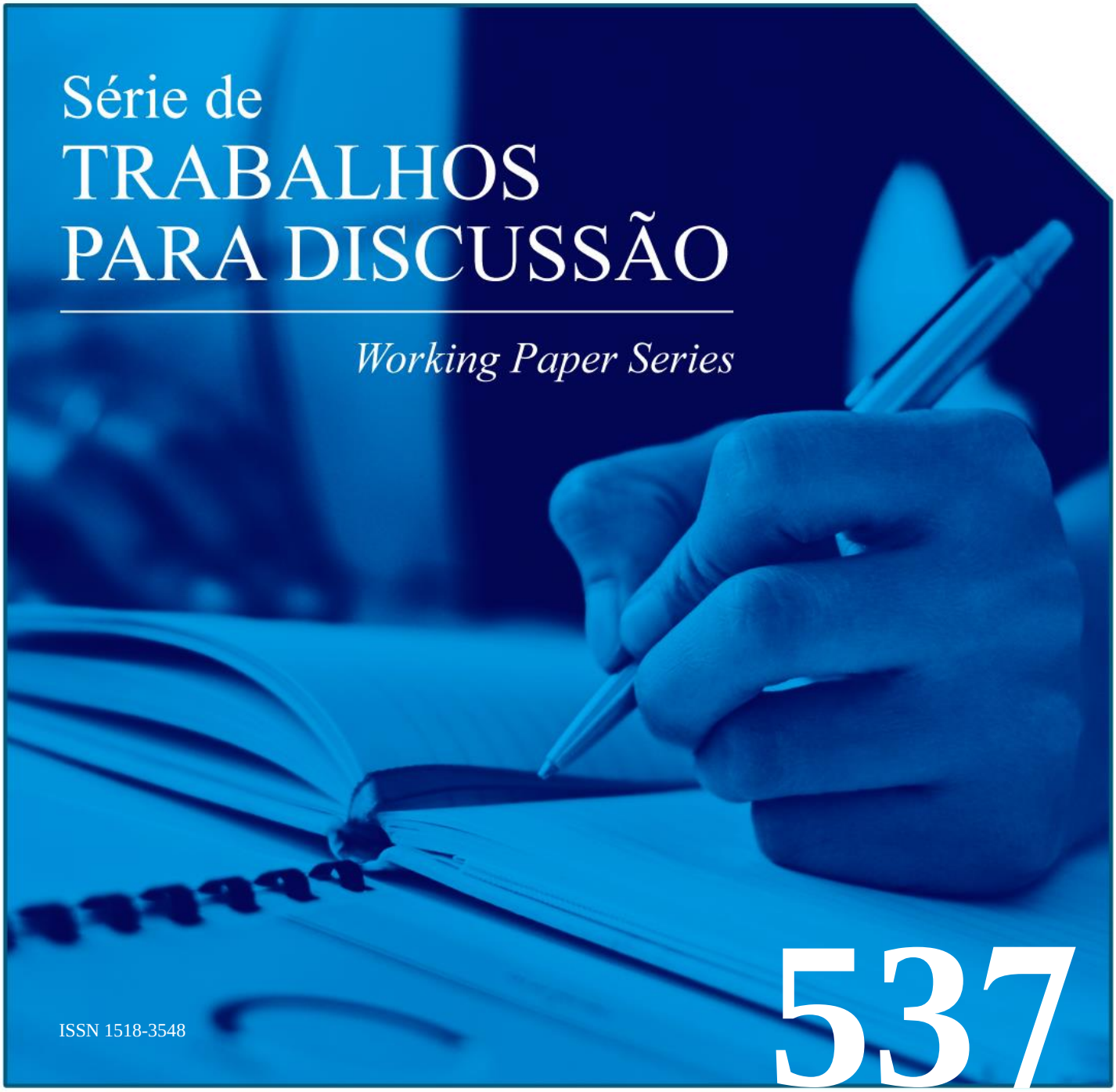

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Countercyclical Liquidity Policy and Credit Cycles: evidence from macroprudential and monetary policy in Brazil

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Non-technical Summary

We analyse the effects of countercyclical liquidity requirements, via reserve requirements (RRs) – i.e., higher (lower) requirements in booms (busts). RRs serve a monetary and a prudential policy purpose. In emerging market economies, local monetary policies through setting interest rates may be ineffective at times, as e.g. higher (lower) policy rates may lead to capital inflows (outflows), thereby exacerbating local credit booms (busts). Not surprisingly, many emerging countries use RRs countercyclically.

For identification, we exploit the Brazilian supervisory credit register and liquidity policy changes in reserve requirements, which affected banks differentially. We evaluate two policy episodes in a difference-in-difference strategy. In November 2008, the Central Bank of Brazil (BCB) reduced RRs with the purpose of alleviating a credit crunch during the Global Financial Crisis (GFC). This policy easing was economically significant, and the BCB introduced cash worth 2.8% of GDP in the banking system. In March 2010, the BCB reversed this policy by substantially increasing RRs to try to offset exuberant credit growth, particularly stemming from the previous six months. The tightening was also economically significant, and the BCB withdrawn cash worth 1.9% of GDP from the banking system.

