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Doctoral Thesis

Four Essays on

Banking Globalization and Financial Stability in Emerging Countries

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To my parents.

Chapter 1

General introduction and outline of the thesis

"... just a few years ago, strong countercyclical policy actions ... would not have been recommended for an emerging market country during a period of crisis, and might not even have been feasible. In earlier crises, foreign investors were not inclined to give emerging market policymakers the benefit of the doubt when they promised low inflation and sustainable fiscal policies. Attempts to support economic activity through conventional expansionary policies thus risked a vicious circle of capital flight, exchange rate depreciation, higher inflation, a worsening balance of payments, and more capital flight."

Ben S. Bernanke, 2010

A distinctive aspect of the recent financial crises is that they emerged primarily in the industrial world. Since the 2008-2009 global financial crisis emerging countries have been therefore confronted with financial shocks triggered at the core of the international financial system, affecting the volatility of capital flows worldwide. Emerging countries' dependence on capital and trade flows, combined with a large presence of foreign-owned banks, has been identified as a central driver of the cross-border transmission of these crises (see IMF, 2009). While historical events such as the Latin American debt crisis or the 1997 Asian financial crisis highlighted the importance of sound balance of payments and inflation targeting policies at the macroeconomic level, the global financial crisis has revealed the importance of weighing the costs and benefits of banking globalization. This is foremost important from a policy perspective, since emerging countries faced for the first time in decades an external shock in a context free of large local macroeconomic imbalances, having to adapt their traditional policy framework to new challenges. This has been emphasized, among others, by the former Chairman of the U.S. Federal Reserve Ben Bernanke. In particular, this changing scenario implied that microeconomic aspects involved in the cross-border transmission of shocks gained increasing momentum in the international policy debate (see for instance Freixas et al., 2015).

Despite of a growing literature on international banking (e.g. Cetorelli and Goldberg, 2011; Buch and Goldberg, 2015), a thorough understanding of the specific microeconomic mechanisms underlying the cross-border transmission of banking shocks is still an open challenge for scholars in the field of international finance. At least three central questions lie at the core of this debate. First, in the presence of several contemporaneous transmission channels, only little is known about the interactions between different dimensions of cross-border exposure and their respective policy implications. Second, the analysis of the cross-border transmission of shocks to the real economy has remained mainly focused at the macroeconomic level. A thoughtful assessment of the impact of different transmission channels on real economic outcomes is therefore needed. Finally, policymakers' reaction since 2008 has been characterized by worldwide innovations in the implementation of monetary policy, financial supervision and regulatory schemes. To this respect, a comprehensive evaluation of these policy interventions is required in order to improve the policy-toolbox developed since 2008.

Even though these remain topical questions also in the industrial world, analyzing them from the perspective of emerging countries is important due to the aforementioned policy implications of the crisis and because of a lack of bank-level evidence about the extent to which the crisis was transmitted to these countries via banks. In fact, most of the recent literature analyses the global spillovers of the crisis from the standpoint of global banks' home countries.[1] More generally, understanding the transmission of the crisis to emerging countries is also important considering the increasing weight of global banks' operations in emerging countries from a consolidated perspective (Claessens and Van Horen, 2014). The role of foreign bank affiliates as internal liquidity providers for their global bank holding companies and the cross-border spillovers of local regulatory and monetary policy actions stress this latter fact. From a methodological point of view, the exogeneity of recent crises for emerging countries makes these countries especially suitable to investigate the cross-border transmission of shocks and its implications for the finance-growth nexus. Thus, looking at the impact of financial crises on emerging countries through the lens of appropriate research designs and well funded economic theory can provide novel insights about how to achieve sustained global financial stability.[2]

This dissertation approaches this debate by unraveling specific financial mechanisms involved in the cross-border transmission of financial shocks to emerging countries via banking activities. While the focus remains on identifying these mechanisms, the four research papers comprised in the dissertation also shine a spotlight on the effect of policymakers' reactions to these shocks. These papers address four types of questions related to the transmission of the global financial crisis to emerging countries and to the policy responses triggered both locally and abroad: Does the pass-through of foreign funding shocks to lending differ between local and foreign banks? Can restrictions in internal capital markets within a country, linking a bank's headquarter and its network of branches, explain the transmission of foreign funding shocks to regional labor markets? Can banks' increasing demand

[1]Examples of this are Aiyar (2012) for the U.K., De Haas and Lelyveld (2014) for a sample of multinational banks, Frey et al. (2016) for Germany or Buch and Goldberg (2015) for a multi-country setting of industrial countries with the exception of Poland. A notable exception to this trend is posed by Ongena et al. (2015), where the transmission of the crisis to the real sector in Eastern Europe and Central Asia via banks' funding shocks is analyzed.

[2]The idea that policy lessons can be derived from emerging countries' experience during the global financial crisis is not new and has been put into the discussion, among others, by the former Chairman of the U.S. Federal Reserve Ben Bernanke or the former Governor of the Reserve Bank of India Raghuram Rajan. In particular, Rajan has highlighted how analyzing the situation of emerging countries can provide insights about the cross-border spillovers of unconventional monetary policy in the industrial world and its implications for global financial stability (see Rajan, 2013).

for liquid assets during a crisis restrict the transmission of unconventional monetary policy to the real economy? And finally, are reserve requirements an effective macroprudential tool to steer the cyclicality of credit growth? By exploring these questions, this thesis comprehensively analyses the interactions between different channels that, at the bank level, explain the transmission of the global financial crisis to emerging countries.

The general contribution of this dissertation to the literature is threefold and can be summarized as follows. First, while previous studies analyze banks' foreign funding exposure and foreign ownership separately (e.g. Cetorelli and Goldberg, 2011; Schnabl, 2012), this dissertation shows that the interaction between foreign funding shocks and foreign ownership is crucial to understand the cross-border transmission of funding shocks. Second, even though some evidence of the real effects of cross-border financial shocks exists, papers have relied on indirect measures of foreign funding shocks and have assumed frictions in global banks' internal capital markets as the key driver of the crisis' transmission (e.g. Popov and Udell, 2012; Ongena et al., 2015). This dissertation shows that the real economic effects of foreign funding shocks can also be driven by frictions in local internal capital markets used by regional bank branches to obtain funding from within the banking conglomerates they belong to. This means that the degree of market incompleteness of branches' funding, in the form of a lack of alternative funding sources, can explain the transmission of shocks at the headquarter level to regional credit markets, a transmission channel that has not been addressed in the literature before. Finally, the evaluation of different policy interventions during the crisis reports consistent evidence of these internal capital market frictions affecting the pass-through of policy decisions to the real economy. Despite of growing contributions in this field, the implications of this specific channel for the effectiveness of policy interventions in the banking sector has not been addressed yet (see for instance Chodorow-Reich, 2014a; Carpinelli and Crosignani, 2015).

Addressing the research questions of this dissertation requires observing bank and branch-level data with a high degree of granularity and frequency over a long period of time. This type of data for emerging countries has not been available to researchers yet, probably explaining the literature's reliance on either macroeconomic data or consolidated data from industrial countries. These data is especially important considering the focus of the dissertation on heterogeneous distributional effects of funding and regulatory shocks across different banks and jurisdictions. I addressed this difficulty by creating a novel data set, called the IWH Latin American Banking Database. This data set is based on bank-level data hand-collected from regulatory call reports in four Latin American countries: Brazil, Chile, Colombia and Peru. While Chapter 2 is based on monthly data from this multi-country setting, Chapters 3 to 5 are based on an extension of the Brazilian data that links balance-sheet information at the bank-headquarter level with similar data at the level of individual regional branches of these banks. These data, combined with established microeconometric approaches in the empirical banking literature (e.g. Khwaja and Mian, 2008; Schnabl, 2012), provides a rich laboratory to investigate the distributional effects of the crisis. Moreover, it also allows exploring the spillovers of several local and foreign policy interventions implemented to cope with the dry-up of banks' liquidity. Setting up this database and making it available for researchers is also a central contribution of this dissertation.

This dissertation begins in Chapter 2 with the paper entitled "Foreign funding shocks and the lending channel: Do foreign banks adjust differently?", which is co-authored with Felix Noth from the Halle Institute for Economic Research. The paper addresses the question whether the pass-through of foreign funding shocks to local credit supply is homogeneous across domestic and foreign banks. We conjecture that foreign ownership proxies for differences in banks' funding structure and in particular for foreign banks' reliance on internal funding from their bank holding companies abroad. Foreign funding shocks and foreign ownership have been mainly analyzed as two separate channels of financial contagion in "horse race" settings (e.g. Ongena et al., 2015). In opposite to this approach, we compare the extent of the transmission of foreign funding shocks to local credit supply by domestic and foreign-owned banks. We argue that foreign funding relationships might differ between domestic and foreign-owned banks due to foreign banks' exposure to liquidity allocation within the multinational banking conglomerate they belong to. This distinctive feature of foreign-owned banks implies a degree of market incompleteness that can boost the pass-through of foreign funding shocks to local lending in comparison to similarly shock-affected domestic banks.

By exploiting the collapse of Lehmann Brothers in September 2008 as a cut-off to define pre- and post-crisis periods, we find that foreign funding shocks in the crisis translated into restrictions in local credit supply in the four countries considered for the analysis: Brazil, Chile, Colombia and Peru. Moreover, we find that this lending channel of foreign funding shocks was stronger for foreign banks. The paper presents evidence in line with the idea that the different nature of foreign funding accessed by foreign and domestic banks drives the results. In particular, foreign banks report generally a higher volatility of foreign funding growth, whereas the size and length of foreign funding shocks during the crisis are significantly larger for this group. The paper's results, which are robust to different identification approaches, imply that the nature of foreign funding in general and the characteristics of foreign funding shocks in particular differ between foreign and local banks. If, as documented here, banks' organizational and financial structure matters for the cross-border transmission of shocks, then countries might benefit from enhancing the coordination of their regulatory and supervisory mechanisms, as it is carefully discussed in the chapter's conclusion.

Chapter 3 corresponds to the second paper included in this dissertation, which is entitled "Banking globalization, local lending and labor market effects: Micro-level evidence from Brazil" and is also co-authored with Felix Noth. This paper extends the analysis discussed in Chapter 2 by asking whether frictions in internal capital markets between a bank's headquarter and its regional branches can affect the transmission of foreign funding shocks to local credit supply. Instead of focusing on aggregate effects of shocks on the real economy, the paper makes its major contribution by tracing the shocks' transmission to the level of regional credit and labor markets in Brazilian municipalities. Narrowing-down the geographical and organizational level at which the effect of a funding shock is observed, permits us to address numerous identification challenges and to further explore the nonlinear components of the transmission of shocks introduced in Chapter 2. The research design in this paper has several advantages. First, it allows avoiding concerns about the endogeneity of funding shocks by tracing the effect of shocks at the level of banks headquarters on credit supply at the level of individual regional bank branches, each of them representing only a marginal share of their banking conglomerates. Second, defining Brazilian municipalities as the relevant market allows controlling for credit demand for all individual branches operating in each region, so that the results focus on the supply-side adjustment driven by the crisis. Finally, this study shows that frictions in local internal capital markets together with specific fragilities in regional credit markets, such as the historical procyclicality of credit growth, can explain the extent of the real effects of foreign funding shocks.

The results show robust evidence of a cross-regional transmission of foreign funding shocks affecting bank headquarters in Brazil during the global financial crisis. In line with our hypothesis, we find that this effect is augmented by branches' pre-shock reliance on internal funding from their headquarters. The baseline setting is further extended in order to explore the interactions between foreign funding shocks and the performance of foreign bank holding companies (FBHC) headquartered abroad. To this respect, we first find that the baseline transmission effect is stronger for foreign-owned banks. This confirms our analysis at the bank-country level as discussed in Chapter 2. Then, by restricting the sample to foreign banks, we find that the extent of the local transmission of the foreign funding shock is conditional on the capital and liquidity adjustments of the FBHCs during the crisis. We also find that FBHCs access to the Term Auction Facility (TAF) program in the U.S. reduces the local effect of shocks. The novelty of this approach is that it introduces a third layer into the analysis: While frictions between local headquarters and branches are still driving the results, there is also a role for frictions in the internal capital markets between a FBHC and its Brazilian subsidiary.

Even in the presence of a lending channel of foreign funding shocks, borrowers can still compensate for the negative credit-supply shock by substituting away from their credit sources. We therefore exploit the regional structure in the data to investigate whether supply-side credit shocks by individual branches translate into adverse real economic outcomes at the municipality level. We find that municipalities that are more exposed to a foreign funding shock exhibit lower aggregated credit growth after September 2008. This aggregate effect of individual shocks translates into weaker GDP and (net) job creation growth during the crisis. Moreover, municipalities with a large historical correlation between credit and job creation growth —a proxy for the procyclicality of credit growth— suffer from a stronger transmission of the funding shock to the real economy. The policy implications of these findings are threefold. First, we present a novel rationale for the transmission of funding shocks in emerging countries, based on the interaction of global and local frictions in banks' internal capital markets. Therefore, central bank liquidity interventions during crisis should aim at effectively oiling the wheels of cross-regional internal capital markets. Second, the results on the cross-border effects of the TAF program confirm that a strong international coordination of unconventional monetary interventions is needed. Finally, improving the supervision of regional credit markets can provide a wider policy toolbox to cope with aggregate disruptions in banks' funding.

Chapter 4 is based on a third research paper entitled "Banks closing their water gates? Liquidity adjustments to interbank shocks and the role of central bank interventions", which is a single-author paper. Using the same data setting as in Chapter 3, this paper investigates whether idiosyncratic shocks to interbank funding at the level of banks' headquarters occurred during the global financial crisis lead regional bank branches to increase their demand for liquid assets. This reaction, referred to in the literature as liquidity hoarding, is considered a precautionary reaction by banks when an increasing fear of exclusion from funding markets exists. I test the hypothesis that idiosyncratic shocks at the headquarter level can trigger liquidity hoarding by branches, ultimately affecting branches' lending supply and, more generally, the pass-through of unconventional liquidity interventions by the Brazilian Central Bank. This paper contributes to the literature on liquidity hoarding and on the effectiveness of unconventional monetary policy in the following ways: first, in opposite to previous studies, the paper highlights that granular interbank funding shocks can be an important driver of financial contagion, even if interbank markets are well funded in the aggregate. Second, the paper presents frictions in internal capital markets as a novel rationale to understand liquidity hoarding reactions within banking networks. Third, the paper claims that liquidity hoarding can be an important obstacle for the pass-through of unconventional monetary policy to credit markets.

A further novelty of this paper is that it combines different macro- and microeconomic methodologies in order to create a setting that allows investigating the research question. This approach is based on three building blocks. First, an algorithm adapted from the macroeconomic literature is used to pin down specific dates around the global financial crisis at which Brazilian bank headquarters are affected by idiosyncratic interbank funding shocks. A special characteristic of this analysis is that the shocks are identified in a context where no aggregate dry-ups in interbank liquidity occur, allowing me to distinguish between banks affected and not by funding shocks. Then, the post-shock behavior of branches from affected and unaffected banks is compared over an event-timeline by simultaneously controlling for headquarter and branch traits along with a battery of fixed effects. Conducting the analysis on a virtual timeline by simultaneously controlling for actual date developments implies that numerous identification challenges can be addressed. Finally, I develop an index that proxies for the extent of banks' access to unconventional liquidity interventions by the central bank during the crisis. I use this index to investigate whether liquidity hoarding affects the pass-through of central bank interventions to credit supply by carefully addressing the natural endogeneity of banks' access to these liquidity facilities.

The paper provides robust evidence of liquidity hoarding by bank branches together with negative spillover effects on credit supply. However, notable heterogeneous effects arise depending on branches' ex-ante liquidity risk exposures. For instance, branches with a higher ex ante leverage vis-à-vis their headquarter banks, as well as those with a generally higher funding concentration, report a stronger liquidity hoarding reaction to funding shocks. These branches also restrict their credit supply by more than other affected branches. While I find that the access to central bank liquidity relative to shocks is effective in restoring credit growth, a significant part of this assistance is stored by branches in the form of cash and bank deposit holdings. In particular, one unit of central bank liquidity is symmetrically divided into higher credit growth and higher liquid assets growth. Two main policy implications can be derived from these findings. First, the granular dimensions of interbank markets matter. Distributional shocks, like the ones investigated in this paper, should be tackled with well targeted interventions considering the specificities of banks' funding risks. Second, while the findings support the effectiveness of unconventional monetary policy, central banks could complement their liquidity interventions with policies aiming at underpinning banks' liquidity buffers and strengthen branches funding structure locally. Financial inclusion policies in emerging countries together with the adoption of liquidity rules like the ones proposed in Basel III are examples that point into this direction.

The dissertation is completed in Chapter 5 with a paper entitled "Macroprudential instruments and intra-group dynamics: The effects of reserve requirements in Brazil". This paper is co-authored with Chris Jürschik and Lena Tonzer from the Halle Institute for Economic Research. The analysis in this chapter seeks to unravel the transmission of a particular type of macroprudential instruments —banks reserve requirements— between banks headquarters and their network of local branches in Brazil. In particular, we ask whether, conditional on the state of monetary policy, changes in reserve requirements lead branches from banks more reliant on deposit funding to adjust their lending supply by more than other branches. This paper contributes to a growing literature assessing the effect of macroprudential policies in three ways: First, we investigate how intra-group dynamics affect the transmission of regulatory shocks. Second, we carefully address the interactions between changes in reserve requirements and other conventional monetary policy decisions taking place during the sample period. Finally, we look at the whole regulatory cycle including both increases and decreases in reserve requirements around the global financial crisis. This allows exploring whether macroprudential policies can effectively handle credit cycles both in times of boom and financial distress. While the first chapters of the dissertation explore the role of banking globalization by analyzing funding shocks driven by the crisis, this chapter evaluates a macroprudential policy aimed at steering the transmission of global credit cycles into local economies.

The debate on the importance and effectiveness of macroprudential policies has been an important part of the post-crisis discussion about global regulatory reforms in the financial sector. Initiatives such as the Banking Union in Europe or the introduction of new capital and liquidity requirements in Basel III reflect this debate. Despite of the novelty of many of these policies in the industrial world, emerging countries have a long history of dealing with macroprudential frameworks from which lessons can be learned. Reserve requirements are typically defined as a share of demandable deposits that banks have to compulsory store at the central bank. While reserve requirements exist also in many industrial countries, analyzing their transmission to credit markets in an emerging country has at least two central advantages. First, reserve requirements in industrial countries are unlikely to be binding, considering their relatively low level and the large availability of non-deposit funding compared to emerging countries.[3]

[3]For example while Brazil had a reserve requirement of 45% of deposits as of 2015, they were set at 1% in the Euro Zone and at 3% to 10% in the U.S. in the same year. Other countries like the U.K. and Sweden do not operate with reserve requirements.

Second, while reserve requirements have been only infrequently adjusted in industrial countries, they are actively managed in emerging countries, which was also the case of Brazil during the global financial crisis.