We show countercyclical liquidity policy smooths credit supply cycles. Economic effects are twice as large during the bust easing than during the boom tightening. Finally, during liquidity easing, larger domestic banks, which respond providing more credit, simultaneously increase collateral requirements, while more financially constrained banks increase credit supply by less.

Sumário Não Técnico

Neste trabalho, avaliam-se os efeitos de requerimentos contracíclicos de liquidez, por meio de recolhimentos compulsórios –i.e., maiores (menores) requerimentos em resposta a períodos de expansão (retração). O compulsório serve tanto à política monetária quanto à macroprudencial. Nos países emergentes, a política monetária local por meio do ajuste de taxas de juros de referência pode ser ineficaz em certas ocasiões, e.g., aumentos (reduções) das taxas de juros de referência podem estimular fluxos positivos (negativos) de capital, exacerbando assim ciclos de expansão (retração) de crédito. Assim, diversos países emergentes utilizam o recolhimento compulsório de maneira contracíclica.

Exploram-se o Sistema de Classificação de Credito (SCR) do Banco Central do Brasil (BCB) e mudanças no nível de liquidez por meio de ajustes no compulsório, que afetaram diferentes bancos de maneira distinta. Avaliam-se dois choques de política por meio de uma estratégia de diferenças em diferenças. Em novembro de 2008, o BCB reduziu o recolhimento compulsório com o objetivo de aliviar um congelamento da concessão de crédito na esteira da grande crise global. Essa política expansionista foi expressiva na medida em que recursos da ordem de 2.8% do PIB foram injetados no sistema bancário. Em março de 2010, o BCB reverteu essa política ao elevar o recolhimento compulsório na tentativa de conter uma expansão acelerada do crédito iniciada seis meses antes. Essa política contracionista também foi expressiva, representando 1.9% do PIB em recursos líquidos drenados do sistema bancário.

O trabalho mostra que os requerimentos contracíclicos de liquidez atenuam ciclos de oferta de crédito. Os efeitos são duas vezes maiores durante períodos de retração (seguidos de uma política expansionista) do que durante períodos de expansão (seguidos de uma política contracionista). Finalmente, durante a expansão de liquidez, bancos domésticos maiores, que usualmente respondem provendo mais crédito, aumentam simultaneamente a demanda por colateral das empresas, enquanto que bancos financeiramente reprimidos aumentam menos a oferta de crédito.

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

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Abstract

We analyze how countercyclical liquidity policy – via reserve requirements (RRs) – affects the credit cycle. For identification, we exploit supervisory credit register data and changes in RRs in Brazil motivated by monetary and prudential purposes. Credit supply effects are binding for firms and *twice as large when policy is eased during credit crunches – crisis* – than when policy is tightened during credit booms. Effects are stronger for larger domestic banks. During crunches, more affected banks increase the supply of credit volume due to policy easing, but increase collateral requirements, while more financially constrained banks retrench. During booms, foreign banks bypass policy tightening.

Keywords: Liquidity, reserve requirements, credit cycles, macroprudential and monetary policy

JEL Classification: E51, E52, E58, G01, G28

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1. Introduction

Credit cycles are key to assessing systemic risk. Throughout history, credit booms have been the best predictors of financial crises, including the 2007-09 Great Financial Crisis (GFC), and of the credit crunches that follow them (Bernanke and Lown, 1991; Schularick and Taylor, 2012; Gourinchas and Obstfeld, 2012; Gilchrist and Zakrajsek, 2012; Jordà, Shularick and Taylor, 2013). Macroprudential policy targets this time-varying (cyclical) determinant of systemic risk by tightening policy in the boom—and hence potentially reducing credit booms—and easing it in the bust, thereby supporting credit (Brunnermeier et al., 2009; BCBS, 2010; Hanson, Kashyap and Stein, 2011; Freixas, Laeven and Peydró, 2015).[1] Since the GFC, countercyclical macroprudential policy has gained greater relevance worldwide among policymakers (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; Farhi and Werning, 2016; Bianchi and Mendoza, 2018; Jeanne and Korinek, 2019).

We analyze the effects of procyclical liquidity requirements using reserve requirements (RRs) –i.e., actively tightening RRs in a boom to drain liquidity (cash) from bank deposits to the central bank, and easing requirements to introduce – countercyclical – liquidity in the banking system in a crisis. RRs can serve both a monetary and a prudential policy purpose (see e.g. Stein, 1998, 2012).[2] Especially in emerging market economies (EMEs), interest rate policy may be ineffective, as raising policy rates may e.g. attract more capital inflows, thereby exacerbating local credit booms and inflationary

[1] For excessive cycles in credit, see e.g. Kiyotaki and Moore (1997), Dell'Ariccia and Marquez (2006), Benmelech and Bergman (2012). The use of time-varying macroprudential policy is part of Basel III (BCBS, 2010) and of policymakers' toolkit worldwide (see e.g. Brunnermeier et al., 2009; Drehmann and Gambacorta, 2012; Galati and Moessner, 2013 and 2018; Borio, 2014; Claessens, 2015; Cerutti, Claessens, and Laeven, 2017).

[2] As a monetary policy instrument, RRs may control money supply and credit growth. On the prudential side, RRs 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 RRs and liquidity requirements as interchangeable expressions throughout this paper, although a key difference between RRs and liquidity requirements is whether regulation drives a minimum amount of bank cash (or liquid assets) to be deposited at the central bank or simply hold by the bank to offset possible future distress, 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) via the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR). Importantly, LCR has been also used as a countercyclical instrument during the Covid-19 pandemic (IMF, 2020).

pressures (Blanchard, 2013; Rey, 2015). Not surprisingly, many EMEs use RRs countercyclically (Montoro and Moreno, 2011; Cordella et al., 2014; Federico, Vegh, and Vuletin, 2014). Following the Covid-19 outbreak, in particular, only a small minority of EMEs cut policy rates to or close to the zero lower bound, unlike the majority of advanced economies (Gopinath, 2020). Instead, the vast majority of EMEs (and very few advanced economies) eased their RRs (IMF, 2020).[3]

To evaluate the effects of countercyclical liquidity policy on credit supply cycles, we exploit the exhaustive supervisory credit register data and policy changes in RRs in Brazil using a difference-in-differences strategy applied to two major policy changes. These policy changes happened first during the GFC (a reduction of RRs, i.e., easing), and second in the following boom in 2010 (an increase in RRs, i.e., tightening). As RRs target different bank liabilities, banks were affected differently. Some banks were even exempted from the RR policy.

Briefly summarized, our results show that the liquidity policy strongly attenuates both the credit crunch and the credit boom. Economic effects are strong both at the loan level (key for identification of credit supply) and at the firm level. Importantly, and somewhat surprisingly, the quantitative effects are two times larger during the crisis-related easing than during the boom-related tightening. This is interesting as certain scholars and commentators argue that monetary policy is more effective in slowing economic activity than it is in stimulating economic activity (e.g. Cover, 1992; Angrist, Jordá and Kuersteiner, 2018) and, in general, less powerful during recessions (Tenreyro and Thwaites, 2016). In crisis times, easing of RRs: (i) supports credit supply by less in the case of more financially constrained (e.g. small) banks; and (ii) leads to a substantial increase in collateral requirements, especially by banks that supply more credit – that is, the effects of easing RRs are stronger during a crisis (than in a boom), but banks offset the higher risk by demanding more collateral. Finally, during credit booms, foreign banks bypass the tightening policy.

Despite the large academic and policy interest on macroprudential policy and the increased use of macroprudential policies, as far as we are aware, this is the first empirical

[3] According to IMF (2020), 61 EMEs and 2 advanced economies eased RRs or cash reserve ratios up to 11 September 2020. The list of EMEs includes countries in Asia (including China and India), Africa, Eastern Europe, Oceania, Latin America (including Brazil and Mexico) and the Caribbean. On top of this list, Chile, South Africa, Korea and Morocco relaxed the liquidity coverage ratio, which should have similar effects. The two advanced economies relaxing RRs are the United States and Iceland.

paper to identify the effects of countercyclical liquidity policies on credit cycles using microdata. The remaining part of this introduction is divided into two parts. First, we provide a detailed preview of the paper. Second, we discuss the related literature and how it contrasts with our paper.

Preview of the paper. In November 2008, the Central Bank of Brazil (BCB) eased RRs 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 RRs to try to offset exuberant credit growth over the previous six months (BCB, 2010; Pereira da Silva and Harris, 2012). This tightening was also economically significant and worth 2.2% of total banks' assets and 1.9% of GDP. 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. RRs affect mostly banks with large core liabilities. Interestingly, in Brazil some small banks are not subject to RRs. 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 heterogeneity, because banks differed (ex-ante) with respect to their mixture of liabilities at the time of the policy announcement.

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 each policy announcement, which happens one or two weeks before the implementation. During easing, there was an average -3.5 p.p. change in the RRs to total liabilities ratio in our sample, but banks' exposure to these policy changes (and related cash injection) varied from 0 to -9.9 p.p. During tightening, there was an average +2 p.p. change in RRs, but banks varied in their exposure from 0 to 25.3 p.p.

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 by including sector*location fixed effects – an approach which has been found to proxy reasonably well for credit demand shocks (Degryse et al., 2019). In addition, we present the results without any (or with a weaker set of) controls to check whether the results are sensitive to the choice 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 RRs of 1 p.p. (easing) is associated with a credit supply increase of 1.38 p.p. Moreover, an increase in RRs of 1 p.p. (tightening) is associated with a decrease of credit supply of 0.73 p.p. in the post policy quarter.

These estimates are robust. Controlling for unobservable firm characteristics (e.g. via firm fixed effects) and other variables (e.g. bank size) do not reduce the economic impact of RRs in easing or tightening. Thus, our key bank treatment variable driven by the policy changes is orthogonal to unobservables (Altonji, Elder, and Taber, 2005; Oster, 2019) and we can comfortably extend our credit supply analysis to: (1) the most comprehensive sample (including firms with a single bank relationship); and to (2) the firm level. Results on the larger sample of all firms are virtually identical at the loan level. Moreover, estimated coefficients are insignificant in periods in which the policy was not changed, which serve as placebo tests.