We find evidence that changes in reserve requirements induce a reallocation of liquidity within banking groups that ultimately affects credit supply by individual bank branches. In particular, increasing reserve requirements restrict banks' available funding and negatively affect lending growth. Importantly, this effect is driven by headquarter banks with a large reliance on deposit funding subjected to reserve requirements. This suggests that under binding constraints in banks' funding structure, reserve requirements can be an effective tool to steer credit growth by influencing banks' internal liquidity dynamics. While the effect of reserve requirement is stronger for domestic compared to foreign banks, we do not find evidence of interactions with monetary policy decisions affecting the results. Two central policy lessons can be derived from these results. First, the effectiveness of macroprudential policies crucially depends on whether policies induce binding constraints to a bank's balance sheet or not. Macroprudential policies might therefore better work within a more general policy framework in which the heterogeneity of banks' funding structures is taken into account. Second, our findings imply that the lending channel of changes in reserve requirements operates independently from the lending channel of monetary policy. This means that, for instance, the negative effect of increasing reserve requirements on credit supply is not reinforced by simultaneous increases in the monetary policy rate. For emerging countries, in which banks' reliance on wholesale funding is smaller, our results entail that reserve requirements can improve the strength of monetary policy actions by targeting banks relatively less exposed to conventional monetary policy.

The dissertation is structured as follows. Chapters 2 to 5 represent the four research papers that conform the main part of the dissertation. Complementing the general contribution of the dissertation outlined in this introduction, each chapter carefully addresses its individual contribution to the literature. Chapter 6 concludes.

Chapter 2

Foreign funding shocks and the lending channel: Do foreign banks adjust differently?

Abstract: *We document for a set of Latin American emerging countries that the different nature of foreign funding accessed by foreign and local banks affected their lending performance after September 2008. We show that lending growth was weaker for shock-affected foreign banks compared to shock-affected local banks. This evidence represents valuable policy information for regulators concerned with the stability and well-functioning of banking sectors.*[*]

2.1 Introduction

A noteworthy aspect of the recent financial crisis was the role played by banks' foreign funding exposures in shaping the cross-border transmission of shocks. The liquidity crunch in global interbank markets chocked off banks' ability to access foreign funding, increasing financial fragility and transmitting the crisis to local credit markets (Cetorelli and Goldberg, 2011; Ongena et al., 2015). However, little is known about how the spreading of the crisis via foreign funding shocks varied with banks' foreign ownership. The nature of foreign funding relationships might differ between local and foreign-owned banks due to foreign banks' access to intrabank liquidity allocation within

[*]This paper is co-authored by *Felix Noth*, Otto-von-Guericke University Magdeburg and Halle Institute for Economic Research, Member of the Leibniz Association. Contact: *felix.noth@iwh-halle.de*. A version of this chapter has been published in *Finance Research Letters* as: Noth, Felix and Ossandon Busch, Matias (2016): Foreign funding shocks and the lending channel: Do foreign banks adjust differently? *Finance Research Letters*, 47(41), 4364–4376.

multinational banks. This could lead to different counterparty information asymmetries, which in turn can affect the characteristics of shocks in the context of global financial distress. We employ a novel bank-level data to investigate whether the effect of foreign funding shocks on local lending in the aftermath of the crisis differed along the foreign-ownership dimension in a group of emerging countries.

Previous literature has separately addressed the role of foreign funding shocks and foreign ownership in transmitting financial shocks. Aiyar (2012) documents that foreign funding shocks translated into lending restrictions during the crisis in the U.K. More generally, Peek and Rosengren (1997) and Schnabl (2012) show that in different crisis episodes foreign banks have served as transmission vectors between banking systems. The relevance of intrabank capital markets for financial contagion has been stressed by De Haas and Lelyveld (2010), who link the performance of parent banks with the one of their network of affiliates abroad. Cetorelli and Goldberg (2011) show that during the global financial crisis, intrabank capital markets were behind the transmission of shocks to countries hosting foreign banks.

We contribute to the literature by exploring the effect of foreign funding shocks on lending along the foreign-ownership dimension. Moreover, the paper presents to the best of our knowledge the first documentation of the transmission of bank-specific foreign funding shocks in emerging countries triggered by the crisis of 2008-09.

2.2 Data and descriptive evidence

To evaluate whether the pass-through of foreign funding shocks to local lending differed by banks' foreign ownership we use bank-level data reported on a monthly basis between January 2006 and January 2012 including all banks in four Latin American countries for which the crisis aroused exogenously: Brazil, Chile, Colombia and Peru. These countries share a similar regulatory framework, including partial ring-fencing policies for foreign banks. We exploit the fact that compared to other regions, foreign banks in Latin America behave much more like local banks, issuing credit in domestic currency and funding themselves primarily with local deposits (Kamil and Rai, 2010). The data comes from banks' call reports reported by local regulatory authorities. We identify the foreign owners using information from Claessens and Van Horen (2014) and banks' websites. To ensure consistency we convert all data to real December-2013 US$ millions.

We restrict the sample to banks without missing values in foreign liabilities during the sample period. To compute bank-specific foreign funding shocks we define a crisis period from January 2008 to March 2009, the period where credit market volatility in the sample jumps compared to the pre-crisis period. To account for the size of shocks relative to banks' balance sheets we first compute foreign funding growth as the 12-month change in foreign liabilities divided by 12-month lagged total assets. Shock-affected banks are defined as those reporting a crisis-average foreign funding growth below the respective country's sample medians. The sample includes 71 banks, out of which 34 were affected by a shock and 29 were foreign-owned. On average these banks represent 54% of total bank assets in the original sample.[1]

Figure 2.1 provides a graphical inspection and displays monthly averages of changes in (log) outstanding credit with respect to August 2008, the last pre-Lehman observation. Panel A reveals no clear changes in the difference in lending growth between shock-affected and unaffected banks when comparing the pre- and post-crisis periods. Panel B displays lending growth by banks' foreign and local ownership for the subsample of non-shocked banks, without suggesting any clear difference in the lending pattern of both groups. Finally Panel C replicates the latter exercise for the reduced sample of shock-affected banks. It evidences a divergence in lending growth between local and foreign banks in the aftermath of the crisis, in line with our hypothesis.

[1] The final sample represents 53.5% of total assets in Brazil, 89.7% in Chile, 73.3% in Colombia and 58.5% in Peru.

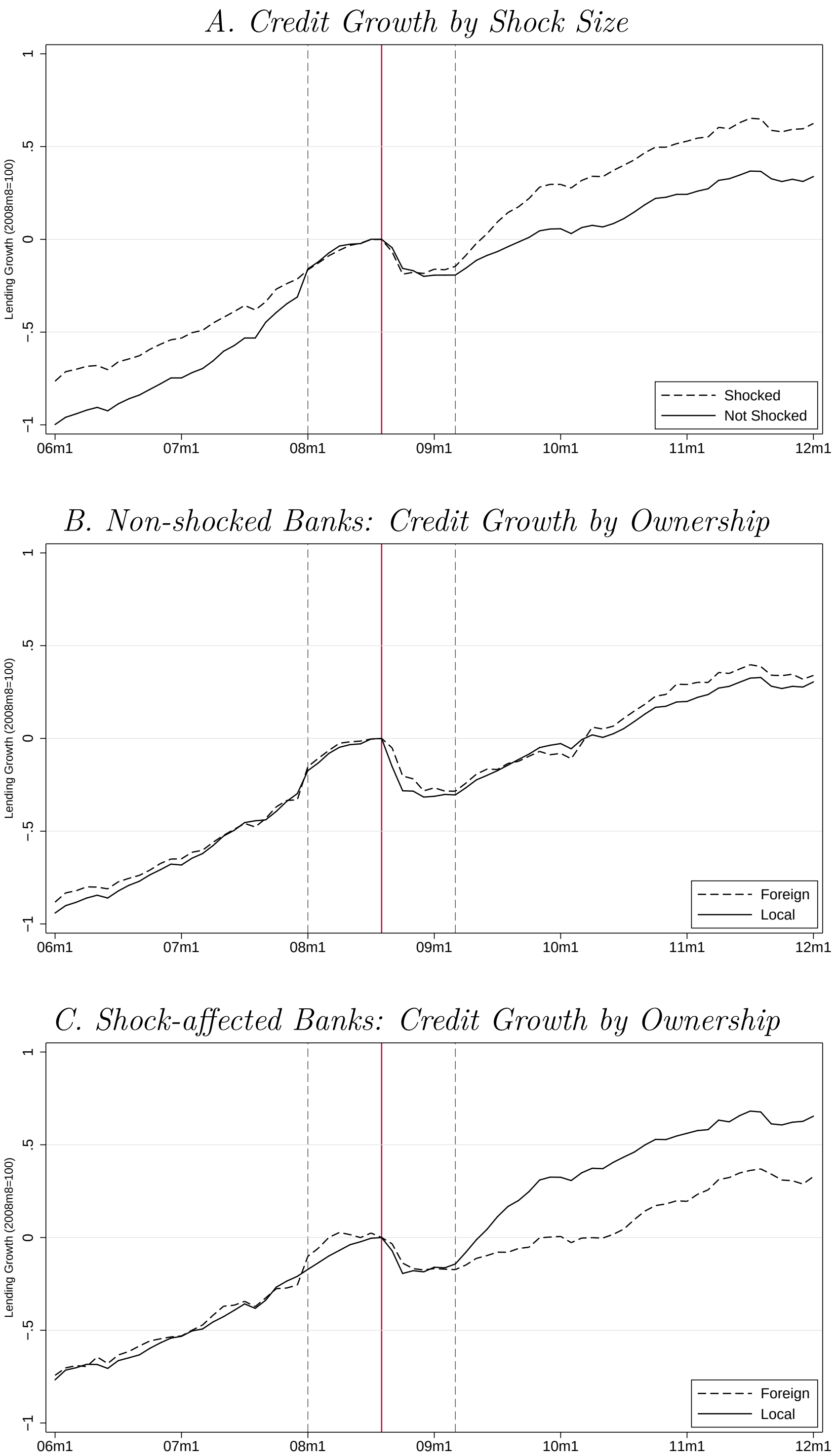

Figure 2.1: Non-parametric Analysis. Proportional change in (log) outstanding credit with respect to August 2008. Panel A displays aggregated credit growth by all banks in the sample distinguishing between shock-affected and non-shocked banks. Panel B displays lending growth for the subsample of non-shocked banks splitting the sample by banks ownership, whereas Panel C replicates the same exercise for the subsample of shock-affected banks.

2.3 Methodology

We test whether shock-affected foreign banks exhibited a different lending performance than shock-affected local banks in the aftermath of the crisis compared to the pre-crisis period. The pre-crisis period covers the months from January 2006 to December 2007, whereas the post-crisis period is defined from April 2009 to January 2012. This approach allows us to timely differentiate between the period when the shock occurs and the one where outcomes are observed. Lending growth is defined as the 3-month change in outstanding credit divided by 3-month-lagged total assets.

Panel A in Table 2.1 shows that the nature of foreign funding accessed by local and foreign banks differed in the pre-crisis period. Foreign-owned banks report on average a larger foreign funding ratio and a larger volatility of foreign funding growth than local banks. Moreover foreign-owned banks experienced shocks that were larger in size and longer in terms of duration during the crisis.

Panels B and C test for the statistical significance of the observations made in Figure 2.1. We compute a non-parametrical difference-in-difference estimator of the effect of foreign ownership on lending growth for the subsamples of non-shocked banks (Panel B) and shock-affected banks (Panel C). Panel B, which focuses on the subample of non-shocked banks, shows no significant differences in lending growth by banks' ownership in the post-crisis period compared to the pre-crisis period.

Conversely, Panel C shows that within the subsample of shock-affected banks there was a differential effect of foreign ownership on lending in the post-crisis period compared to the pre-crisis period: foreign banks reduced their lending growth by 0.99 percentage points more than local banks in the post-crisis period. This findings should alleviate concerns about a bias stemming from different ex-ante characteristics between shock-affected and non-affected banks that might explain their adjustments after September 2008.

To formally verify the preliminary findings from Figure 2.1 and Table 2.1

TABLE 2.1: Descriptive statistics and non-parametric analysis.

	A: Foreign funding characteristics by banks' ownership			
	Foreign	Local	Dif.	t-stat.
$FF/Asset$ (%)	4.63	2.40	2.23	13.51
FF Volatility (%)	2.98	1.54	1.43	16.09
Shock Size (%)	2.32	1.58	0.74	8.89
Shock Lenght	3.83	3.12	0.71	6.27

	B: Average lending growth by non-shocked banks				C: Average lending growth by shock-affected banks			
	Foreign	Local	Dif.	t-stat.	Foreign	Local	Dif.	t-stat.
Pre−crisis	1.37	2.29	−0.92	−4.71	1.28	1.43	−0.15	−0.82
Post−crisis	1.37	2.10	−0.74	−3.32	1.02	2.16	−0.15	−0.82
Post−Pre	0.00	−0.19	0.19	0.61	−0.26	0.73	−0.99	−3.23

Notes: This table displays, on Panel A, average characteristics of foreign funding (FF) and foreign funding shocks by banks' ownership. FF ratio and FF volatility are computed as pre-crisis averages. FF volatility is defined as the standard deviation of average 12-month FF growth rate during the pre-crisis period. Shock size is defined as the (negative) average 12-month growth rate of FF during the crisis period. Shock lenght represents the average number of months during the crisis period where the 12-month FF growth rate remains negative. Panels B and C report the results of comparing average lending growth by foreign and local banks within the samples of non-shocked banks (Panel B) and shock-affected banks (Panel C). Averages are computed by collapsing the data for a pre- and a post-crisis period. The first one is defined between January 2006 and December 2007, while the post-crisis period goes from April 2009 to January 2012. All variables are winsorized at the 1st and 99th percentiles.

we estimate the model described in Equation (2.1), in which lending growth depends on a post-crisis indicator, the foreign funding shock identifier and a foreign-ownership dummy:

$$\frac{\Delta Credit_{i,t}}{Assets_{i,t-3}} = \beta_1 \left[Post_t \times Shock_i \times Foreign_i\right] + \beta_2 \left[Post_t \times Shock_i\right] + \beta_3 \left[Post_t \times Foreign_i\right] + \beta' Bank_{i,t} + \gamma_i + \tau_t + \varepsilon_{i,t} \quad (2.1)$$

We are interested in the triple interaction coefficient β_1 that indicates differences between shock-affected banks over the crisis along the ownership dimension. The estimation includes a set of bank and time fixed effects and a vector of bank-specific control variables $Bank_{i,t}$ (liquidity/assets ratio, capital/assets ratio and banks' total assets in log US$ billions). To control for demand effects we follow Aiyar (2012) and calculate for each bank i the change in credit demand as $\sum_{j \varepsilon J} s_{ij} \Delta TBL_J$, where ΔTBL_J is the 3-month growth rate in credit in sector j by all banks in a given country except bank i and s_{ij} represents the share of sector j in bank's i credit portfolio. To

Table 2.2: Regression Results.

	(1) Panel	(2) Matching	(3) Collapsed	(4) Placebo
Post × Shock × Foreign	−1.157**	−1.255**	−1.034*	−2.222
	(0.584)	(0.604)	(0.582)	(1.627)
Post	0.129	0.242	−0.396	6.777***
	(0.570)	(0.595)	(0.321)	(1.899)
Post × Shock	0.863**	0.857**	0.920**	0.135
	(0.376)	(0.386)	(0.411)	(0.876)
Post × Foreign	0.149	0.250	0.120	0.421
	(0.307)	(0.346)	(0.286)	(1.210)
Credit Demand	0.000	0.000	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity/Assets	−0.022	−0.024	0.133	−0.092
	(0.029)	(0.029)	(0.127)	(0.077)
Capital/Assets	−0.010	−0.053	0.180	0.495
	(0.100)	(0.117)	(0.122)	(0.317)
Log Total Assets	−0.271	−0.322*	0.302	3.286
	(0.199)	(0.191)	(0.339)	(2.218)
Observations	4094	3875	142	1751
R-squared	0.407	0.405	0.914	0.317

Notes: This table shows estimates of Equation (2.1) for different specifications. Column 1 reports the baseline results from the panel estimation. Column 2 estimates the results using a propensity score matching model in which banks are matched by their propensity of experiencing a foreign funding shock. Column 3 replicates the baseline regression by collapsing the time dimension by taking averages for each variable for the pre- and post-crisis periods. Column 4 reports the results estimating Equation (2.1) with the pre-crisis period defined between January 2006 and December 2006 and the post-crisis period defined between January 2007 and December 2007. Regressions include bank and time fixed-effects, standard errors are clustered at the bank level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

compute ΔTBL_J we rely on sectoral data on commercial, consumer and mortgage loans. We ensure consistency by clustering standard errors at the bank level.

2.4 Empirical results

Table 2.2 presents the regression results. The baseline specification in column (1) confirms our previous findings from Table 2.1, reporting a negative differential effect of foreign funding shocks on lending for foreign-owned banks. Shock-affected foreign banks report a 1.2 percentage points lower average lending growth than local affected banks when comparing the pre- and post-crisis periods.

A natural concern with our baseline estimates is the fact that the size of the shock is unlikely to be randomly assigned across banks. As we reported on Table 2.1 foreign banks are, for instance, reporting different ex-ante characteristics of their foreign funding compared to local banks. To verify that the results are in fact driven by the foreign funding shock itself we estimate a propensity score matching estimation in which banks are matched according to the size of the shock.[2] The results from this estimation are reported in Column (2) showing that our main results remain intact.

Column 3 confirms our results by collapsing the panel using averages for all variables in the respective pre- and post-crisis periods to account for serial correlation concerns (Bertrand et al., 2004). Although the coefficient for β_1 becomes somewhat smaller in size than in the baseline estimation, it is still significant at the 10% level. Column 4 reports the results of running a placebo test for Equation (2.1) in which we define a pre-crisis period between January 2006 and December 2006, whereas the virtual post-crisis period is set between January 2007 and December 2007. Column 3 shows that the coefficient for β_1 is not statistically significant, as we expected.

In further extensions we change the definition of shock-affected banks to those banks with an average growth in foreign liabilities during the crisis below the 25th percentile of the respective country distributions. This analysis confirms that our baseline results are driven by banks affected by large negative foreign funding shocks. We also change the definition of the shock itself by computing it as the growth rate of foreign liabilities between August 2008 and March 2009. This analysis also confirms our main findings. Finally we estimate the baseline model for the country-specific subsamples. Even though our main findings remain unchanged, we do find differences in the size of the triple interaction coefficient across countries: while the effect is stronger for Colombia and Peru, it is less so for Chile and Brazil. These results are reported in Appendix A.

[2]For this exercise we rely on a one-to-one nearest neighbor matching approach, which reduces the sample size from 71 to 70 banks.

2.5 Conclusion

Using a novel micro bank-level data set for Brazil, Chile, Colombia and Peru we found that post-crisis lending growth was weaker for shock-affected foreign banks compared to affected local banks. Our results suggest that the nature of foreign funding in general and the characteristics of foreign funding shocks in particular differ between foreign and local banks, triggering differential effects on lending when a shock strikes.