Firms can arguably mitigate these credit supply effects – e.g. extending relationship lending with the least affected banks. To account for this particular general equilibrium effect, the analysis at the firm level is just as relevant. Thus, we construct a treatment variable at the firm level using the *ex-ante* bank-firm credit exposure to weight the

treatment variable and bank controls (see e.g. Jiménez et al., 2017). We find that firms exposed to a 1 p.p. decrease in RRs through their ex-ante bank relationship lenders end up with 1.03 p.p. more credit availability at the end of the following quarter (or 1.64 p.p. for one standard deviation of RRs). Similarly, firms exposed to a 1 p.p. increase in RRs end up with 0.50 p.p. less credit availability (or 0.86 p.p. for one standard deviation of RRs). For the comprehensive sample, including the ones with only one banking relationship (pre-policy), not surprisingly, results are stronger (for 1 p.p. of RRs, 1.57 p.p. in crisis easing and 0.72 p.p. in boom tightening), as for these firms substitution across different lenders is more difficult. Note that the economic effects are large as the mean (standard deviation) of the change in firm credit (in real terms) is 0.02 (0.52) and 0.06 (0.52) in the crisis and boom respectively. In sum, countercyclical liquidity policy is potent to smooth credit supply cycles but with much stronger quantitative effects in crisis times.

We further analyze heterogeneous effects across banks and risk-taking. 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 are in greater need of the liquidity). In particular, smaller banks (which suffered more during the crisis due to an interbank market freeze and a run on deposits),[4] foreign banks (which directly suffered from the GFC), and banks with more exposure to foreign trade firms (which also suffered more from the GFC and global trade collapse associated) provide not only less credit supply on average during the crisis, but their credit supply also increase by less by the additional liquidity injection from RRs.

Second, larger banks, which supply more credit following the easing of RRs, also increase collateral requirements substantially. A 1 p.p. decrease in RRs is associated with a 3.1 p.p. increase in the number of bank-firm credit relationships to which new collateral is posted. From a risk-taking channel perspective, during the liquidity easing (in crisis times), banks supply more credit but require more collateral. These effects on collateral are less pronounced during tightening (in credit booms).

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

Contribution to the literature. Despite the great interest of academics and policymakers for macroprudential policy — as highlighted in the first paragraph of this Introduction — this is to the best of our knowledge the first empirical paper to identify the effects of countercyclical liquidity policies on credit supply using microdata.

Regarding more concretely RRs, rather than other macroprudential policies, on the theoretical front, Stein (2012) introduces a central bank whose only purpose is financial stability. The paper finds a pigouvian tax (e.g. RRs) addresses "an externality in which (financial) intermediaries issue too much short-term debt and leave the system excessively vulnerable to costly financial crises". Building on this framework, Kashyap and Stein (2012) present a model where central banks can also change short-term interest rates. Their model 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 latter result has important implications: in the context of a central bank with a dual mandate, RRs become a useful tool to face "credit bubbles" (Kashyap and Stein, 2012).[5] In addition, Bustamante and Hamann (2015) and Agénor, Alper, and Pereira da Silva (2018) introduce specific countercyclical rules for RRs with similar effects on credit cycles. Bianchi and Mendoza (2018) and Jeanne and Korinek (2019) show how a pigouvian tax can help manage credit booms and busts, and that the optimal macroprudential policy is a countercyclical "tax". Farhi and Werning (2016) moreover show the importance of macroprudential policy when monetary policy via interest rates is limited. In this paper, we provide empirical evidence of these theoretical channels.

On the empirical front, there have been more studies on bank capital for macroprudential policies as well as on household macroprudential policies.[6] For example, 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 (e.g. see also Auer and Ongena, 2016; Basten and Koch, 2015). We instead show that countercyclical *liquidity* policy not only attenuates the credit crunch in crises but also smooths the credit supply boom. In this sense, liquidity requirements are more effective

[5] Reinhart and Rogoff (2013) corroborate with this view arguing that the Fed has narrowed its policy instruments since the 1970s. However, the use of multiple instruments (and particularly RR) are desirable to support dual mandates.

[6] See also Akinci and Olmstead-Rumsey (2018).

than capital requirements to tame the credit cycle in booms. There is also evidence on macroprudential policies on borrowers, e.g. loan to value (LTV) and debt to income (DTI) limits (e.g. Acharya et al., 2018; Araujo, Barroso and Gonzalez, 2020; Epure et al., 2017; Benetton, 2018; DeFusco, Johnson and Mondragon, 2020).[7] We complement these studies by showing the effects over the credit cycle of *lender (bank) liquidity* requirements rather than policies on the borrower side.

Our paper also contributes to the literature on monetary policy (in particular RRs) and lending. In general, reserve requirements have been analyzed with macro-data from the monetary policy (e.g., Bernanke and Blinder, 1988; Stein, 1998, Glocker and Towbin, 2012; Areosa and Coelho, 2013) and also for macroprudential policy perspectives (e.g. Cerutti, Claessens and Laeven, 2017). Camors et al. (2019) uses loan level data to explore a policy tightening in Uruguay, where RRs were increased in an attempt to cool a credit boom fueled by capital inflows to the banking sector.[8] The authors find that a tightening of RRs has negative effects on credit supply. While this policy was targeting cross-sectional risk, the policy we analyze targets the *time-varying dimension of risk*, i.e. the effects of the countercyclical liquidity policy on credit supply throughout the cycle in Brazil. Finally, while part of the literature uses loan level data to analyze the relevance of the bank lending and risk-taking channel of interest rate policy (see e.g. Jiménez et al., 2012 and 2014), we turn to RRs and our results suggest a potent countercyclical instrument broadly used for monetary and macroprudential purposes and particularly effective to smooth credit cycle in EMEs.