All in all, this result indicates that the extent of the local consequences of an interruption in global interbank markets can be related to the organizational and financial structure of banks. The role of foreign banks in transmitting the foreign funding shock documented here, implies that countries might benefit from a more effective coordination of their regulatory and supervisory mechanisms. This coordination might take the form of wider burden-sharing agreements on the fiscal cost of banking resolution and ex-ante arrangements between central banks on large-scale foreign exchange swap lines in the spirit of the US dollar swaps between the US Fed and a number of central banks implemented in late 2008.

Moreover countries might benefit from coordinated prudential limits on foreign wholesale funding, which could reduce banks' funding risk while limiting the possibility of cross-border regulatory arbitrage. Finally, an effective coordination of banking supervision can prevent countries from imposing full ring-fencing policies on foreign banks. Full ring-fencing policies could end up increasing foreign banks' funding cost and impeding global banks from efficiently allocating capital and liquidity worldwide, hampering the benefits of global financial integration.

Appendix A

This appendix provides further details on the data and results. The first part of the appendix describes the construction of the data set used in the paper, specifying the data sources and the adjustments made to the raw data. The second part reports complementary tables and figures that were not included in the article. This second part also presents the results of robustness tests mentioned in the paper.

A.I Data construction

Bank-level data was retrieved from banks' call reports collected and published by regulatory authorities in Brazil, Chile, Colombia and Peru. This data set consists of information on banks' balance sheets and income statements on a monthly basis reported in local currency. The data was downloaded from the websites of the Brazilian Central Bank, the Chilean "Superintendencia de Bancos e Instituticiones Financieras"(Banking and Financial Institutions Superintendency), the Colombian "Superintendencia Financiera de Colombia" (Colombian Financial Superintendency) and the Peruvian "Superintendencia de Banca y Seguros" (Banking and Insurance Superintendency). After downloading the information the data was adjusted and merged taking into account the consistency in the own countries' definition of the variables needed for the analysis. Mandatory reporting by banks ensures a comprehensive coverage of all financial institutions holding a banking license in the respective countries.

To account for valuation effects and to facilitate interpreting the information we converted the data from its original definition in nominal local currency to real December-2013 millions of U.S. dollars. For this purpose end-of-month data on the respective exchange rates was collected from the website of the Federal Reserve Bank of St. Louis. From the same source we obtained end-of-month inflation data for the U.S. This data was used to compute a Dollar deflator where 100% is set at December 2013. All the variables in the paper were converted using this deflator.

TABLE A.I: Summary descriptive statistics.

	Obs.	Mean	p50	S.D.	Min	Max
Lending Growth (%)	4094	1.675	0.575	3.281	−7.989	47.453
Local Banks	2424	1.932	0.793	3.455	−6.716	47.453
Foreign Banks	1670	1.300	0.348	2.971	−7.989	20.335
Shock Size (%)	4094	1.861	0.430	2.940	−1.398	11.414
Local Banks	2424	1.552	0.206	2.854	−0.888	11.148
Foreign Banks	1670	2.311	1.020	3.006	−1.398	11.414
Total Assets (log US$ bill.)	4094	2.612	2.484	1.970	−1.956	7.696
Local Banks	2424	3.038	2.766	2.024	−1.476	7.696
Foreign Banks	1670	1.994	2.051	1.709	−1.956	6.408
Liquidity (% of total assets)	4094	3.796	0.284	6.279	0.000	53.347
Local Banks	2424	3.567	0.263	5.563	0.000	34.740
Foreign Banks	1670	4.129	0.301	7.181	0.000	53.347
Capital (% of total assets)	4094	5.628	4.796	4.342	0.083	26.549
Local Banks	2424	5.231	4.206	4.108	0.083	19.579
Foreign Banks	1670	6.206	5.617	4.602	0.187	26.549

Notes: The table reports descriptive statistics on the main variables used in the analysis. Variables are defined in Table A.I.

The original data was extended by including information on banks' ownership status. This latter set of information was collected from banks' websites and from the Claessens and Van Horen (2014) Banks Ownership Database.

A.II Complementary tables and figures

This section provides complementary information on the structure of the data set and the paper's main findings.

Table A.I reports summary statistics on the variables used in the analysis. For each variable the statistics for the subsamples of local and foreign banks are also reported. The summary statistics are retrieved from the panel sample used for the baseline estimation showed in the first column of Table 2.2 in the paper. Table A.I shows that on average foreign banks are better capitalized and held a larger liquidity ratio than their local peers. Moreover local banks tend to be larger in terms of the size if their balance sheets than foreign ones. The comparison of the variables' means and medians shows that the respective variable distrubutions are relatively skewed even after winsorizing the sample at the 1st and 99th percentiles.

Table A.II shows the number of banks included in the sample and in the different groups included in the analysis. Out of a total sample of 71 banks, 34 were affected by a relatively large negative shock in foreign liabilities.

Table A.II: Number of banks by subsample.

	Foreign	Local	Total
Shock-affected	11	23	34
Non-affected	18	19	37
Total	29	42	71

Notes: The table reports the number of banks included in the sample distinguishing between foreign and local banks as well as between shock-affected and non-affected banks.

This latter group can be further divided into 11 foreign banks and 23 local banks.

Table A.III: Preliminary regressions.

	(1) Non-affected	(2) Shock Affected
PostXForeign	0.194	−0.998***
	(0.267)	(0.254)
Post	−0.196	0.727***
	(0.186)	(0.144)
Foreign	−0.929	−0.141
	(0.613)	(0.685)
Obs.	2134	1960
R-squared	0.052	0.041

Notes: The table reports the results of a difference-in-difference estimator for the subsample of banks that were not affected (column 1) and affected (column 2) by a foreign funding shock.

Table A.III replicates parametrically the results reported in Table 2.1 in the paper concerning a difference-in-difference estimation of the effect of foreign ownership after vs. before the crisis for the subsamples of non-affected banks and shocked-affected banks. As in the paper, it shows that the differential effect of foreign ownership on credit growth after the crisis compared to the pre-crisis period emerges only within the subsample of shock-affected banks.

Table A.IV shows the regressions' results including extensions not reported in the paper. Columns (1) to (3) replicate the results of Table 2.2 in the paper reporting the estimated coefficients for all control variables. Column (4) reports the results of including only the main variables of interest without any fixed-effects. Column (5) further includes the credit-demand control whereas Column (6) incorporates the rest of the control variables.

TABLE A.IV: Robustness tests.

	Panel (1)	Collapsed (2)	Placebo (3)	Panel (4)	Panel (5)	Panel (6)	p25 (7)	8m1-9m3 (8)
PostXShockXForeign	−1.157**	−1.034*	−2.222	−1.191**	−1.258**	−1.243**	−1.388**	−1.364**
	(0.584)	(0.582)	(1.627)	(0.582)	(0.596)	(0.601)	(0.686)	(0.548)
Post	0.129	−0.396	0.756	−0.196	−0.056	−0.039	0.239	0.258
	(0.570)	(0.321)	(0.748)	(0.224)	(0.248)	(0.215)	(0.552)	(0.552)
PostXShock	0.863**	0.920**	0.135	0.924**	0.956**	0.929**	1.682***	0.792**
	(0.376)	(0.411)	(0.876)	(0.369)	(0.382)	(0.366)	(0.587)	(0.374)
PostXForeign	0.149	0.120	0.421	0.194	0.205	0.128	−0.089	0.211
	(0.307)	(0.286)	(1.210)	(0.298)	(0.310)	(0.301)	(0.300)	(0.331)
Shock				−0.868	−0.857*	−0.706*		
				(0.612)	(0.521)	(0.405)		
Foreign				−0.929	−0.874*	−1.217**		
				(0.613)	(0.512)	(0.489)		
ShockXForeign				0.788	0.620	0.826		
				(0.890)	(0.759)	(0.703)		
Credit Demand	0.000	0.000	0.000***		0.000***	0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Liquidity/Assets	−0.022	0.133	−0.092			−0.014	−0.024	−0.020
	(0.029)	(0.127)	(0.077)			(0.022)	(0.028)	(0.028)
Capital/Assets	−0.010	0.180	0.495			0.096*	−0.032	−0.012
	(0.100)	(0.122)	(0.317)			(0.055)	(0.105)	(0.102)
Log Total Assets	−0.271	0.302	3.286			−0.221**	−0.305	−0.351*
	(0.199)	(0.339)	(2.218)			(0.099)	(0.205)	(0.196)
Bank FE	Yes	No	Yes	No	No	No	Yes	Yes
Time FE	Yes	No	Yes	No	No	No	Yes	Yes
Obs.	4094	142	1751	4094	4094	4094	4094	4094
R-squared	0.407	0.914	0.317	0.044	0.492	0.574	0.411	0.407

Notes: Standard errors are clustered at the bank level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%. Variables are defined in Table A.VII Columns 1-3 replicate the results of Table 2 in the paper reporting the full set of control variables. Column (4) reports the results of the baseline specification without fixed-effects and considering only the main variables of interest. Columns (5) and (6) further include the credit-demand control and the rest of the control variables respectively. Column (7) changes the definition of shock-affected banks by considering as such banks with an average growth in foreign liabilities during the crisis below the 25th percentile of the respective country distributions. Column (8) changes the definition of the shock by computing it as the change in foreign liabilities between August 2008 and March 2009 divided by January 2008 total assets.

In all these regressions the results remain similar in size and statistical significance compared to our baseline estimation.

Finally columns (7) and (8) report further extensions of the analysis. The results from Column (7) are derived by changing the definition of shock-affected banks by considering as such banks with an average growth in foreign liabilities during the crisis below the 25th percentile of the respective country distributions. The estimation in Column (8) changes the definition of the shock itself by computing it as the growth rate of foreign liabilities between August 2008 and March 2009 (peak-to-trough effect). These results remain in line with our main baseline findings.

Table A.V displays the results of estimating the model in Equation (2.1) by using a propensity score matching estimation. In this robustness test

TABLE A.V: Propensity score matching estimation.

	Non-Affected (1)	Shock-Affected (2)	Baseline (3)	Controls (4)	Collapsed (5)
PostXShockXForeign			−1.516**	−1.546**	−1.093*
			(0.724)	(0.730)	(0.662)
Post	−0.150	1.156**	−0.150	−0.010	−0.406
	(0.225)	(0.491)	(0.223)	(0.213)	(0.323)
PostXShock			1.306**	1.249**	1.059**
			(0.535)	(0.548)	(0.507)
PostXForeign	0.085	−1.431**	0.085	0.046	0.110
	(0.318)	(0.657)	(0.315)	(0.299)	(0.301)
Credit Demand				0.000	0.000
				(0.000)	(0.000)
Liquidity/Assets				−0.016	0.129
				(0.030)	(0.125)
Capital/Assets				0.079	0.190
				(0.089)	(0.130)
Log Total Assets				−0.437	0.392
				(0.286)	(0.536)
Obs.	1930	1945	3875	3875	140
R-squared	0.042	0.021	0.404	0.405	0.912

Notes: This table shows estimates of Equation (2.1) obtained after weighting banks by their propensity score. The propensity score is computed from a probit regression and indicates the probability of a given bank facing a negative foreign funding shock conditional on the foreign ownership dummy and the rest of the control variables described in the paper. Columns (1) and (2) report the results for the subsamples of non-affected banks and shock-affected banks respectively. Column (3) presents a baseline full sample estimation whereas Column (4) includes the full set of control variables. Column (5) replicates the results by collapsing the time dimension into pre- and post-crisis averages for all the variables of interest. Regressions reported in columns (3) to (5) include bank and time fixed-effects, standard errors are clustered at the bank level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

banks are matched according to their probability of being affected by a foreign funding shock conditional on the foreign ownership dummy and the bank traits included as control variables in the baseline regressions. For this purpose we rely on a nearest-neighbor matching where banks are matched in a one to one fashion. This causes the sample to be reduced from 71 banks to 70 banks. Columns (1) and (2) replicate the preliminary difference-in-difference estimation reported in Table 2.1 in the paper for the subsamples of non-affected banks and shock-affected banks respectively. As in the benchmark estimation the interaction between the post-crisis and the foreign ownership dummy is negative and statistically significant only for the sample of shocked banks. Columns (3) to (5) include the full sample of banks using different specifications, in which our main findings remain intact.

Table A.VI reports the results from estimating Equation (2.1) for country-specific subsamples of banks. This exercise mirrors the baseline panel specification displayed in Table 2.2, Column (1) in the paper. Even though the size

Table A.VI: Effect within country-specific subsamples.

	Brazil (1)	Chile (2)	Colombia (3)	Peru (4)
PostXShockXForeign	−0.678***	−1.617	−7.297**	−2.587**
	(0.239)	(1.401)	(2.235)	(0.803)
Post	0.442***	−0.007	−0.351	−0.554
	(0.067)	(0.289)	(0.850)	(0.499)
PostXShock	0.917***	2.316*	2.001	1.885***
	(0.187)	(1.237)	(1.836)	(0.282)
PostXForeign	−0.617***	0.585	3.853**	0.645
	(0.104)	(0.607)	(1.556)	(0.452)
Credit Demand	0.000***	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity/Assets	0.103	0.036	−0.083	−0.058**
	(0.072)	(0.103)	(0.149)	(0.020)
Capital/Assets	0.064***	0.170*	−0.847*	−0.134
	(0.020)	(0.091)	(0.454)	(0.228)
Log Total Assets	−0.048	−0.106	−2.126	−1.854
	(0.060)	(0.338)	(1.535)	(1.212)
Obs.	2494	638	522	440
R-squared	0.067	0.059	0.091	0.146

Notes: This table shows estimates of Equation (2.1) for the country-specific subsamples included in the data set. For each country the table reports the results of estimating the baseline estimation with control variables and bank and time fixed-effects. Standard errors are clustered at the bank level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

of the coefficient on the triple interaction term varies across countries, our main conclusions remain the same. This analysis shows that the effect tends to be larger in Colombia and Peru and weaker in Brazil and Chile, although the coefficient is no longer statistically significant for this latter country. These results should be interpreted with caution due to the potential effect of the subsamples' sizes on the results.

Figure A.I depicts the time series of the volume of foreign liabilities held by banks in the sample, whereas Figure A.II depicts the aggregated credit-market volatility as it can be retrieved from our sample. We define this latter variable as the standard deviation of the ratio of operative income to total loans within a six-month varying time-window, defined between three months before and six months after a given date. This plots supports our crisis-period definition by showing that between January 2008 and March 2009 credit markets remained operating with a high volatility. Finally, Table A.VII summarizes the variables' definitions and sources.

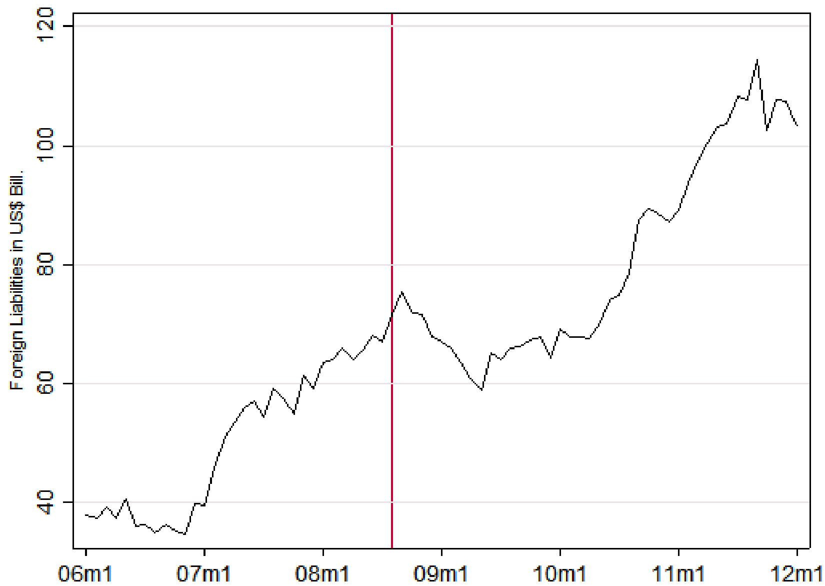

FIGURE A.I: Volume of aggregated foreign liabilities. Notes: This figure displays aggregated foreign liabilities (in US$ bill) held by banks in the sample. The continuous vertical line is set at 2008m8, the last pre-lehman observation. Source: banks' call reports, authors' calculations.

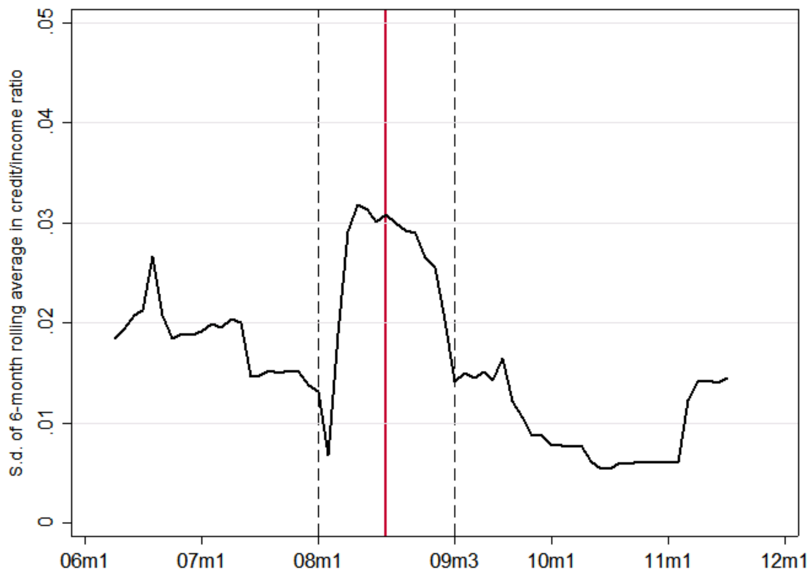

FIGURE A.II: Aggregated credit market volatility. Notes: This figure depicts the aggregated volatility of banks' income to credit ratio. The volatility is measured as the standard deviation of the ratio of operative income to total loans within a six-month varying time-window, defined between three months before and six months after a given date. The crisis period lies between the two dotted lines set at 2008m1 and 2009m3 respectively. The continuous vertical line is set at 2008m8.

TABLE A.VII: Variables definitions.

Variable	Definition	Source	Unit
Lending Growth	3-month change in total outstanding credit divided by 3-month lagged total assets. Aggregated from commercial, consumer and mortgages loans.	Regulatory Authorities	%
Total Assets	Total size of banks' balance sheets.	Regulatory Authorities	Log US$ Bill.
Foreign Funding Ratio	Ratio of outstanding foreign liabilities to total assets.	Regulatory Authorities	%
Foreign Funding Volatility	Standard deviation of the 12-month growth rate in outstanding foreign liabilities.	Regulatory Authorities	%
Shock Size	Crisis average of 12-month change in outstanding foreign liabilities divided by 12-month lagged total assets.	Regulatory Authorities	%
Shock Lenght	Nº of months during the crisis where the 12-month growth rate in outstanding foreign liabilities was negative.	Regulatory Authorities	Months
Foreign Ownership	Dummy equal to 1 if a bank is foreign-owned.	Claessens and van Horen (2015) & banks' websites.	0 / 1
Post	Dummy equal to 1 for the period between March 2009 and January 2012.	Authors' calculations	0 / 1
Shock	Dummy equal to 1 for banks reporting a shock size below the respective countries' sample medians.	Regulatory Authorities	0 / 1
Credit Demand	Proxy for the 3-month change in bank-specific credit demand.	Regulatory Authorities	%
Liquidity/Assets	Ratio of liquid to total assets. Liquid assets include cash holdings, interbank deposits, bank reserves and gold holdings.	Regulatory Authorities	%
Capital/Assets	Ratio of equity to total assets.	Regulatory Authorities	%

Notes: This table reports the definition, source and reporting unit of the variables in the sample. Regulatory authorities stands for data collected from Central Banks and banking regulatory authorities in Brazil, Chile, Colombia and Peru.

Chapter 3

Banking globalization, local lending and labor market effects: Micro-level evidence from Brazil

Abstract: *This paper estimates the effect of a foreign funding shock to banks in Brazil after the collapse of Lehman Brothers in September 2008. Our robust results show that bank-specific shocks to Brazilian parent banks negatively affected lending by their individual branches and trigger real economic consequences in Brazilian municipalities: More affected regions face restrictions in aggregated credit and show weaker labor market performance in the aftermath which documents the transmission mechanism of the global financial crisis to local labor markets in emerging countries. The results represent relevant information for regulators concerned with the real effects of cross-border liquidity shocks.*[*]

3.1 Introduction

Since the outbreak of the 2008-2009 global financial crisis, the cross-border transmission of liquidity shocks through banks, as a particular element of banking globalization, has (re)gained attention in financial economics. Contributions have stressed how disruptions in one financial system can be transmitted to other markets and affect bank lending (Puri et al., 2011) as well as firms' investment and performance (Schnabl, 2012; Ongena et al., 2015).

Such studies also face several identification challenges though (Schnabl, 2012). First, due to the systemic nature of liquidity shocks, identifying

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affected and unaffected financial institutions becomes difficult without accessing very granular data. Second, a key requirement for investigating a lending channel of cross-border liquidity shocks is disentangling the supply from the demand drivers of the credit provision (Khwaja and Mian, 2008; Degryse et al., 2016). Liquidity shocks and credit demand might be determined by the same economic forces. Third, even if empirical results support a lending channel of liquidity shocks, borrowers may be able to substitute for a shortfall in bank lending. Therefore, it is important to trace the shocks to a level that makes an analysis of real effects possible.

This study follows established research to investigate how the 2008-2009 global financial crisis affected a large emerging country through regional bank lending, employment, and gross domestic product (GDP) growth. In particular, we rely on a novel, bank-level, micro data set for Brazil and investigate the extent to which bank-specific foreign funding shocks triggered by the crisis affected lending by individual bank branches and the performance of local labor markets in Brazilian municipalities. Similar to De Haas and Horen (2012), Chodorow-Reich (2014b) or Ongena et al. (2015), we use the collapse of Lehman Brothers in September 2008 as a cut-off point, separating the pre-crisis period from the crisis itself. With these two periods, we calculate the difference in foreign interbank funding for each bank and thereby identify banks that were largely affected by the sudden reduction in the availability of foreign funding.

A key innovation of our research design is that though foreign funding shocks occur at the level of the headquarters of banking conglomerates, we observe lending at the individual bank branch level. This approach has three main advantages. First, it enables us to separate the corporate level at which the shock takes place from the the level at which outcomes are observed, thereby avoiding double-causality concerns. Second, by observing the lending by each branch in each municipality, we can partial out demand effects, similar to Khwaja and Mian (2008), Schnabl (2012), or Degryse et al. (2016). That is, we introduce municipality fixed effects in a regression with first differences of lending and foreign funding. Third, using hand-collected data about job creation and job termination at the municipality level, we can trace the effect of the foreign funding shock's lending channel on regional labor markets. With this empirical setup, we can investigate the real effects of the cross-border transmission of the 2008-2009 global financial crisis. To the best of our knowledge, this study is the first to analyze the real effects, in the form of labor market outcomes of a lending channel of foreign funding shocks funneled through a network of regional bank branches.

Our robust results show that a bank branch connected to a parent bank that experiences a drop of foreign funding of 26% percent (one standard deviation in our sample) between the crisis and the pre-crisis period decreases its credit growth by 7.41%. Given a mean value for credit growth of 14%, this decrease is sizeable and indicates an economically significant bank(-branch) lending channel of financial contagion triggered by the September 2008 events. This contagion channel led to fewer interbank, commercial, and consumer loans; real estate loans and leasing operations appear less sensitive to the shock. These results remain robust even when we use different definitions for the crisis period and alternative methods to compute the size of the foreign funding shocks. Moreover the empirical model reveals consistent results when testing different specifications.

Complementing extant literature, we carefully consider how the nature of foreign funding shocks might differ between local and foreign banks (Noth and Ossandon Busch, 2016). Foreign funding relationships might differ between groups, due to foreign banks' access to intra-bank liquidity allocation through their multinational bank holding companies. Global banks' tendency to manage and allocate liquidity from a consolidated perspective can lead these banks' subsidiaries to be more sensitive to international shocks.[1] Consistent with this hypothesis, the channel of foreign funding shocks is mainly driven by foreign banks. Conversely, we find no evidence of a lending channel by government-owned banks.

By extending our sample to account for the characteristics of foreign

[1]Cetorelli and Goldberg, 2011 provide evidence of how global banks' consolidated liquidity allocation affected the stability of lending in emerging countries during the crisis.

banks' international exposures, we also find that the lending channel crucially depends on the performance of the foreign bank holding companies (FBHC) headquartered abroad during the crisis. If foreign banks belonging to FBHC suffer from higher capital losses and increase their liquid asset buffers during the crisis, they reduce lending more than do other foreign banks, in response to reported foreign funding shocks. This effect is somewhat moderated by FBHC's access to the U.S. Term Auction Facility (TAF) program, which indicates cross-border spillovers of large monetary interventions during the crisis.

Regarding the link between the lending channel of foreign funding shocks and local adjustments in the real economy, we find that in municipalities more affected by the shock, the growth rates of aggregated credit and net job creation drop significantly more after September 2008. In particular, a 1% increase in the market share-weighted foreign funding shock (i.e., our proxy for local exposures to shocks), reduces aggregated credit growth by around 0.58% and also reduces the growth rate for the net job creation per capita by 0.57%. Similar results emerge for GDP growth and alternative measures of labor market outcomes, suggesting the far-reaching effect of the shock on local economies. When we extent the analysis, we also find that this effect is increasing with municipalities' ex ante financial vulnerabilities, as measured by the credit-to-GDP ratio, the historical procyclicality of local credit markets, and foreign banks' market penetration.

Our research relates to literature that investigates international banking activities, the transmission of shocks between financial systems, and whether the shocks affect lending or the real sector. In particular, the notion that international banking activities can transmit financial shocks to the real economy across borders goes back to Peek and Rosengren (1997), who discuss how Japanese banks' U.S. affiliates contributed to transmit the Japanese recession of 1990 to the United States. Van Rijckeghem and Weder di Mauro (2001) also provides evidence of the existence of common-lender contagion effects during the Mexican, Thai, and Russian crises, and De Haas and Lelyveld (2006) reveal that home-country economic conditions crucially determine lending by foreign-owned banks in Eastern Europe.

The financial crises of the late 2000s brought to light a renewed interest in the role of banks for transmitting shocks across countries. De Haas and Lelyveld (2010) thus investigate the role of internal capital markets in relating global banks' financial strength to lending by their foreign affiliates. Jeon et al. (2013) explicitly measure foreign banks' reliance on parent banks' funding to show how intra-bank capital markets can affect lending in countries that host foreign banks. Schnabl (2012) also highlights the importance of cross-border funding shocks for banks by analyzing the 1998 Russian crisis and tracing the effect of the associated international liquidity shock on lending by Peruvian banks. That study suggested that Peruvian firms could not offset the negative liquidity shock. Our focus on the role of foreign-owned banks in shaping the transmission of shocks also links our research to De Haas and Lelyveld's (2014) exploration of the impact of the characteristics of a global bank headquartered abroad on local lending. We explicitly explore the interactions of foreign funding shocks and other dimensions of banking globalization to advance this literature stream.

The case of the global financial crisis provides ample evidence that international liquidity conditions shape the extent of its cross-border spillovers. Previous studies show that the extent of the transmission of the crisis related to the home country liquidity conditions of foreign bank affiliates (Cetorelli and Goldberg, 2011), to the size of bank-level foreign funding shocks (Aiyar, 2012; Noth and Ossandon Busch, 2016), to information asymmetries in the global market for syndicated loans (De Haas and Horen, 2012; Giannetti and Laeven, 2012), and to global banks' exposures to wholesale interbank markets (De Haas and Lelyveld, 2014). Buch and Goldberg (2015) provide a more general picture of how global liquidity conditions affected local lending across the globe by relying on several country-level studies as part of the International Banking Research Network.[2]

[2]These authors summarize country-level evidence obtained using regulatory data about 11 countries. Using a similar methodology, they also find that local lending and cross-border lending were affected by banks' ex ante liquidity risk during times of high global interbank distress. These findings support the hypothesis of a global transmission of

Furthermore, Popov and Udell (2012) find that German firms relying on funding from relatively more affected banks were the ones that faced more difficulties during to the crisis. Other studies similarly offer evidence that German savings banks more exposed to the crisis rejected significantly more loan applications ex post (Puri et al., 2011) and reduced employment and labor compensations (Popov and Rocholl, 2016). Aiyar's (2012) explicit analysis of foreign funding shocks is closer to our study, though he focuses on indentifying a lending channel of shocks in England during the crisis. Besides analyzing how this lending channel varies according banks' characteristics, we expand the analysis by tracing the entire channel of financial contagion, from foreign funding shocks to real economic outcomes.

Finally, the transmission of the global financial crisis from an emerging economy perspective has scarcely been explored. Most studies rely on country-level data (Cetorelli and Goldberg, 2011), which prevent a clear identification of the underlying bank-level mechanisms driving the transmission of liquidity shocks. An exception is Ongena et al. (2015), who use a sample of yearly matched, bank-firm-level data for Eastern Europe and Turkey to analyze adjustments to the firms' outcomes that stem from banks' ex ante exposures to the crisis. The authors compare firms borrowing from locally funded domestic banks with those borrowing from foreign-funded domestic banks or foreign-owned banks and find evidence of the transmission of the crisis through banks' ex ante international exposures. In contrast to their approach we track the timing and size of foreign funding shocks on a monthly basis for both domestic and foreign banks. Moreover, we allow the shocks to interact with the ownership dimension of foreign exposure and with the traits of FBHC abroad, thus drawing a more comprehensive picture of the link between banking globalization and local lending during the crisis.

Overall then, our work differs from previous studies in three central respects. First, we investigate the transmission of the global financial crisis to

shocks; our study is different in that we put a spotlight on an explicitly observed foreign funding shock, as well as on the real effects of the lending channel triggered by the shock.

the largest economy in Latin America, Brazil, using local, bank-level regulatory data. Second, this study makes a major contribution by documenting the lending channel and the real effects of bank-level foreign funding shocks funneled through internal capital markets throughout Brazil. Third, we carefully address the interaction between foreign funding shocks and other dimensions of banking globalization, documenting the more complex nature of the transmission of shocks to the real economy than what previous literature indicated.

3.2 Identification and data

3.2.1 Identification

The aim of this study is to identify how a foreign funding shock to banks' headquarters in Brazil affects the credit supply of their affiliated branches operating in Brazilian municipalities. Our purpose is to isolate this specific supply channel from other economy-wide trends, so the identification must fulfill two central requirements to produce unbiased results. First, the foreign funding shock must be uncorrelated with branches' ex ante credit supply. Second, to identify effects on the credit supply, we need to exclude the possibility that the analysis is driven by demand considerations, such as by different borrower fundamentals faced by banks that experience greater drops in foreign funding during the crisis.

Regarding the exogeneity requirement, we argue that the default of Lehman Brothers in September 2008 is unaffected by credit supply in Brazil, in line with other studies that use this collapse to identify the transmission of international funding shocks (De Haas and Horen, 2012; Ongena et al., 2015). Considering that we analyze credit supply at the branch level, this argument is even stronger, in that it is unlikely that any feedback effects from the lending behavior of the branches spread to disruptions in international interbank markets. Even if these arguments hold, the shock still should reflect banks' own decisions to reduce their exposure to global interbank markets in the context of the crisis. As we discuss subsequently, the

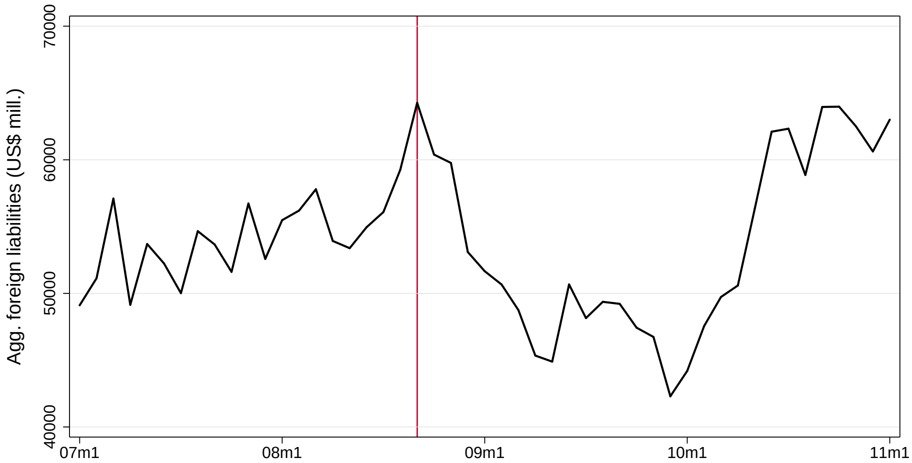


FIGURE 3.1: This figure shows the development of aggregated foreign funding for Brazilian banks between January 2007 and December 2010. The vertical line is set at September 2008, the month when the collapse of Lehman Brothers triggered a freeze in global interbank markets. Foreign funding is aggregated from the bank-level data in the baseline sample. The variable is reported in real 2013 US$ millions.

banks in our sample never fully halted their foreign funding practices during the crisis. This situation helps reduce any concerns that foreign funding demand considerations drive the analysis.

Our identification also acknowledges the significant impact of the collapse of Lehman Brothers on Brazilian banks' access to foreign funding. Figure 3.1 shows the development of aggregated foreign funding (expressed in real US$ millions) of banks in Brazil,[3] documenting the steady increase of foreign funding before September 2008 and sharp decrease right after. The sharp decrease after the Lehman default in September 2008 constitutes the core of our identification strategy. Similar to Khwaja and Mian (2008), we use the varying impacts of this drought in foreign funding on banks in Brazil to investigate how the magnitude of the decrease affects local lending through bank branches.

A second requirement for the identification of a bank lending channel is the distinction between credit demand and supply adjustments that correlate with the funding shock. To avoid concerns about a demand-driven, bias we rely on a within-borrower estimation (Khwaja and Mian, 2008), exploiting our observation of several banks operating in a single municipality. Equation

[3]Note that we transformed our data to real 2013 US$ millions.

(3.1) contains the baseline regression for the bank lending channel.

$$\Delta \text{Log credit}_{ij} = \lambda_j + \beta_1 \Delta \text{Log foreign funding}_i + \sum_{k=2}^{K} \beta_k x_{kij} + \epsilon_{ij}, \quad (3.1)$$

where ΔLog credit is the change in the natural logarithm of the total amount of credit of branch i in municipality j between the pre- and post-crisis periods. To compute this value, we take the average outstanding credits of branch i for the periods January 2007 to August 2008 and September 2008 to December 2010. Then ΔLog credit represents the change in the logarithm of these averages between the two periods. Our main explanatory variable is ΔLog foreign funding, which indicates the change in the (log) foreign funding of branch i's headquarters between the same two periods. Our coefficient of interest is β_1, which indicates the effect of a foreign funding shock at the headquarter level on lending by regional bank branches. In Brazil, only banks' headquarters may obtain direct funding from foreign interbank markets, so we are able to separate the corporate level, where the shock strikes, from retail banking operations at the branch level. In our regulatory data, foreign funding pertains to credits obtained in interbank markets abroad.

If the model delivers results in line with the hypothesis of a lending channel of foreign funding shocks, we would expect β_1 to produce a positive sign. Moreover, the positive sign for β_1 should be driven mainly by banks' experiences of a negative foreign funding shock that reduces their credit balances proportionally more than those of other banks. In Section 3.3.2, we extend Equation (3.1) to test this specific prediction.

To differentiate between demand and supply effects, the model includes municipality fixed effects represented by λ_j, introduced after first differentiating the data. We restrict our sample to municipalities that host at least two banks active in global interbank markets, so that λ_j holds fixed anything that is municipality-specific, such as local demand for credit. Therefore β_1 should function to isolate the credit-supply channel linking foreign funding shocks and lending activity.[4]

As an important feature, Equation (3.1) permits us to collapse the sample's time dimension by computing the variables' averages per period. Instead of working with the monthly underlying data at hand, we adopt this procedure and thus avoid concerns about our standard errors being biased due to auto-correlation (Bertrand et al., 2004). This approach also adds simplicity to the structure and interpretation of Equation (3.1), because aggregated time trends and banks' unobserved, time-invariant characteristics get ruled out of the analysis by first-differentiating the data. Collapsing the time dimension rules out the possibility that the error terms might correlate across branches within the same banking conglomerate or that are active in the same regions. Accordingly, our analysis considers clustering the standard errors at either the municipality or the bank headquarter level (Khwaja and Mian, 2008; Petersen, 2009). The only variables that we can observe separately in both periods are the ones included in the vector of controls x_k. This identification approach leads us to work with a sample that consists of one observation per branch, with control variables reported as either pre- or post-crisis averages. Our estimation includes these latter two alternatives.

We select multiple headquarter and branch level characteristics to serve as control variables within the vector x_k. At the branch level, we include the log of total assets and the ratios of liquid assets and deposits to total assets to control for their size and the characteristics of their funding structure. We also introduce bank traits that control for the characteristics of the banks' headquarters. A dummy identifying banks with a foreign owner is a central control variable, in line with evidence that indicated the notable role played by foreign-owned banks for transmitting the crisis across borders (Ongena et al., 2015). The information to define foreign ownership comes mainly from the banks' websites and from Claessens and Van Horen's (2014) Bank

[4] An underlying assumption of this approach is that demand shocks are homogeneously distributed across branches in each municipality. Because credit demand cannot be observed explicitly, a natural concern would be that branches operate in different segments of the local credit markets, such that λ_j does not completely alleviate concerns of a demand-driven bias. To account for this issue, Section 3.3 presents an extension of Equation (3.1) in which the empirical model is estimated for different credit segments in which branches are active.