The paper proceeds as follows. Section 2 describes the economical and institutional context of the policy Section 3 describes the datasets and the empirical strategy. Section 4 presents and discusses the results. Section 5 concludes.

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

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 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

[7] See also Fuster and Willen (2017).
[8] Mora (2014) evaluates a similar policy in Lebanon with bank level data.

2008, despite falling commodity prices and currency depreciation, GDP still grew 5 p.p. (between June and September 2008, annualized growth), reflecting mostly quarterly positive consumption (2.5 p.p.) 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% and rollover ratio of foreign debt decreased from over a 100 to 22% 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%, and in the following two quarters, it reached -5%. (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 RRs (Barbosa, 2010).[9] The ratio of reserve requirements in Brazil represented on average 23% of total liabilities subject to RRs (LRR) from 2008 to 2015. This ratio 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 RRs 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]

[9] 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.

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)[10] . 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 RRs to its pre-crisis levels. Relative to other local prudential policies implemented during the same period, RRs 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.

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 the 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 RRs) and unaffected banks (not subject to RRs). 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 October 2008. However, after the announcement and implementation window, 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: RRs on demand deposits (unremunerated), on savings (remunerated according to the savings accounts reference

[10] 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.

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 RRs (see BCB, 2009; and Cavalcanti and Vonbun, 2013). During the easing of 2008, the RRs were waived for certain small financial institutions because of an increased minimum capital threshold to compute liabilities subject to RRs (i.e., an increase in RR deductions that virtually exempted certain smaller banks from this requirement).

The countercyclical measures adopted in November 2008 were the following: (i) the two additional components on demand and term deposits were reduced (-3 p.p. each)[11]; (ii) reduction in RR ratios for demand deposits (-3 p.p.)[12]; (iii) higher deductions for term deposits and in the additional component that released some small banks from RRs[13]; (iv) conditional deductibles on certain exposures acquired from small financial institutions or on interbank lending provided to these banks[14]. The amount of cash released to the average affected bank represented on average -3.5% of their total liabilities.

In 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 RRs (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.

[11] 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.
[12] Implemented by Circular 3,413.
[13] 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.
[14] 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 RRs 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).

The BCB routinely computes counterfactual RRs to monitor the implementation of its policies. Considering the changes in RRs, 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 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 RRs relatively to 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 easing, the bank treatment variable represents a change in the rules available up to October 2008, i.e.: (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); and (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 bank treatment variable to capture the tightening, relatively to the state of RR regulation (and total liabilities per bank) available until February 2010. These rules are: (i) RR ratio of 13.5% on term deposits increased by 1.5 p.p. during tightening[15]; (ii) RR ratio of 42% for demand deposits (unchanged during tightening)[16]; (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)[17]; and (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)[18]. It is worth noticing that the deductibles were not fully reversed[19].

[15] Circular 3,468 further decreased RR on term deposits from 15% to 13.5% in September 2009, and Circular 3,485 reversed this last policy in February 2010.
[16] 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.
[17] Circular 3,426 from December 2008 further decreased the additional RR on term deposits to 4%. Circular 3,486 in February 2010 increased the additional on term and times deposits back to the pre-crisis levels.
[18] Circular 3,485 in February 2010 changed the deductible of the small and bigger banks.
[19] These are the banks with Tier I capital under BRL 2 billion (Circular 3,410 from October 2008). While they were affected by the easing, they were unaffected by the tightening. We use a balanced sample of banks in this paper. Therefore, this group of banks have a zero treatment in the tightening phase of this cycle.

3. Data and Empirical Strategy

We evaluate the easing and tightening policies independently using the two policy changes, in 2008 and 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.[20] 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.

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

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

where b refers to bank and t to time (month). We measure this regulatory change (in equation (1)) in the announcement month t – e.g. in the month of October 2008 (with the variables measures as of October) 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).

[20] For firm control variables, we use the matched employer-employee database from Ministry of Labor and Employment ("Relação Anual de Informações Sociais" - 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.

In order to analyze changes in credit volume (and in collateral), 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, new $\text{collateral}_{b,f,t:t+2}$, 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. In addition, 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 RRs 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 RRs 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 ($\text{foreign currency}_{t-1}$) and for the ex-ante net exposure to the trade-related sector of each bank ($\text{net trade share}_{t-1}$). As mentioned before, trade-related sector firms,[21] exporters in

[21] 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

particular, are more deeply affected by the GFC and its related foreign exchange liquidity squeeze. While the depreciation of the BRL against major currencies 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.[22] We further introduce one last firm-bank control, $risk_{t-1}$, representing the average ex-ante expected losses 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 focus on the loan and firm level. The first equation assesses the credit supply channel of RRs. The dependent variable is the change in the log of credit between *t-1* 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.[23]

$$\Delta \ln\left(\text{credit}_{b,f,t-1:t+2}\right) = \beta \Delta \text{ResReq}_{b,t} + \theta X^{b}_{f,t-1} + \alpha_{f} + \varepsilon_{b,f,t-1:t+2} \qquad (2)$$

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.