TABLE 3.1: Variables definitions.

Variable	Definition
Δ Log credit	Δ in log average outstanding credit in the post- minus the pre-crisis period.
Δ Log foreign funding	Δ in log average foreign liabilities balances in the post- minus the pre-crisis period.
Headquarter level	
Size (Log Assets)	Log of total assets.
Capital Ratio	Ratio of total equity to total assets.
Liquidity Ratio	Ratio of liquid assets (cash, bank deposits, gold) to total assets.
Deposit Base	Ratio of total deposits (interbank, sight and savings deposits) to total assets.
Credit Risk	Ratio of non-performing loans to total outstanding credit.
Foreign	Dummy equal to 1 if a bank is foreign-owned.
State-owned	Dummy equal to 1 if a bank is government-owned.
Foreign Funding Ratio	Pre-crisis average ratio of foreign funding to total assets.
Branch level	
Size (Log Assets)	Log of total assets of an individual bank branch.
Liquidity Ratio	Ratio of liquid assets (cash, bank deposits and gold) to total assets.
Deposit Base	Ratio of total deposits (interbank, sight and savings deposits) to total assets.
RoA	Ratio of net income to total assets.
Net Interbank Assets	Pre-crisis average ratio of net interbank assets (loans + deposits) to total assets.
FBHC-level	
Δ Capital Ratio	Change in capital ratio between 2009 and 2007.
Δ Liquidity	Change in the ratio of liquid assets to total assets between 2009 and 2007.
Δ Deposit Ratio	Change in the ratio of deposits to total assets between 2009 and 2007.
Δ RoA	Change in the RoA ratio between 2009 and 2007.
TAF Index	Normalized average ratio of TAF balances to capital divided by the normalized inverse of the foreign funding shock.
Size (Log Assets)	Log of unconsolidated total assets.
Capital Ratio	Ratio of total equity to total assets.
Liquidity Ratio	Ratio of unconsolidated liquid to total assets.
Deposit Base	Ratio of unconsolidated deposits to total assets.
Municipality-level	
Size (GDP)	Annual GDP in real US$ mill.
Credit / GDP Ratio	Ratio of total aggregated credit to municipal GDP.
Job Creation	Number of signed job contracts per month.
Net Job Creation	Job creation minus the number of job contracts terminated.

Notes: This table provides a description of the main variables used for the empirical analysis reported in the paper. The sources are the Brazilian Central Bank, the Brazilian Institute of Geography and Statistics, the Brazilian Ministry of Labor, Bloomberg (for TAF data) and BankScope (for FBHC traits).

Ownership Database. We follow the standard that indicates that banks are foreign owned if at least 50% of their shares are held by foreign firms. We also introduce a second dummy to identify government-owned banks, noting Coleman and Feler's (2015) finding that government-owned branches in Brazilian municipalities helped offset the effects of the global financial crisis. Furthermore, we control for the log of total assets as a measure of size, the capital-to-asset ratio, liquidity, and deposits, mirroring the controls at the branch level, as well as a measure of credit risk. This latter variable corresponds to the share of non-performing loans, as a proportion of total outstanding credit at the headquarter level. Table 3.1 provides a detailed description of all variables. In choosing these variables, we expect to capture the main characteristics of banks' funding and assets structure.

3.2.2 Data and descriptive statistics

To address the research question, we rely on information on banks' balance sheets and income statements from call reports published by the Brazilian Central Bank. This source provides monthly data on banks' lending activity and funding structure. We integrate a data set that contains information on Brazilian banks' headquarters with the (unconsolidated) balance sheets of their individual branches located in Brazilian municipalities. Thus we can observe both the characteristics of the parent bank at the country level as well as the characteristics of the individual regional branches of each bank.[5] Our sample covers the period from January 2007 to December 2010. We restrict the sample to banks with a network of municipal branches throughout the period, so that we can assess the impact of shocks on lending at individual region level. This restriction reduces the sample of 123 banks active in Brazil as of January 2007 to 100 banks.

When analyzing banks' global linkages, we consider two main bank characteristics: foreign funding and foreign ownership. Foreign banks have a strong presence in Brazil, representing 37% of total assets in the (reduced)

[5] See Appendix B for further details on the data collection process.

sample as of January 2007. Foreign banks operating in Brazil are headquartered in 20 different countries of origin, ranging from regional players like Mexico and Argentina to banks from Korea and Japan. Spain and the United States have the largest representation of foreign banks in the sample, with 6 and 8 banks, respectively.

For the sampling, we also require banks and individual bank branches to have been active during the whole sample period from January 2007 to December 2010. Because we observe lending at the individual regional bank branch level, we restrict the sample to municipalities that host at least two active banks over the sample period. This restriction is important for the identification strategy outlined previously, in that it enables us to control for common credit-demand shocks that affected the two or more active branches in each region. Furthermore, we check that the banks regularly report positive balances of foreign funding, which means we can compare banks that are similarly active in global interbank markets that continued relying on foreign funding during the crisis. As previously mentioned, this filter underpins our interpretation of the foreign funding shocks as a supply-driven phenomenon, also allowing us to focus on the intensive margin of foreign funding shocks. As a final sample restriction, we drop branches with missing information for the bank traits we use as control variables, while ensuring that after this restriction, each municipality still reports the activity of at least two individual branches.

Through this screening procedure, we retain a sample of 41 banks that provide credit to 1,768 municipalities through 6,632 branches in the period from January 2007 to December 2010. The banks in our sample represent the largest institutions in Brazil, such that our restricted sample still represents 62.6% of the total banking assets in the country. Furthermore, the outstanding credit observed in the final sample covers 76.3% of the aggregated credit market in Brazil. In terms of geographical coverage, it accounts for more than 90% of total assets in 23 of the 27 federal states. The sample is less representative in the country's main financial centers though, which is to be expected, considering our focus on regional branches and retail credit.

TABLE 3.2: Descriptive statistics of the bank sample.

	Statistics				Shock-affected		
	Mean	SD	Min	Max	Yes	No	Diff
ΔLog Credit	0.14	0.26	-0.76	0.70	0.05	0.18	-0.13*
ΔLog Foreign Funding	0.25	0.60	-1.22	1.46	-0.35	0.55	-0.90*
Headquarter level							
Size (log Assets)	9.15	1.40	8.13	12.72	9.10	9.04	0.06
Capital Ratio	0.13	0.07	0.04	0.32	0.14	0.13	0.01
Liquidity Ratio	0.22	0.10	0.06	0.43	0.19	0.23	-0.05
Deposit Base	0.41	0.13	0.24	0.74	0.35	0.42	-0.08*
Credit Risk	0.13	0.08	0.04	0.27	0.12	0.14	-0.02
Foreign	0.39	0.49	0.00	1.00	0.57	0.30	0.28*
State-owned	0.20	0.40	0.00	1.00	0.21	0.19	0.03
Branch level							
Size (log Assets)	5.18	2.07	1.33	8.76	5.19	5.13	0.06
Liquidity Ratio	0.06	0.06	0.00	0.22	0.06	0.07	-0.01
Deposit Base	0.15	0.18	0.01	0.73	0.12	0.16	-0.04
RoA	0.08	0.04	0.02	0.18	0.08	0.07	0.00
Pre-crisis trends							
Credit growth	0.05	0.36	-0.77	1.51	0.06	0.05	0.00
Assets growth	0.08	0.29	-0.49	0.96	0.03	0.11	-0.08
Deposits growth	0.09	0.28	-0.49	0.85	0.08	0.09	0.00

Notes: This table provides a description of the main variables used for the empirical analysis reported in the paper. The sources are the Brazilian Central Bank, the Brazilian Institute of Geography and Statistics, the Brazilian Ministry of Labor, Bloomberg (for TAF data) and BankScope (for FBHC traits).

That is, banks focused solely on the investment or corporate sectors, with a larger presence in financial centers, are not represented in the sample.

Our sample banks report an average ratio of foreign funding to total assets of 11.6% in the pre-crisis period. This ratio varies considerably along the foreign-ownership dimension; foreign banks report an average ratio of 15.5%, whereas domestic banks finance their balance sheet, with an average of 5.6% of foreign funding. We cannot observe the counterparts of foreign funding relationships, but this latter observation can be interpreted as foreign banks that access different sources of foreign funding compared with local banks. In particular, the different funding ratio might be related to foreign banks' access to internal liquidity through their bank-holding companies abroad.[6] This preliminary evidence is in line with the findings about foreign funding in Brazil presented by Noth and Ossandon Busch (2016).

[6] As Figure B.I in Appendix B reveals, pre-crisis exposure to foreign funding related inversely to the size of the foreign funding shock after September 2008. This is important because it reveals that the mere fact of having active balances in foreign funding does not predict per se a large funding shock during the crisis. This heterogeneity in the size of funding shocks permits us to investigate the differential impact of the shock on lending, depending on the size of the shocks.

Table 3.2 provides descriptive statistics for the variables in our analysis and shows the mean values for the pre-crisis period for two groups of banks, according to whether they experienced a change of (log) foreign funding below (shock affected) or above (non-affected) the sample median. We compute normalized differences (Imbens and Wooldridge, 2009; Lambert et al., 2015) to investigate whether the differences in variables between the two groups differ significantly from each other. Relevant prior literature suggests that absolute values smaller than 0.25 indicate a non-significant difference.

The first two lines in Table 3.2 report summary statistics for the main variables of interest for the identification strategy: the changes in log credit and log foreign funding between the two aforementioned periods. By construction, Table 3.2 shows that foreign funding growth was weaker for shock-affected banks. Credit expanded in a slower fashion in the case of shock-affected banks, which report 13 percentage points lower credit growth between the pre- and post-crisis periods.

In addition, Table 3.2 documents that banks affected or not by a foreign funding shock shared similar characteristics in the pre-crisis periods. The only significant differences appear in the deposit ratio at the headquarter level and in terms of the likelihood of being a foreign-owned bank. These statistically significant differences are marked with asterisks. Shock-affected banks tend to operate with fewer deposits at the headquarter level and are more likely to be foreign-owned in the pre-crisis period. The foreign-ownership dimension becomes important when analyzing the transmission of foreign funding shocks and for interpreting the results in Section 3.3. For the rest of the control variables, we cannot reject the null hypothesis that the averages between the banks affected or not by the shock are equal. We control for these (level) variables in our regressions and thus are confident that the rather small differences between shock-affected and non-affected banks are not a matter of concern for our results.

A further critique of the identification strategy is the potential existence of ex ante trends in banks differently affected by foreign funding shocks. More affected banks already might be experiencing weaker credit growth in the pre-crisis period, which would prompt a bias in our estimation. The assumption of parallel trends in the pre-crisis period therefore must be addressed explicitly. In the bottom panel of Table 3.2, we report the results of tests of whether average pre-crisis growth in credit, total assets, and deposits differed significantly between the two groups of banks. Our results do not indicate any statistically significant differences in pre-crisis trends between banks affected or not by the funding shock. This result implies that ex ante sorting in our sample should not be a substantial concern when interpreting the results.

The potential bias in the ordinary least squares (OLS) estimation of Equation (3.1), arising from contemporaneous credit demand shocks, can be positive or negative, ex ante. The sign depends on the correlation between the size of the foreign funding shock and the adjustment in credit demand by each bank's borrowers during the crisis. Perhaps, shock-affected banks are also more sophisticated financial institutions, serving customers with a more diversified funding structure, such that they can better offset the effects of the crisis and accordingly experience relatively small reductions in their credit demand. Alternatively, shocked-affected banks might have faced larger vulnerabilities overall prior to the crisis, inducing borrowers to switch off their credit sources and triggering relatively large credit demand shocks for those banks. If the former hypothesis is true, a simple OLS estimation of Equation (3.1) would produce conservative estimates of the true effect of ΔLog foreign funding on ΔLog credit. We return to this point in our discussion of the empirical results, but Table 3.2 provides some preliminary on this regard. That is, we find no statistically significant differences in the ex ante profitability of branches largely affected by the shock, possibly because they serve relatively similar firms and households compared to other branches, facing similar demand shocks. Still, we remain cautious about this interpretation. The results obtained from estimating Equation (3.1) will shed some light on the actual sign of the demand-driven bias in the model.

Before turning to the results, we use Figure 3.2 to provide some preliminary non-parametric evidence about the effect of the foreign funding shock on

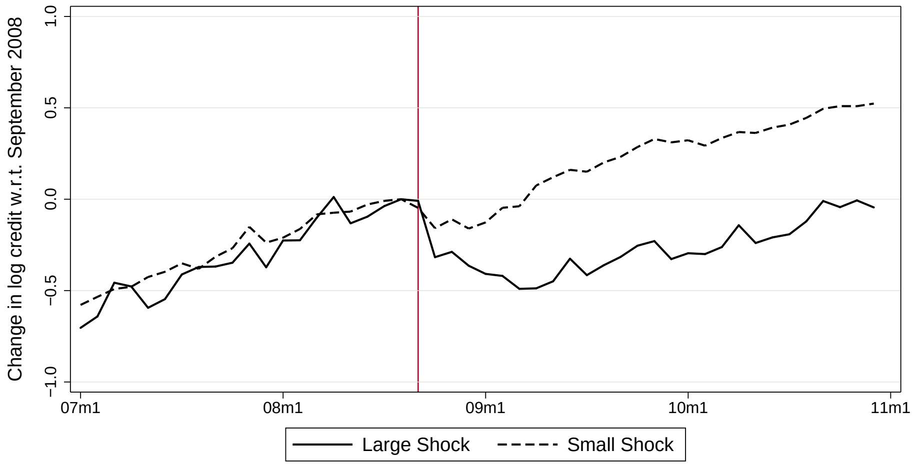


FIGURE 3.2: This figure illustrates the different pattern of credit growth followed by banks affected or not by a foreign funding shock after September 2008. The vertical line is set at September 2008, the month when the collapse of Lehman Brothers triggered a freeze in global interbank markets. The volume of outstanding credit is aggregated from the branch level data per bank group and plotted as log first differences with respect to September 2008. Banks affected by a relatively large shock are those with a change in log foreign funding below the sample median.

lending by Brazilian banks. It shows the change in aggregated log outstanding credit for groups of banks reporting a change in log foreign funding, both above and below the sample median after September 2008. Credit growth is computed as proportional to outstanding credit as of September 2008. Figure 3.2 supports the suggested identification strategy, in that it shows no diverging pre-trends in lending between these two groups of banks, in accordance with our findings from Table 3.2. After the outbreak of the crisis, shock-affected banks reduce lending by more, and credit growth remains in the negative region until the end of the sample period. We conducted simple difference-in-differences tests to confirm that the difference between the two groups is statistically significant only in the post-crisis period. However, this preliminary analysis cannot rule out the possibility that the diverging paths observed in Figure 3.2 might be driven by different credit-demand shocks or by bank or branch traits correlated with the size of the foreign funding shock.

In Section 3.3, we discuss the baseline results of estimating Equation (3.1), as well as several extensions of the model intended to shed light on the mechanisms behind the cross-border transmission of the foreign funding shock.

3.3 Results

3.3.1 The bank lending channel

The baseline results obtained from Equation (3.1) are in Table 3.3. The baseline model with municipality fixed effects appears in Column (1).[7] A 1% decrease in foreign funding growth after the crisis led to a significant reduction in the growth rate of lending, of about 0.29%. Considering that shock-affected banks experienced an average drop in foreign funding of 35%, the foreign funding shock explains roughly 10% of the average growth rate of credit within that group (35×0.29=10.15). Compared this with the average growth rate in credit within that group (5%), the model explains a sizable portion of credit growth in the sample.

Consider now the difference between the average growth rates in foreign funding of affected and non-affected banks. Our estimates imply that, on average, credit growth was 26% (90×0.29) lower for affected banks as a consequence of the shock. If an average non-affected bank would had realized the foreign funding growth rate of an average affected bank, its credit growth rate would have been more than three times lower (18% versus -8.1%). This illustrates the extent of the effect of the shock on local credit supply.

The documentation of a bank lending channel for the Brazilian financial system mirrors the findings of other studies that analyze how funding shocks affect banks' lending behavior (e.g., Khwaja and Mian, 2008; Schnabl, 2012; Ongena et al., 2015). Even though we rely on a similar approach to control for credit demand, the use of borrower fixed effects could fail to fulfill its purpose if banks face idiosyncratic credit demands. For example, firms within a municipality might demand two distinct credit products, commercial loans and working capital funding. If two banks operate in this municipality, and each of them focuses exclusively on one of these products, municipality fixed

[7]Note that we use standard errors clustered at the branch level throughout Table 3.3.

Table 3.3: Effect of foreign funding shocks on lending growth.

	(1) Baseline Model	(2) Commercial Lending	(3) Consumer Lending	(4) Mortgage Lending	(5) Leasing Balances	(6) Interbank Lending
ΔLog foreign funding	0.285***	0.424***	0.313***	0.060	−0.008	0.197**
	(0.103)	(0.127)	(0.077)	(0.044)	(0.022)	(0.081)
Headquarter level						
Size (log Assets)	0.033	0.001	0.045	0.003	−0.004	0.060***
	(0.024)	(0.028)	(0.028)	(0.026)	(0.006)	(0.021)
Capital Ratio	−0.608	−0.123	0.417	−3.187***	−0.210	0.850
	(1.008)	(1.279)	(0.892)	(1.123)	(0.145)	(0.925)
Liquidity Ratio	−1.669***	−1.140**	−0.782*	−1.807***	0.037	0.758**
	(0.435)	(0.487)	(0.400)	(0.295)	(0.125)	(0.329)
Deposit Base	0.306	0.224	0.310	−0.409	−0.081	0.161
	(0.551)	(0.695)	(0.449)	(0.543)	(0.076)	(0.370)
Credit Risk	−1.658***	0.423	−1.259**	−1.441***	−0.090	0.297
	(0.506)	(0.621)	(0.475)	(0.522)	(0.180)	(0.418)
Foreign	−0.062	−0.082	0.120	−0.033	0.012	0.047
	(0.085)	(0.113)	(0.072)	(0.087)	(0.015)	(0.089)
State-owned	0.309***	0.050	0.362***	0.267***	0.014	−0.119
	(0.073)	(0.097)	(0.073)	(0.063)	(0.029)	(0.092)
branch level						
Size (log Assets)	0.041	0.046**	0.056**	0.016	0.008*	0.032*
	(0.027)	(0.021)	(0.023)	(0.020)	(0.005)	(0.017)
Liquidity Ratio	0.065	−0.207	−0.196	0.833*	0.540**	0.050
	(0.667)	(0.589)	(0.596)	(0.489)	(0.259)	(0.822)
Deposit Base	0.024	0.079	−0.054	−0.015	−0.012	0.163**
	(0.092)	(0.090)	(0.072)	(0.045)	(0.014)	(0.079)
RoA	2.826**	0.118	2.750***	−1.629**	−0.114	−1.678***
	(1.141)	(0.958)	(0.930)	(0.633)	(0.121)	(0.599)
Obs.	6632	6632	6632	6632	6632	6632
R-squared	0.405	0.318	0.456	0.612	0.117	0.344

Notes: This table reports the results of estimating Equation (3.1) for different specifications. In all regressions, the dependent variable is a measure of the change in log average outstanding credit between the post- and pre-crisis periods for specific credit segments. The pre-crisis period is between January 2007 and August 2008; the post-crisis period is between September 2008 and December 2010. Column (1) reports the baseline specification with municipality-FE from Equation (3.1) using total outstanding credit to compute the dependent variable. Columns (2) to (6) replicate the estimation for the segments of commercial lending, consumer lending, mortgage lending, leasing and interbank lending, respectively. For a detailed definition of all variables, see Table 3.1. We provide standard errors clustered on the branch level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

effects would fail to capture the dynamics of credit demand, leading to biased results.