[22] 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 in February 2010 also poses preferential RR treatment for these banks. Banks on top of this Tier 1 capital threshold are not eligible to any deductible.

[23] 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.

where: β is the coefficient of interest, which corresponds to the treatment variable; $X^{b}_{f,t-1}$ 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 $\Delta ResReq_{b,t}$ is orthogonal to firm controls (following e.g. Oster (2019)'s test and Altonji, Elder and Taber (2015)), 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 allows 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.

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

$$\Delta \ln\left(credit_{b,f,t-1:t+2}\right) = \beta \Delta ResReq_{b,t} + \gamma \Delta ResReq_{b,t} * X^{b}_{t-1} + \theta X^{b}_{f,t-1} + \alpha_f + \varepsilon_{b,f,t-1:t+2} \quad (3)$$

where we have two coefficients of interest β – as before – and γ, which corresponds to the interaction between the treatment variable and bank controls (X^{b}_{t-1}). The bank controls are $capital_{t-1}$, ROE_{t-1}, net $trade\ share_{t-1}$, and dummy variables identifying $foreign_{t-1}$, $government_{t-1}$, and $small_{t-1}$ banks. Additionally, 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 (equation 4).

$$\text{new collateral}_{b,f,t:t+2} = \beta\Delta\text{ResReq}_{b,t} + \gamma\Delta\text{ResReq}_{b,t} * X^{b}_{t-1} + \theta X^{b}_{f,t-1} + \alpha_{f} + \varepsilon_{b,f,t:t+2} \quad (4)$$

We analyze the firm level effects in equations (5) and (6). To assess (more 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 RRs 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).

$$\Delta\ln\left(\text{total credit}_{f,t-1,t+2}\right) = \beta\Delta\text{ResReq}_{f,t} + \theta w X^{b}_{f,t-1} + \eta X_{f,t-1} + \alpha_{s*c} + \varepsilon_{f,t-1:t+2} \quad (5)$$

$$\text{new collateral}_{f,t:t+2} = \beta\Delta\text{ResReq}_{f,t} + \theta w X^{b}_{f,t-1} + \eta X_{f,t-1} + \alpha_{s*c} + \varepsilon_{f,t:t+2} \quad (6)$$

where $X_{f,t-1}$ represents 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 for 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 RRs) 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, see Table 1).

[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), these results suggest 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 RRs 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 RRs on average less than the easing one. In other words, bank credit supply is more reactive to the easing in crises than to the tightening of countercyclical liquidity policy in credit booms.

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 countercyclically (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.

Because introducing firm fixed effects (i.e. comparing column (4) with (5) and (9) with (10)) does not change the estimated coefficients (despite 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.[24] Hence, in Table 3 when we replicate Table 2, in the comprehensive sample (with all firms) where we just use sector*county fixed effects (instead of firm fixed effects to control for credit demand shifts), results are very much in line with those of Table 2, though a bit stronger in absolute value (but not statistically different from those of 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.[25]

[24] Importantly, the estimated coefficients are also independent of bank controls such as for example bank size. In the main text, we highlight firm fixed effects because of the subsequent analyses on firm level credit availability and firm-bank effects for the comprehensive sample of firms (including the firms with only one lender).

[25] 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, possibly due to the negative effects for global banks during the GFC. Foreign banks in both crisis and boom

[Insert Tables 4 and 5 here]

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 RRs (Table 4), and they decrease credit by 1.75 p.p. in response to an increase in RRs of 1 p.p. (Table 5).

Foreign banks, in particular, operate as conduits of foreign monetary policy introducing risk aversion and global liquidity (Morais, Ruiz, and Peydró, 2019). Hence, during the crisis, results suggest they are not sensitive to the local policy easing (Table 4).The late-2009 and early-2010 are recovery periods for most emerging countries and Brazil and several other emerging markets received high capital inflows from developed countries. 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 RRs, 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 RRs 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). 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 endogenous changes in

times react less to policy, and hence results during the crisis are also consistent with foreign banks somewhat bypassing the RR policy (though as they also cut credit supply in general during the crisis, and they were directly affected by the GFC, we believe that results are more consistent with the latter hypothesis rather than just bypassing the change in the RR policy).

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 RRs, which is substantially lower than in the crisis easing and non-significant in the comprehensive sample. Interestingly, more affected government banks ask require less collateral (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). These results are both statistically and economically significant, and corroborate a credit supply and collateral channel of macroprudential liquidity policy. During tightening, we find the opposite behavior, i.e. more affected banks decrease credit supply while demanding fewer collateral requirements, but results are statistically and economically weaker.

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 firm credit availability at the end of the first post policy quarter. During tightening, an increase in RRs 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 (with stronger effects for firms with only one bank, unsurprisingly). 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, see 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 discussed in Section II. We find that private liquidity support does 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.[26] 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 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

Policymakers and academics are paying greater attention to macroprudential policy over the cycle and its related transmission channels. In this paper, we turn to countercyclical liquidity policy using RRs and its effects on credit supply. To evaluate the effects of countercyclical liquidity policy on credit supply cycles, we exploit the exhaustive supervisory credit register data and policy changes in RRs in Brazil during the GFC (a reduction of RRs, i.e., easing), and then in the following boom in 2010 (an increase in RRs, i.e., tightening). As RRs target different bank liabilities, banks were affected differently. Some banks were even exempted from the RR policy.