To overcome this concern, we extend our analysis in Table 3.3 for subsets of five different credit segments: commercial loans, consumer loans, mortgages, leasing, and interbank loans. The bank-lending channel holds, even for specific credit categories. In particular, commercial, consumer, and interbank loans are sensitive to the variation in foreign funding triggered by the crisis. In contrast, we do not find evidence of a bank lending channel for mortgages or leasing. This finding might reflect the importance of collateral in retail credit markets, especially during a global financial crisis (Ongena et al., 2015). Whereas mortgages and leasing products can insure banks against repayment delinquency, the other three categories of credit do not necessarily provide this function. We expect this to be a relevant factor in Brazil considering the theoretical and empirical evidence on the importance of collateral for credit markets in emerging countries compared to developed countries (e.g., Fostel and Geanakoplos, 2008; Menkhoff et al., 2006). In support of this interpretation, we note that unlike the United States, Brazil did not experience a housing bubble before or during the crisis.

The strongest explanatory power associated with commercial credit speaks to the importance of the funding shock for credits related to investment and trade, both of which fall within this category. Because funding from abroad typically is denominated in foreign currency, we expect banks with more exposure to foreign funding to serve firms that are also active in the foreign trade, infrastructure, and physical capital investment sectors. This evidence suggests a potential transmission of the lending channel to real economic outcomes through firms' investments, an aspect that we carefully address in Section 3.4, when we analyze the real effects of the funding shock.

A higher exposure to credit risk is associated with a weaker credit growth. Also branches whose headquarters report larger liquidity ratios reduce credit by more, what might be related to a liquidity hoarding effect, as documented for the global financial crisis in the United States by Cornett et al. (2011) and Berrospide (2013). In this sense greater liquidity holdings might be built up as cushion against an uncertain business environment that threatens the strength of credit growth. In line with previous findings by Coleman and Feler, 2015, we find credit supply to be positively correlated with government ownership of banks, evidencing a potential offsetting effect of government-owned banks interventions in local credit markets. To shed more light into this finding, we explicitly explore the link between government ownership and the lending channel of foreign funding shocks in Section 3.3.2. At the branch level, we find credit supply to be positively associated with branches' size and liquidity ratios in some of the specifications. Branches' profitability, as measured by the RoA ratio, reports ambiguous effects on credit supply depending on each credit segment.

The main results hold after controlling for foreign ownership, which represents important evidence regarding the cross-border transmission of shocks. There is ample evidence that global banking networks contributed to the spread of financial distress (Cetorelli and Goldberg, 2011; De Haas and Horen, 2012), yet thus far foreign ownership has been analyzed only as a separate channel, in comparison with direct foreign funding exposures (Ongena et al., 2015). The evidence in Table 3.3 shows that foreign funding shocks continue to be important vectors for the transmission of financial distress even when we control for the ownership status of a bank. Although somewhat puzzling, this first result regarding the effect of foreign ownership on lending also leads in to some interesting insights about the bank lending channel, as we discuss subsequently.

3.3.2 Robustness and alternative shock definitions

Standard errors and control variables. Table 3.4 provides the results for alternative specifications of Equation (3.1). Column (1) presents the results when including only ΔLog foreign funding as the explanatory variable. Columns (2) and (3) add the control variables at the headquarter and branch level, respectively. Although the statistical significance of the coefficient for ΔLog foreign funding remains unchanged, the size of the coefficient increases when adding the vector of controls x_k. The regression in Column (3) replicates the baseline results from Table 3.3, Column (1), but without municipality fixed effects or clustered standard errors. All these specifications report similar estimates of the lending channel of foreign funding shocks.

An open question in our estimation is whether standard errors should be better clustered at the bank headquarter or municipality level. On the one hand, we are working with several hundred branches per bank, so the results for branches associated with a particular bank holding company are likely to be correlated. On the other hand, regional specificity issues related

TABLE 3.4: Alternative specifications of the model.

	(1) Baseline Model	(2) Headquarter Controls	(3) Branch Controls	(4) Regional Cluster	(5) Bank Cluster	(6) Lagged Model
ΔLog foreign funding	0.082***	0.336***	0.301***	0.301***	0.301***	0.285***
	(0.012)	(0.016)	(0.016)	(0.030)	(0.078)	(0.088)
Headquarter level						
Size (log Assets)		0.018***	0.007	0.007	0.007	0.069**
		(0.004)	(0.005)	(0.009)	(0.026)	(0.033)
Capital Ratio		−1.626***	−0.869***	−0.869**	−0.869	−0.474
		(0.204)	(0.202)	(0.401)	(0.894)	(0.885)
Liquidity Ratio		−1.630***	−1.565***	−1.565***	−1.565***	−0.117
		(0.098)	(0.095)	(0.187)	(0.363)	(0.410)
Deposit Base		−0.136	0.187**	0.187	0.187	−0.289
		(0.089)	(0.091)	(0.152)	(0.529)	(0.370)
Credit Risk		−1.564***	−1.501***	−1.501***	−1.501**	−1.406***
		(0.133)	(0.140)	(0.232)	(0.566)	(0.288)
Foreign		0.002	−0.040**	−0.040	−0.040	0.083
		(0.019)	(0.019)	(0.025)	(0.079)	(0.069)
State-owned		0.260***	0.243***	0.243***	0.243***	0.454***
		(0.020)	(0.019)	(0.032)	(0.062)	(0.081)
Branch level						
Size (log Assets)			0.084***	0.084***	0.084***	−0.084**
			(0.003)	(0.004)	(0.027)	(0.032)
Liquidity Ratio			−0.115	−0.115	−0.115	−0.236
			(0.172)	(0.263)	(0.442)	(0.477)
Deposit Base			0.093***	0.093***	0.093	0.329***
			(0.019)	(0.025)	(0.137)	(0.074)
RoA			2.426***	2.426***	2.426**	−0.343
			(0.194)	(0.238)	(0.964)	(0.691)
Constant	0.279***	0.717***	0.216**	0.216	0.216	
	(0.005)	(0.102)	(0.101)	(0.206)	(0.529)	
Obs.	6632	6632	6632	6632	6632	6632
R-squared	0.007	0.144	0.232	0.232	0.232	0.433

Notes: This table reports the results of estimating Equation (3.1) for different specifications. In all regressions, the dependent variable is the change in log average outstanding credit between the post- and pre-crisis periods. The pre-crisis period is between January 2007 and August 2008; the post-crisis period is between September 2008 and December 2010. In Columns (2) to (5), the control variables are computed as averages during the post-crisis period. Column (6) reports the results of the control variables entering the model as pre-crisis averages. Standard errors are clustered at the municipality-level in Column (4) and at the parent-bank level in Columns (5) and (6). For a detailed definition of all variables see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

to the functioning of the banking sector and the level of industrialization of each municipality might lead to regional correlations in the standard deviations of the estimation. Therefore, in Columns (4) and (5), we replicate the regression from Column (3) by adding municipality and headquarter bank clustered standard errors, respectively. These regressions do not include the municipality fixed effects. Both regressions produce similar results, but the use of headquarter level clusters generates standard errors that are slightly higher. Therefore, we use this latter setup, which provides a more conservative estimation of the bank lending channel, and our subsequent analyses in this section rely on standard errors clustered at the bank headquarter level.

The coefficient for the funding shock in Table 3.4, Column (5), is only marginally larger than our baseline regression on Table 3.3, Column (1) with municipality fixed-effects. Thus, if anything, the OLS estimation of Equation (3.1) is underestimating the true effect on credit growth. The positive bias induced by credit demand is in line with the preliminary evidence in Table 3.2 regarding the similar ex ante profitability of largely affected branches in the pre-crisis period. This result is pertinent to our subsequent discussion of the identification strategy for the real effects of the lending channel (see, Section 3.4).

A further concern might arise because the preceding results were estimated using the control variables computed as post-crisis period averages. Although all these variables refer to levels, they might capture changing patterns in banks' assets and liability structures that could be correlated with both the foreign funding shock and the credit growth rate. The regression in Column (6) rules out this concern, by replicating our prefered estimation using the control variables computed as pre-crisis period averages. The estimated coefficient for β_1 remains significant reporting the same size as in our baseline regression in Table 3.3.

Crisis definition. A potential drawback of our identification is that we rely on very specific definitions, both for the crisis period and for the way in which we compute the foreign funding shock. The aim of this section is to check that the baseline results hold when we allow for alternative definitions of the shock and for the crisis period itself.

In Figure 3.2, we saw that the collapse of Lehman Brothers was associated with a strong divergence in the credit growth trends displayed by banks that were more versus less affected by the shock. These two groups of banks appear to maintain their different growth paths throughout the post-crisis period, such that our baseline results might be driven not by the funding shock itself but rather by an overall shift in banks' capacities to obtain liquidity abroad. Recall that Equation (3.1) computes the shock as the change in log foreign funding between the averages of the pre- and post-crisis periods. Although unlikely, the baseline regressions theoretically could be capturing the effects of events occurring after September 2008, which are not related directly to the global financial crisis. This concern is particularly pertinent because we define the post-crisis period as lasting until December 2010, which is the approximate date at which the volume of foreign funding in Brazil returned to its pre-crisis level.

Table B.I in Appendix B shows that this latter concern did not affect our results though. We alternatively define the shock as the log change in foreign funding between September 2008 and June 2009 and between December 2009 and December 2010 for this analysis. The former window captures the peak-to-trough change in foreign funding, but the latter functions like a placebo test. Comparing the results from Columns (1) and (2) in Table 3.3, we find that the foreign funding shock explains credit growth only if computed around September 2008. To avoid the possibility that these results were driven by the arbitrary definition of the months when we computed the shock, we ran regressions in which we defined the shock as the change in log foreign funding from three months before to three months after a given date, to create rolling time windows between January 2008 and January 2010. The estimated coefficients are in Figure B.III in Appendix B; they show that the positive and significant coefficient from Table 3.3, Column (1), emerges only when we define the shock as starting around September 2008. The lending channel we identify thus is strictly related to the foreign funding shock triggered by Lehman's collapse.

We also check the results when we defined the shock as the average 12-month growth rate in log foreign funding during the months between September 2008 and June 2009. This alternative shock definition confirms our main results (see Column (3) in Table B.I). With a falsification test during the pre-crisis period, we also exclude the possibility of the results being driven by pre-crisis diverging trends in credit growth, which already is a rather minor concern according to our analysis in Table 3.2. For this purpose, we define a (virtual) crisis between June 2007 and August 2008. The (virtual) pre-crisis period is from January 2007 to May 2007. As expected, the results reported in Table B.I, Column (4), show no significant effects of the virtual shock on credit growth.

Nonlinear effects of the foreign funding shock. Our results might be also be driven by multiple banks reporting a very large increase in both foreign funding and credit after September 2008. Although unlikely, this concern is important, in that the positive coefficient of ΔLog foreign funding in Table 3.3 cannot explicitly reveal whether the effect stems from negative funding shocks associated with a contraction in lending, as we expect, or from positive funding shocks associated with a large increase in lending. To ensure that the results can be interpreted as driven by large negative funding shocks, we ran a nonlinear version of Equation (3.1), which takes the following form:

$$\Delta\text{Log credit}_{ij} = \lambda_j + \beta_1 \Delta\text{Log foreign funding}_i + \beta_2 \Delta\text{Log foreign funding}_i^2 + \sum_{k=3}^{K} \beta_k x_{kij} + \epsilon_{ij}. \tag{3.2}$$

With the additional squared term of Δ Log foreign funding, we can estimate the marginal effects of our baseline results along the distribution of foreign funding shocks in the sample. If our hypothesis is true, the coefficient should be positive and statistically significant only on the left-hand side of the distribution of foreign funding growth.

Figure 3.3, which shows the marginal effects for ΔLog foreign funding coming from Equation (3.2), provides evidence that the bank lending channel is driven by the bank that experienced a strong negative decrease in foreign funding. For banks reporting an increase in foreign funding, the lending channel is not significant. This result affirms that the main findings from Table 3.3 can be interpreted in line with our hypothesis, namely, as a signal that the negative foreign funding shocks after September 2008 led to a significant reduction in the supply of credit by Brazilian banks.

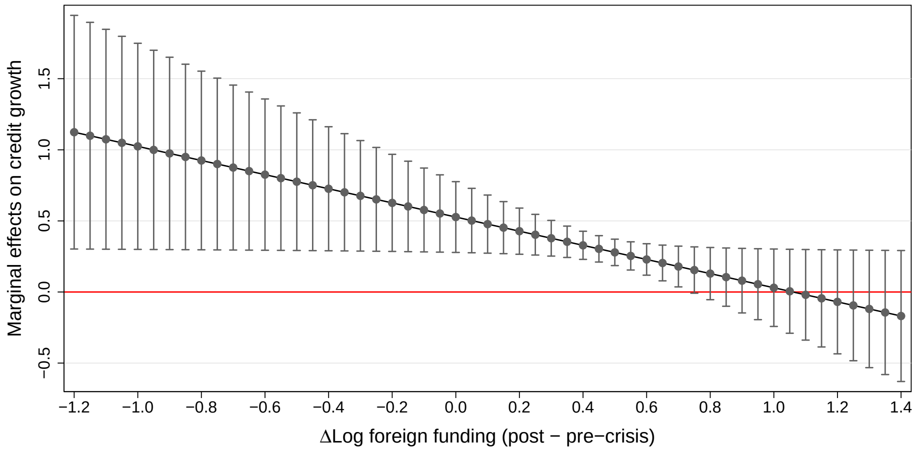


FIGURE 3.3: This figure illustrates the marginal effects at the 95% confidence level from Equation (3.2). The estimated coefficients of the underlying regression from which marginal effects are retrieved are in Columns (1) and (2) in Table B.II.

Our analysis thus far has relied on the underlying assumption that frictions in internal capital markets between a branch and its parent bank explain the within-country transmission of the shock. Although our regulatory data do not reveal the funding obtained by a branch from its headquarters, we do know, in the aggregate, the volume of interbank credits and deposits held by each branch in its balance sheet. If, as we expect, a branch obtains much of this funding from the same banking conglomerate to which it belongs to, then branches that ex ante dependent more on these funds should experience a stronger adjustment in credit growth. This evidence would suggest that branches that are more dependent on internal funding cannot easily replace their funding sources in the interbank market, so shocks at the headquarter level get transmitted to a greater extent. We test this hypothesis by replicating an alternative to Equation (3.2), in which ΔLog foreign funding interacts with the average pre-crisis ratio of net interbank assets to total assets (NIA). A low value of NIA reflects a branch being a net borrower in the interbank market.

Figure 3.4 reveals the marginal effects of the shock on credit growth along the distribution of net interbank assets to total assets. We find that the positive coefficient on ΔLog foreign funding decreases along the distribution the net interbank assets ratio. Thus, net borrower branches adjust credit growth to a larger extent as a consequence of the collapse of Lehman

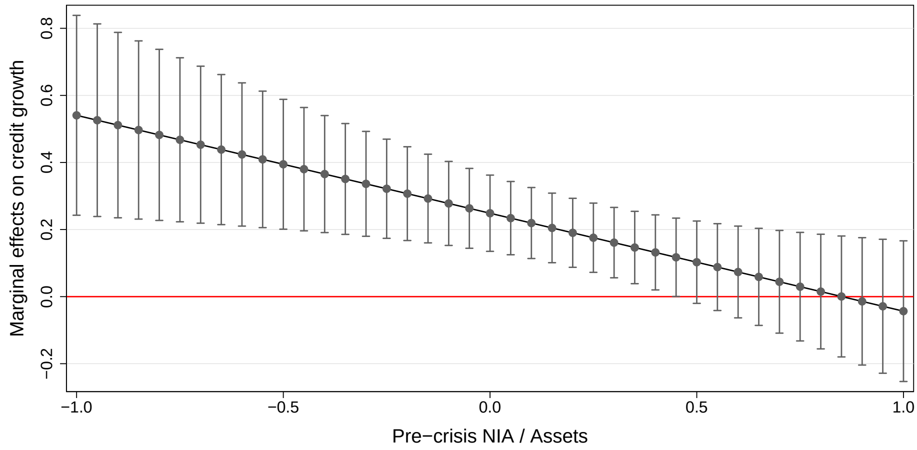


FIGURE 3.4: This figure illustrates the marginal effects at the 95% confidence level from an alternative version of Equation (3.2), in which ΔLog foreign funding interacts with the average pre-crisis ratio of net interbank assets to total assets (NIA). The estimated coefficients of the underlying regression from which marginal effects are retrieved is reported in Columns (7) and (8) in Table B.II.

Brothers, in line with the assumption that internal capital market frictions drive our results. This finding is consistent by previous evidence on the sensitivity of bank branches to the performance of their banking conglomerate (e.g., Houston and James, 1998; Houston et al., 1997; Boutina et al., 2013). More generally, Giroud and Mueller (2017) show that business establishments in the United States were sensible to the financial leverage of their firm conglomerates during the global financial crisis. Our results add to this literature by providing evidence on how local internal capital markets augmented the effect of banks foreign funding shocks during the crisis.

Pre-crisis foreign funding exposure as an instrument for the shock. Our identification strategy and robustness tests address numerous concerns associated with estimating Equation (3.1), but it could be still argued that ΔLog foreign funding is not sufficiently exogenous to branches' credit growth. For example, strong correlations in credit growth across branches in a given banking conglomerate might lead a bank's headquarters to cut its demand for foreign funding, as a reaction to deterioration of local credit market conditions. In this case, the observed contraction in foreign funding might reflect not only the sudden freeze in global interbank markets after September 2008 but also a weaker demand for these funds, due to an expectation adjustment that occurs locally in Brazil. We consider this a minor concern in our study, in that banks in the sample never fully stop relying on foreign funding, but we still address the potential exogeneity of ΔLog foreign funding with an instrumental variables approach.

Specially, we follow Aiyar, 2012 and rely on banks' pre-crisis exposure to foreign funding as an instrument for the shocks' size. The average pre-crisis ratio of foreign funding to total assets for banks' headquarters in the sample is the same variable used in Figure B.I. Reasonably, banks with a greater exposure to foreign funding should be more likely to suffer from greater drops in the growth rate of foreign funding during the crisis, as supported by the preliminary evidence in Figure B.I. In support of the exogeneity of the instrument, because the headquarters' foreign funding ratio is a stock variable realized before the shock occurs, it is unlikely to be determined by future changes in branch level local lending. We run regressions after first differentiating the data, such that it also becomes unlikely that this ratio would affect local branch lending by channels, beyond the size of the corresponding foreign funding shock itself. These arguments make it plausible that the pre-crisis ratio of foreign funding is a valid instrument for the size of the shocks during the crisis.

When estimating Equation (3.1) with the IV approach, we continue to identify the lending channel of foreign funding shocks similarly to the way we have for our previous analysis. The estimation results appear in Table B.III in Appendix B. Column (1) reports the first stage of the estimation, with ΔLog foreign funding as the dependent variable and the pre-crisis foreign funding ratio as the main explanatory variable. Consistent with our previous discussion, a larger pre-crisis ratio predicts a lower growth rate of foreign funding after September 2008. Column (2) reports the results of the second stage using our preferred FE estimation. The IV estimation confirms the baseline estimated effect of ΔLog foreign funding on ΔLog credit.

Columns (3) and (4) perform a final test in which we replicate the instrumental variable model for the subsample of banking conglomerates whose headquarters report a pre-crisis foreign funding ratio below the 25th percentile of the headquarters' sample distribution. Following Angrist et al., 2010, we expect these banks to be "never-takers", in the sense that the model should not be informative about their lending channel because the instrument should not affect the size of their funding shocks. The results confirm this hypothesis. As we expected, the instrument is only informative about the size of shocks and effectively identifies a lending channel for banks with relatively large ex ante exposure to foreign funding.

3.3.3 Zooming in: The role of foreign banks

Foreign ownership. Table 3.3 provides evidence that the foreign ownership dummy, identifying banks in Brazil that belong to a FBHC, has no effect on the main finding of the empirical model, namely, that a positive relationship existed between negative foreign funding shocks and the contraction in credit during the crisis. Foreign ownership is an important aspect of banking globalization, so in this section we seek to provide further insights into the role of foreign banks in affecting the lending channel identified at this stage.

The baseline results suggest that the effect of the funding shocks persists when controlling for foreign ownership, yet the size of this effect might differ, depending on the ownership structure of a bank. In contrast with domestic banks, foreign banks have access to liquidity allocations within the international network of financial institutions to which they belong. During a global financial crisis, such intra-bank capital markets could work either in favor or against the stability of a foreign-owned bank in Brazil. On the one hand, FBHC can provide internal liquidity even if global interbank markets are suffering from distress, compensating for the freeze in traditional interbank funding sources. On the other hand, FBHC affected by the crisis might allocate liquidity from a consolidated perspective. If a foreign bank in Brazil can provide a source of liquidity for other members of its banking network, its own capacity to underpin its core credit business might suffer. The actual role of foreign ownership in shaping the effects of a foreign funding shock is therefore a more complex question that cannot be properly addressed by our baseline results.

As a first step toward analyzing the role of foreign ownership, we extend the baseline model by adding an interaction term between ΔLog foreign funding and foreign ownership. This approach is different from previous studies on the effect of foreign funding exposures on lending, in which foreign ownership and proxies for foreign funding exposure enter the empirical model separately (Ongena et al., 2015). We already have shown that the effect of foreign funding shocks is relevant for all banks, so we believe that an interaction model can provide more detailed information about the differential effects of the shock conditional, on ownership characteristics. Under this setup, Equation (3.1) is modified to:

$$\begin{aligned}\Delta\text{Log credit}_{ij} = \lambda_j &+ \beta_1 \Delta\text{Log foreign funding}_i \\ &+ \beta_2 \Delta\text{Log foreign funding}_i \times \text{Foreign}_i \\ &+ \sum_{k=3}^{K} \beta_k x_{kij} + \epsilon_{ij}.\end{aligned} \tag{3.3}$$

With Equation (3.3) we can retrieve the marginal effect of the foreign funding shock for foreign and domestic banks. In Columns (1) and (2) in Table B.IV we show that the positive coefficient is significantly larger and has greater explanatory power for foreign banks. According to this analysis, on average, the pass-through of foreign funding shocks to lending was more pronounced for foreign banks. Our results confirm that our two dimensions of banking globalization – foreign funding and foreign ownership – relate strongly, and the underlying transmission channel of a foreign liquidity shock arises from their interaction, not solely from their stand-alone effects.

By replacing the foreign ownership dummy by a government ownership dummy, we can also show with Equation (3.3) whether a differential effect of ΔLog foreign funding on ΔLog credit for the group of government-owned banks exists. This analysis splits the sample between government- and privately owned banks, estimating whether the baseline effect of ΔLog foreign funding varies between the two bank groups. The results from this extension show that this is not the case (see Columns (3) and (4) in Table B.IV). This contrasts with findings by (Coleman and Feler, 2015), where aggregated banks' balance sheets in Brazil at the municipality-level are used to show that municipalities with a larger presence of government-owned banks suffered from lower credit restrictions in the crisis. Our analysis with granular branch level data shows that even if the regional presence of government-owned banks could have been beneficial in the aggregate, the specific lending channel of foreign funding shocks was still similarly active for these banks compared to other institutions.

Crisis performance of foreign parent banks. Can the differential effect of the shock for foreign banks be linked to the performance of their FBHC headquartered abroad during the crisis? If the FBHC of a given bank was, for example, exposed to the U.S. subprime mortgage market in the U.S., the Brazilian affiliates of that bank likely would be more affected by a foreign funding shock than its other foreign-owned competitors.

To shed light on this potential heterogeneity in the lending channel, we restrict the sample to foreign-owned banks and add variables that can account for the distinct performance of FBHC after September 2008. From Bureau Van Dijk's BankScope, we obtain yearly information about FBHCs' yearly assets, liquid assets, capital, deposits and net returns. From this data we compute ratios of capital, liquidity, deposits and net returns to total assets for 2008 and 2009. Then we compute the change in these end-of-year ratios between 2008 and 2009 in order to capture the effect of the crisis on FBHCs assets and liabilities' structure, capitalization and profitability. We follow Ongena et al., 2015 in measuring banks' performances during the crisis with this approach. By construction the aforementioned ratios increase when a FBHC increases its capital, liquidity, deposits or net profit ratios in 2009 compared to 2008. We use hand-collected identifiers of the FBHCs of banks in our sample to merge the FBHC variables with our baseline Brazilian sample. The information to create this identifier comes from banks' own websites and from the the Claessens and Van Horen (2014) Banks Ownership Database.

By merging these data sources, we aim to determine whether the lending channel's primary identification with foreign-owned banks relates to the link between the size of foreign funding shocks and the performance of FBHC during the crisis. If so, it would provide indirect evidence that an international internal capital markets channel is driving our results. Moreover, it would address the open question about why foreign funding shocks and foreign ownership seem to interact when it comes to identifying the lending channel of foreign funding shocks.

The reduced sample of foreign banks consists of 16 foreign-owned banks with a total network of 545 bank branches. As in our baseline specification, we ensure that at least two foreign-owned banks are active in each municipality and thus can estimate our preferred model with municipality fixed effects, to capture common shocks to all banks within each regional entity. Extending the model in Equation (3.1), we can account for the interaction between foreign funding shocks and FBHC traits, similar to our previous extensions. Formally,

$$\begin{aligned}\Delta\text{Log credit}_{ij} = \lambda_j &+ \beta_1 \Delta\text{Log foreign funding}_i \\ &+ \beta_2 \Delta\text{Log foreign funding}_i \times \Delta\text{FBHC trait}_i \\ &+ \sum_{k=3}^{K} \beta_k x_{kij} + \epsilon_{ij}.\end{aligned} \tag{3.4}$$

The variable ΔFBHC trait represents the change in the ratios of capital, liquidity, deposits or net profit ratios to the FBHC between 2008 and 2009. In Appendix B, Table B.V provides descriptive statistics about the FBHC traits. Mirroring Figure 3.2 we split the reduced sample by the median shock size to define banks that were more and less affected by the foreign funding shock. Overall, 267 branches belong to shock-affected banks, and 278 branches represent the group of non-affected banks. Replicating Table 3.2 then we report the difference in the average FBHC-trait between these two groups of banks. FBHC-traits are well distributed across banks differently affected by funding shocks. Tests of normalized differences show that, if anything, largely affected banks tend to belong to FBHCs that increase their capitalization by more after 2008. We exploit this feature in the data to estimate the differential pass-through of banks with a similar ΔLog foreign funding for different values of ΔFBHC trait.

To explore this hypothesis formally, we estimate Equation (3.4) and provide results in Table B.VI in Appendix B. Our main variable of interest is the interaction term between ΔFBHC trait and ΔLog foreign funding. The ΔFBHC trait identifies the respective FBHC performance measures at the top of Columns (1) to (4). We add to the vector of controls x_k the log of total assets, the ratios of capital-to-assets, liquidity-to-assets and deposits-to-assets as of 2007, computed at the FBHC level. We expect these variables to capture the effect of the size, the capitalization, and the funding structure of FBHC on their ability to cope with the effects of the crisis.

Bank branches from FBHC that lose relatively more capital and increase their liquidity ratios by more than other FBHC report weaker credit growth as a consequence of the foreign funding shock. We do not find evidence of the effect of the shock being correlated with adjustments in FBHC profitability or funding structures though. This result links our previous findings to an international internal capital market that becomes disrupted after September 2008. In other words, local frictions in internal capital markets between the branches and their headquarters are not the only influences that shape the transmission of the crisis; international frictions in access to foreign funding also explain substantial heterogeneity in the estimated lending channel when compare domestic with foreign banks.

In more detail, Figure 3.5 depicts the marginal effects of the foreign funding shock on lending growth along the distribution of changes in the capital ratio (upper panel) and in the liquidity ratio (bottom panel). In line with the preceding discussion, the pass-through of the foreign funding shock is more likely to occur if FBHC face a negative capital shock or increase their available liquid assets. In particular, this latter finding could be linked to

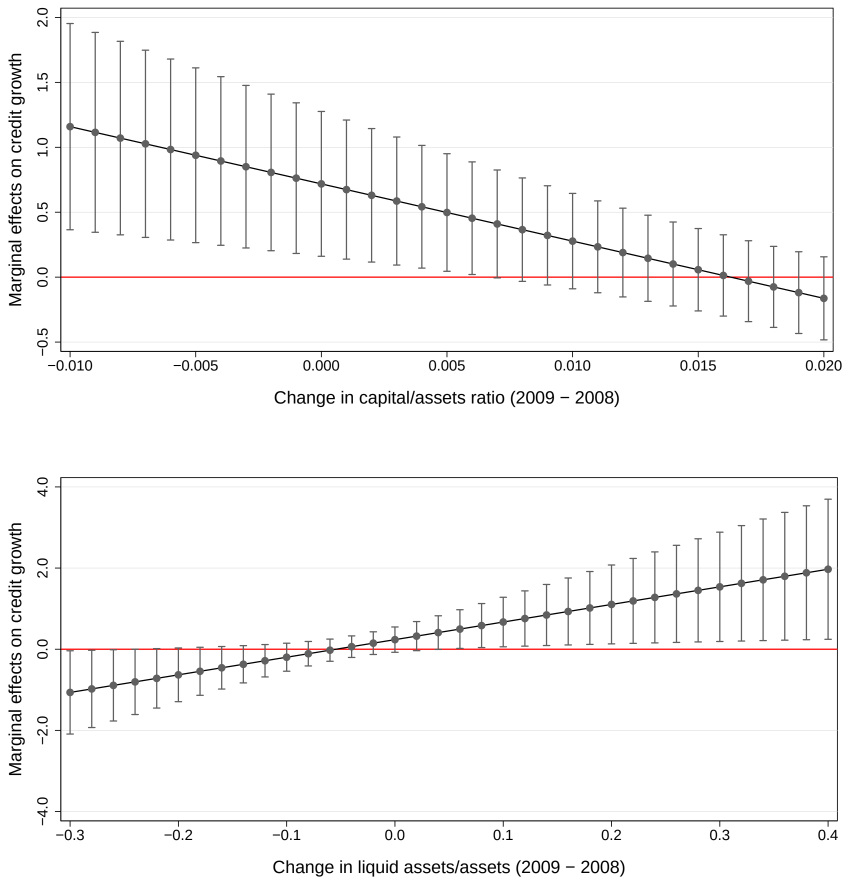


FIGURE 3.5: This figure illustrates the marginal effects at the 95% confidence level of Equation (3.4) estimated for the subsample of foreign-owned banks. The upper panel shows the marginal effects of ΔLog foreign funding along the distribution of the change in the capital-assets ratio between 2008 and 2009. The bottom panel replicates the exercise using the ratio of liquid to total assets. The regression results are reported in Table B.VI in Appendix B.

a cross-border spillover of the liquidity hoarding reaction by banks documented for the global financial crisis by Cornett et al., 2011, Berrospide, 2013 and Acharya and Merrouche, 2013. Even though we do not observe the counterpart of Brazilian banks' foreign liabilities, the analysis suggests a high sensitivity of the lending channel to the performance of FBHC during the crisis for foreign banks in Brazil. This finding is in line with the hypothesis of the existence of internal capital market frictions between foreign banks and their FBHC abroad.

Overall, our analysis of FBHC suggests some degree of sensitivity of the lending channel to the performance of FBHCs during the crisis, in line with previous findings on the importance of cross-border internal capital markets in emerging countries (e.g., De Haas and Lelyveld, 2010; Cetorelli and Goldberg, 2011). Our findings depict the lending channel of foreign funding shocks as a complex phenomenon, in which different dimensions of banking globalization – foreign funding, foreign ownership and cross-border internal capital markets – interact to determine the extent of the pass-through of foreign funding shocks to local credit supply.

U.S. Government bailouts. A final extension of our baseline model involves an analysis of large liquidity injections in the United States after the outbreak of the crisis. In our sample, FBHC are mostly large global banks that had access to the Term Auction Facility (TAF) program than enabled depository institutions in the United States to borrow, once the interbank markets show signs of financial distress. The auctions were conducted between 2008 and 2010 and represented an important alternative source of liquidity for banks facing a sudden freeze in interbank markets. Koetter et al. (2015) show that TAF access translated into credit interest rate adjustments by banks in Germany that had an affiliated bank in the United States, but no evidence exists for how TAF access influence lending adjustments by foreign banks in emerging countries. To investigate the potential cross-border spillover of the TAF program, we adjust our baseline specification as follows:

$$\begin{aligned}\Delta\text{Log credit}_{ij} = \lambda_j &+ \beta_1 \Delta\text{Log foreign funding}_i \\ &+ \beta_2 \Delta\text{Log foreign funding}_i \times TAF_i \\ &+ \sum_{k=3}^{K} \beta_k x_{kij} + \epsilon_{ij},\end{aligned} \tag{3.5}$$

where TAF is an index indicating the extent of access to the TAF program for a given FBHC, weighted by the size of the foreign funding shock of its subsidiary in Brazil. To transform this index into a variable thar is easier to interpret, we first normalize the inverse of the ΔLog foreign funding to generate a continuous variable between 0 and 1, where 1 indicates banks with a relatively large negative foreign funding shock. Next, we collect monthly data about individual access by FBHC to the TAF program from Bloomberg. This source also enables us to compute the average ratio of TAF balances to capital during the post-crisis period. This latter variable constitutes the TAF ratio. Finally, we divide the TAF ratio by the foreign funding shock index and normalize the statistic to obtain a continuous variable between 0 and 1 that increases when the TAF ratio is larger, relative to the size of the foreign funding shock. The economic intuition behind this index is that it should reflect the extent of the excess liquidity provided by the U.S. Fed, relative to the liquidity shortage at the Brazilian subsidiary level, triggered by the foreign funding shock.

We follow the same approach we used for the FBHC traits to assess whether the lending channel can be identified for a given portion of the distribution of the TAF index. Preliminary results in Table B.V show that FBHC from more affected foreign banks reported similar TAF ratios in the post-crisis period compared to less affected banks. However, we do find statistically significant differences in the TAF index. On average, more affected banks reported a lower access to TAF liquidity at the FBHC-level relative to the size of their foreign funding shocks.

The formal results of this analysis are reported in Columns (1) to (3) in Table B.VII in Appendix B. As a first test, we report in Column (1) the interaction term between ΔLog foreign funding and the (unweighted) TAF ratio. This interaction enters the model with a negative sign, indicating that the positive coefficient for ΔLog foreign funding decreases and approaches 0 when the TAF ratio increases, that is, when access to the TAF program is relatively large relative FBHC capitalization. We then replicate the exercise by using the average TAF index in Column (2), finding similar results. Since the TAF-access data is reported on a monthly basis, using the average TAF index might fail to properly capture TAF liquidity if a given FBHC only reports relatively large balances in a few months across the post-crisis period. In a final specification we therefore recalculate the index as the maximum post-crisis TAF ratio weighted by the respective shocks' size. Results reported in Column (3) confirm our findings.

A natural concern with this analysis is the potential correlation between access to TAF liquidity and the financial health of the FBHC. If FBHC self-select into the TAF program when they face larger financial restrictions in the crisis, then TAF access could correlate with ΔLog foreign funding. If the TAF index is not weighted by the shocks' size, this latter concern would lead us to expect the interaction term in Table B.VII to be positive – that is, a stronger lending channel if FBHC report greater access to the TAF. We regard this as a minor concern, because the shock weight in the TAF index allows us to specify the effect of TAF access on the identified lending channel, conditional on the size of the reported funding shock. Moreover, the negative coefficient on the interaction term contradicts the prediction that would stem from this critique.

While still considering our previous results, we also compute the marginal effects of ΔLog foreign funding along the distribution of the TAF index, as reported in Figure 3.6. The estimated coefficient for the foreign funding shock turns positive and statistically significant for banks whose FBHC abroad had relatively less access to the TAF program, relative to the shock. In other words, wider access to the TAF program partially offset the negative consequences of foreign funding shocks in Brazilian foreign bank affiliates.

This latter result is important in at least two critical regards. First, it documents, for the first time, that access to liquidity facilities by global banks during the crisis had internal effects on those institutions worldwide. Brazilian banks whose FBHC were able to obtain more resources from the TAF program benefited from having an alternative to compensate for the foreign funding shock. Second, the evidence in Figure 3.6 shows that countries can benefit from a better coordination of liquidity interventions when financial distress is global. Interventions in one country can affect the worldwide banking network, so countries should coordinate the timing, size, and target of large liquidity interventions to make them more effective as policy tools.