Our results suggest that the liquidity policy strongly attenuates both the credit crunch and the credit boom. Economic effects are strong both at the loan level (key for identification of credit supply) and at the firm level. Importantly, and somewhat surprisingly, the quantitative effects are two times larger during the crisis-related easing than during the boom-related tightening. This is interesting as certain scholars and commentators argue that monetary policy is more effective in slowing economic activity

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

than it is in stimulating economic activity and, in general, less powerful during recessions. In crisis times, easing of RRs: (i) supports credit supply by less in the case of more financially constrained (e.g. smaller) banks; and (ii) leads to a substantial increase in collateral requirements, especially by banks that supply more credit – that is, the effects of easing RRs are stronger during a crisis (than in a boom), but banks offset the higher risk by demanding more collateral. Finally, during credit booms, foreign banks bypass the tightening policy.

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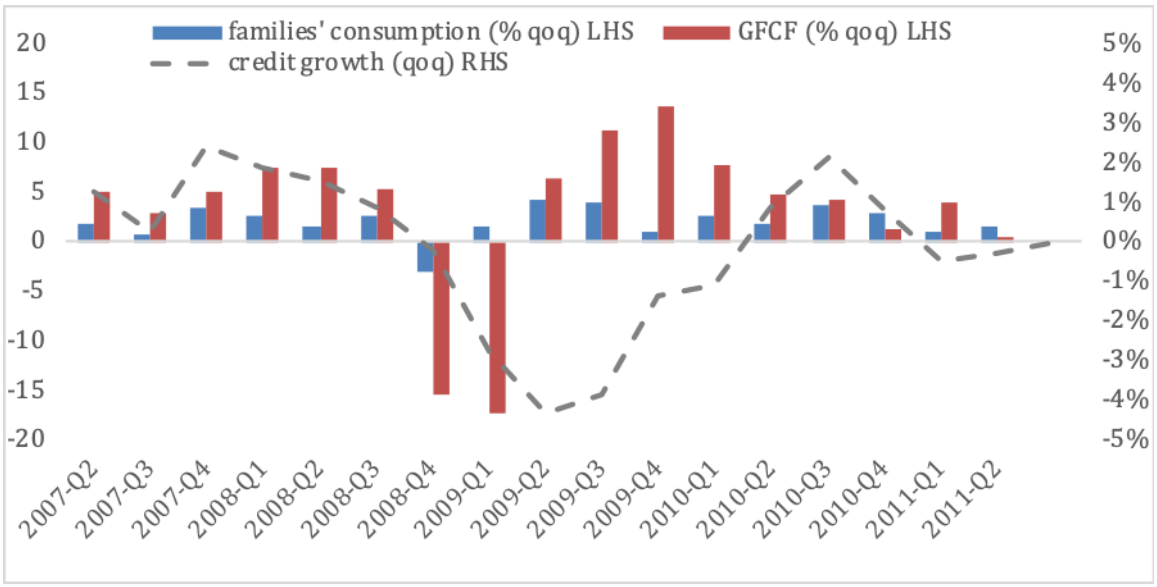
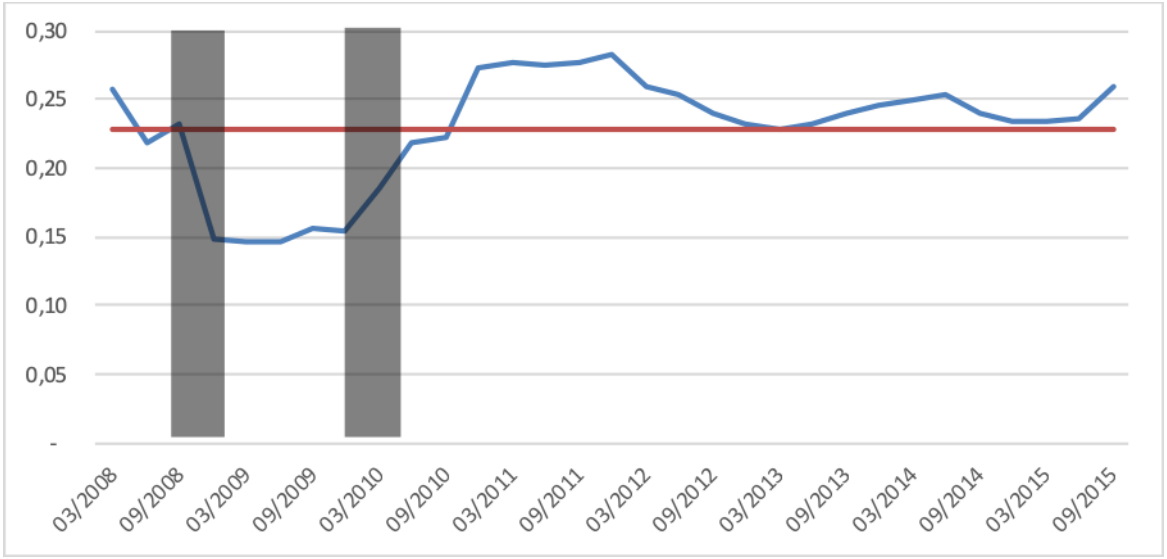
Figures and Tables

Figure 1: The credit crunch and recovery



Source: Central Bank of Brazil, National Accounts
Notes: The changes in gross fixed capital formation (GFCF), consumption and credit growth are relatively to the same quarter of the previous year.

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

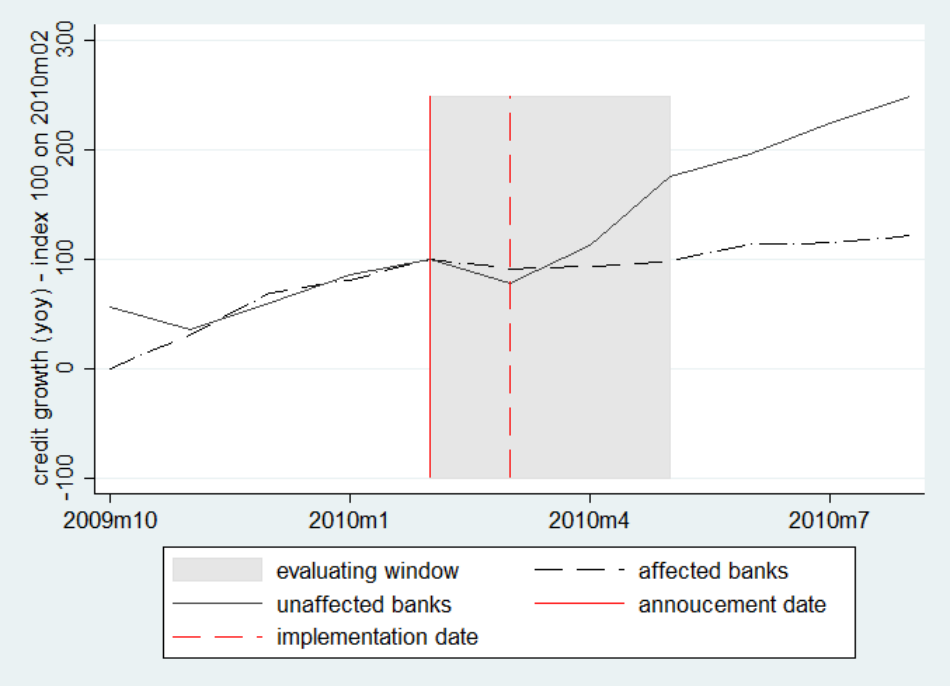


Source: Central Bank of Brazil
Notes: The red dashed line is the average, 23% of total liabilities subject to RR (LRR). Darker areas represent the estimating window of the easing and tightening respectively, and the blue line represents average RR ratios in Brazil.

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 counterfactual 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 for firms with multiple bank relationship

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 policy change. The counterfactual treatment variable is ΔResReq $_{b,t}$ and measures the difference between RRs 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 RRs and models (6)-(10) represent the tightening. Standard errors are 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 policy change. The counterfactual treatment variable is ΔResReq $_{b,t}$ and measures the difference between RRs 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 RRs and models (6)-(10) represent the tightening. Standard errors are clustered at the bank and (2-digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 4: Loan-level analysis - Bank interactions during easing and effects on credit supply

	Dependent variable: $\Delta\ln(\text{credit}_{b,f,t-1:t+2})$								
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,* $\Delta\ln(\text{credit}_{b,f,t-1:t+2})$, where *t* is the announcement month of the policy change. 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 clustered at the bank and (2-digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 5: Loan-level analysis - Bank interactions during tightening and effects on credit supply

	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*, Δln(credit $_{b,f,t-1:t+2}$), where *t* is the announcement month of the policy change. 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 clustered at the bank and (2-digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 6: Loan-level analysis: Bank interactions during easing and effects on risk-taking

	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 policy change. 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 clustered at the bank and (2-digit) firm sector levels. *** p< 1%; ** p<5%; and * p<10%.

Table 7: Loan-level analysis: Bank interactions during tightening and effects on risk-taking

	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 policy change. 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 clustered at the bank and (2-digit) firm sector levels. *** p< 1%; ** p<5; * p< 10*.

Table 8: Firm-level analysis: estimates on credit 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

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

Notes: In Panel A, the dependent variable is the change in 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 policy change. The counterfactual treatment variable, $\Delta\text{ResReq}_{f,t}$, the bank, and the firm-bank controls are all weighted averaged to the firm level using the *ex-ante* firm-bank credit exposure. All models have firm-bank, bank, firm-level controls and sector*county FEs. Models (1) and (3) represent the sample of multiple relationship firms and models (2) and (4) 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: Δln(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*, Δln(credit $_{b,f,t-1:t+2}$), where *t* is the (fake) announcement month of the policy change. The (placebo) treatment variable is ΔResReq $_{b,t}$ and measures the difference between RRs 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

	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 $_{b,t}$	-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)
Δln(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 FEs and all firm-bank and bank controls. 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. Hence, this variable controls for contemporaneous support provided by (big banks) to small banks against a RR deductible. See more on section 2. 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%.

Panel 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 FEs 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. Hence, this variable controls for contemporaneous support provided by (big banks) to small banks against a RR deductible. See more on section 2. 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%.