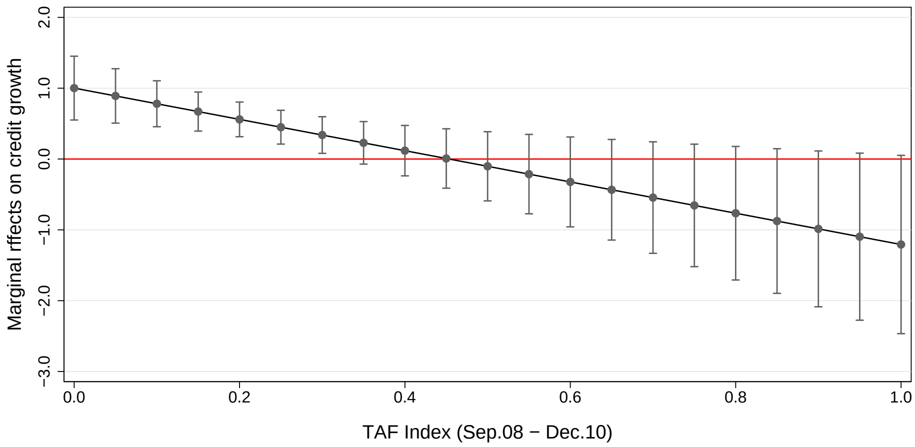


FIGURE 3.6: This figure illustrates the marginal effects at the 95% confidence level of Equation (3.5) estimated for the subsample of foreign-owned banks. The associated regression results are reported in Table B.VII in Appendix B.

3.4 Real effects of the bank lending channel

The most relevant aspect of a bank lending channel is whether it gets transmitted to the real economy or if borrowers can compensate for a shortfall in credit from one affected bank by tapping another, less affected bank. We provide a second set of regressions in which we investigate if and how real outcomes at the municipality level were affected by a shock to the foreign funding position of banks that were active in those regions.

For this purpose, and according to Khwaja and Mian (2008), we include all bank branches that were active in the municipalities from our baseline analysis in Section 3.3 at each point in time. In doing so, we allow for the possibility that borrowers might offset the lending restriction imposed by shock-affected banks by accessing credit in other banks, even those without direct exposures to global interbank markets. For this analysis, we aggregate the data at the municipality level by weighting bank traits by the share of each bank in each municipality's credit market.[8] With this data set, we ran

[8]If a bank has missing data related to its foreign funding position, we impose an assumption that the bank experienced a growth in "virtual" foreign funding of 0 between the two periods analyzed. Khwaja and Mian, 2008 instead might suggest an assumption in which the banks experience foreign funding growth equal to the sample average, with no variation in the results. We need to retain banks that do not report regularly active positions of foreign liabilities in the sample to obtain conservative estimates of the borrowing channel of financial contagion. If we instead consider only the 41 banks from the baseline sample, we would only allow customers to switch off their funding sources across banks. The final sample including all banks features 100 banks and 11,134 bank branches in the

the following regression:

$$\Delta\text{Log outcome}_j = \alpha_0 + \alpha_1 \Delta\text{Log foreign funding}_j + \sum_{k=2}^{K} \alpha_k x_j + \epsilon_j, \tag{3.6}$$

where outcome refers to four real outcome variables on the municipality level j: the total amount of credit (monthly), number of jobs created (monthly), difference between jobs created and terminated (monthly), and real GDP (yearly).

From Equation (3.6), it becomes clear that the credit demand control described in Equation (3.1) cannot be implemented in this stage of the analysis. By construction, all variables are aggregated at the municipality level. Recall the correlation between foreign funding shocks and demand shocks that arise from our results, such that we confirmed that an OLS estimation of Equation (3.1) underestimates the true effect of the lending channel, in that shock-affected banks tend to experience large positive credit demand shocks too. Furthermore, shock-affected banks served more profitable firms in the pre-crisis period, resulting in a larger average profitability of the credit portfolio. Leveraging these previous arguments, we assert that an OLS estimation of Equation (3.1) provides conservative estimates of the real adjustments triggered by the bank lending channel.

To ensure that our analysis of the borrowers' perspective on the foreign funding shock mirrors that from the previous section, we retain the control variables from Equation (3.1). For example, the virtual deposit ratio of a given municipality is defined as the credit market share-weighted deposit ratio of all bank branches active in that municipality at a given point in time. We again collapse the time dimension to avoid concerns of serial correlation. As municipality-level control variables, we include their size (GDP in log US$ million) and the ratio of total credit to GDP. This latter variable should capture the effects of financial depth and financial dependence on regional

same 1,768 municipalities. This restriction ensures a reasonable and consistent comparison between the two bodies of results provided herein.

economic performance during the crisis. The municipality GDP data are reported by the Brazilian Institute of Geography and Statistics. Aggregated credit can be computed from branch level data.

As a first step in the analysis, we note that if we expect to observe an effect of the funding shock on local labor markets, we should observe first that borrowers were not able to compensate for the shock by switching their funding sources, even to banks that were not directly exposed to the shock. We test this prediction by estimating the effect of the (market-share weighted) shock on the change in log aggregated outstanding credit in each municipality. The results in Column (1) of Table 3.5 confirm this condition: Municipalities facing a larger market-weighted shock in their banks experience weaker credit growth, and the result is statistically significant. We thus have initial evidence that borrowers were unable to offset the shock, opening a path for further consequences in local economies. The same data source has been previously used by Carvalho (2014) to investigate the real effects of government-owned banks in Brazil.

3.4.1 Lending channel and labor market outcomes

We can trace the foreign funding shock to a regional level and investigate its effects on real outcomes, such as job creation in each municipality in each month. We collected relevant data from the website of the Brazilian Ministry of Labor, which reports these statistics under the General Survey of Employed and Unemployed (Cadastro-Geral de Empregados e Desempregados). The Brazilian government uses these official statistics to assess developments in the labor market. Firms must report all new labor contracts and terminated contracts at the end of each month. The results are made publicly available, aggregated to the municipality level. The measures only cover the official labor market, so we cannot observe trends in the informal labor markets. The Ministry of Labor also conducts studies of the real coverage of the labor statistics and has concluded that they represent approximately 73% of total hiring and firing per month. We cannot confirm this evaluation, but relying on data from the official labor market provides a

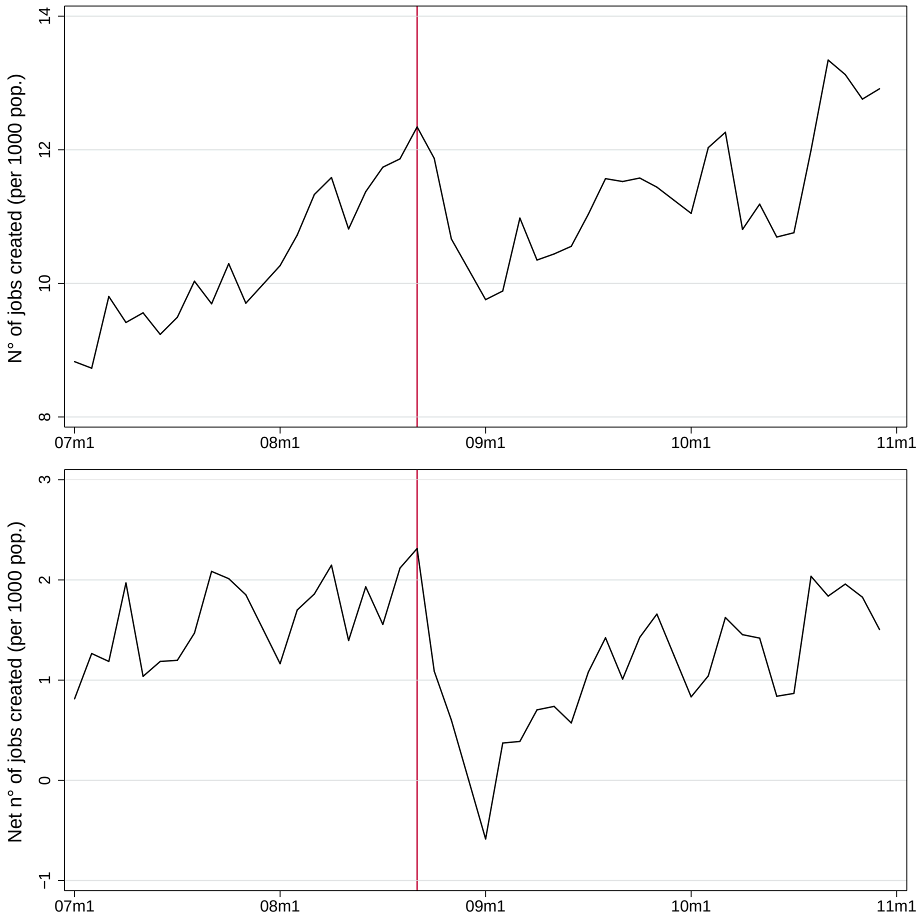


FIGURE 3.7: Aggregated job creation (first panel) and net job creation (second panel) per 1000 population in Brazilian municipalities. The underlying time series report the number of working contracts officially signed in a given municipality per month, as well as the number of working contracts terminated during the same period. Net job creation is computed by subtracting the terminated contracts from the number of new contracts. The graph shows the disruption in local labor markets triggered by the global financial crisis in September 2008 (vertical line).

reasonable context to understand the relationship between credit and labor markets, because informal and less institutionalized firms likely are excluded from formal credit markets anyway.

We construct two measures for labor market outcomes: the change in the log of the average jobs created in the post-crisis period minus the average in the pre-crisis period, or “job creation”, and the net number of jobs created (number of jobs created minus number of jobs destroyed) in each region, or “net job creation”. The absolute number of jobs created relates directly to the size of each municipality, so we add regressions in which the measures of job creation are weighted by the municipalities’ population and reported in terms of jobs created per 1000 inhabitants. The time series of these variables are plotted in Figure 3.7, which shows large disruptions in job creation (first panel) and net job creation (second panel), coinciding with the outbreak of the global financial crisis.

The results of estimating Equation (3.6) are reported in Columns (1) to (6) in Table 3.5. Column (1) reports the aforementioned effect on aggregated credit growth. The baseline results on labor market performance in Columns (2) and (3) show a significant effect with the expected positive sign of the funding shock on job creation and net job creation. We anticipate that these results might be affected by heterogeneity in municipalities' size, so we weighted the outcome measures by the municipalities' population, obtained from the yearly statistics of the Brazilian Institute of Geography and Statistics. This extension, reported in Columns (4) and (5), confirms the effect of the lending channel of foreign funding shocks on labor market outcomes. The results for the population-weighted net job creation, which reflects more economically meaningful results, show that a 1% decrease in market-share weighted foreign funding growth translates into a 0.57% lower growth rate in net job creation in the post-crisis period.

Column (6) further shows that the economic fragility triggered by the funding shock is not restricted to the job market in particular; GDP (change in log GDP between 2008 and 2009) is also weaker as a consequence of the funding shock. A cross-border lending channel like the one identified in Section 3.3 thus is by no means innocuous. When borrowers fail to access alternative funding sources to substitute for their reliance on affected banks, the lending channel can have significant effects on the real economy.[9]

[9]For robustness, we check our results by employing the pre-crisis exposure to foreign funding as an instrument for the shocks' size as in Section 3.3.2, when we consider the bank lending channel on the branch level. We report first and second stage results and results for the reduced form in Figure B.IV. The top panel shows that the instrument is relevant for ΔLog foreign funding and that the second stage results remain significant for the different dependent variable we use in Table 3.5. The bottom panel reports regressions for the subsample of municipalities with a foreign funding ratio below the 25th percentile of the sample distribution. Here, the first stage results and the reduced form regressions are insignificant providing evidence for the exclusion restriction of our instrument.

Table 3.5: Real effects of the lending channel.

		Unweighted		Per 1000 population		
	Agg. ΔCredit (1)	ΔJob Creation (2)	ΔNet Job Creation (3)	ΔJob Creation (4)	ΔNet Job Creation (5)	ΔGDP 08-09 (6)
ΔLog foreign funding	0.580***	0.461**	0.917***	0.364***	0.567***	0.157*
	(0.168)	(0.197)	(0.287)	(0.133)	(0.198)	(0.081)
Headquarter level						
Size (log Assets)	−0.004	−0.102***	−0.087*	−0.060**	−0.049	−0.003
	(0.029)	(0.032)	(0.052)	(0.024)	(0.039)	(0.015)
Capital Ratio	0.028	3.920***	2.907*	2.044**	2.464*	0.838*
	(0.979)	(1.211)	(1.765)	(0.827)	(1.266)	(0.500)
Liquidity Ratio	−1.606	−2.769***	−4.908***	−1.934***	−4.231***	−1.083**
	(1.073)	(0.935)	(1.751)	(0.713)	(1.443)	(0.532)
Deposit Base	0.847	1.681***	1.800*	1.362***	2.308***	−0.067
	(0.566)	(0.625)	(1.030)	(0.491)	(0.833)	(0.323)
Credit Risk	−5.219**	3.946**	4.248	1.907	2.230	3.980***
	(2.057)	(1.812)	(3.242)	(1.377)	(2.492)	(0.976)
Foreign	−0.396*	−0.454*	−0.852**	−0.387**	−0.929***	−0.348***
	(0.231)	(0.244)	(0.400)	(0.187)	(0.306)	(0.120)
State-owned	0.518*	−0.111	−0.049	−0.116	−0.326	−0.473***
	(0.303)	(0.274)	(0.480)	(0.215)	(0.385)	(0.147)
Branch level						
Size (log Assets)	−0.005	0.005	−0.003	−0.003	−0.018	−0.027***
	(0.018)	(0.019)	(0.030)	(0.015)	(0.024)	(0.009)
Liquidity Ratio	9.653***	17.683***	18.416***	6.011***	6.686**	0.617
	(2.470)	(3.488)	(5.382)	(2.023)	(3.266)	(1.471)
Deposit Base	0.649***	0.279	0.449	0.198	0.115	−0.059
	(0.168)	(0.222)	(0.322)	(0.158)	(0.237)	(0.094)
RoA	−4.492*	−8.336**	−12.042**	−4.051	−4.867	−1.926
	(2.649)	(3.693)	(5.190)	(2.582)	(3.757)	(1.381)
Municipality-level						
Size (GDP)	0.049***	0.031**	0.034	0.030***	0.024	0.029***
	(0.014)	(0.014)	(0.020)	(0.012)	(0.018)	(0.006)
Credit/GDP Ratio	−0.012***	0.008	−0.008	0.010*	0.012*	−0.006**
	(0.004)	(0.006)	(0.007)	(0.005)	(0.007)	(0.003)
Constant	0.297***	−0.101*	−0.072	−0.095**	−0.132	0.157***
	(0.050)	(0.059)	(0.105)	(0.047)	(0.082)	(0.034)
Obs.	1768	1768	1768	1768	1768	1768
R-squared	0.185	0.077	0.042	0.048	0.027	0.053

Notes: This table reports the results of estimating Equation (3.6) for different real economic outcomes at the municipality-level. The sample includes the 42 banks of the baseline sample plus all other active banks not relying on foreign funding during the sample period. This makes an overall sample of 100 banks and 11,134 bank branches. This data set is aggregated at the municipality-level. The pre-crisis period is defined between January 2007 and August 2008, whereas the post-crisis period is defined between September 2008 and December 2010. Standard errors are clustered at the municipality-level. The real outputs considered are the change in log aggregated outstanding credits (Column (1)), the change in the log number of new contracts ("job creation", Column (2)), the change in the log number of new contracts minus terminated contracts ("net job creation", Column (3)), the change in log job creation per 1000 inhabitants (Column (4)), the change in log net job creation per 1000 inhabitants (Column (5)), and the change in log GDP between 2008 and 2009 (Column (6)). For a detailed definition of all variables see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

3.4.2 Are regions equally vulnerable?

As was the case at the bank level, different municipalities might vary in their adjustment to the funding shock. Several vulnerabilities might come into play; one that deserves attention is the fragility arising from a large procyclicality of credit (Borio et al., 2001). If our results regarding the real economic consequences of the lending channel are correct, we expect the results to be associated with more structural underlying fragility in the financial sectors of the individual municipalities. Substantial procyclicality has been associated with information asymmetries and moral hazard faced by financial institutions. If the current risk of a borrower cannot be assessed effectively, this uncertainty will lead banks to overreact in times of both booms and crisis. Evidence that our results are driven by municipalities for which this particular fragility is historically stronger would help confirm that the effect of the funding shock is transmitted to the real economy when banks operate under higher degrees of uncertainty. Moreover, it would have important policy implications; instead of a foreign funding shock stemming exogenously from abroad, the local procyclicality of credit can be addressed by local macroprudential policies.

For a more widespread analysis of regional ex-ante vulnerabilities, we address the role of other characteristics that have been identified in prior literature as affecting the transmission of financial shocks to the real sector. To do so, we augment Equation 3.6, as follows:

$$\begin{aligned} \Delta\text{Log outcome}_j = \alpha_0 &+ \alpha_1 \Delta\text{Log foreign funding}_j \\ &+ \alpha_2 \Delta\text{Log foreign funding}_j \times MP_j \\ &+ \sum_{k=3}^{K} \alpha_k x_j + \epsilon_j, \end{aligned} \tag{3.7}$$

and we test four interacting variables separately, represented by MP. First, we interact the shock with our measure of the credit-to-GDP ratio. Following Rajan and Zingales, 1998, we expect the pass-through of the funding shock to be stronger in financially dependent municipalities. Second, we interact the shock with the municipalities' size, measured as the log of GDP. Khwaja and Mian, 2008 find that smaller firms are more likely to be affected by financial shocks. We test whether a similar conclusion exists at the regional level, such that smaller municipalities have more trouble offsetting the size of the funding shock. Finally, we determine whether we can replicate our results regarding the role of foreign banks from Section 3.3 in this analysis of real economic outcomes. Accordingly, we interact the funding shock with foreign banks market shares in each municipality.

For this final exercise, we estimate Equation (3.7). The interacting variables correspond to the credit-to-GDP ratio, log GDP, average market share of foreign banks, and the average historical correlation (2005-2008) between the month-on-month change in log aggregated credit and the month-on-month change in log net job creation in the municipalities in the sample. We therefore rely on the earliest observations available for credit and job market credit, dating back to 2005. We compute these variabes in the pre-crisis period in order to avoid double-causality concerns. The dependent variable is the change in net job creation per 1000 population (see Table 3.5, Column (5)).

In Table B.VIII in Appendix B, the vulnerability measures correspond to one of the aforementioned variables related to the expected characteristics of municipalities that might affect the pass-through of the foreign funding shock. In line with predictions, this pass-through is stronger when municipalities report a large credit-to-GDP ratio, a large market share of foreign banks, and a large procyclicality of credit growth. We do not find evidence of a differential pass-trough of the lending channel for small vs. large municipalities.

The marginal effect of the funding shock on net job creation along the distributions of credit-to-GDP ratio (top panel) and credit versus job market correlation (bottom panel) are depicted in Figure 3.8. The results confirm our conjecture that the effects are driven by municipalities with substantial financial dependence, as measured by the credit-to-GDP ratio and historically large procyclical banking sectors.

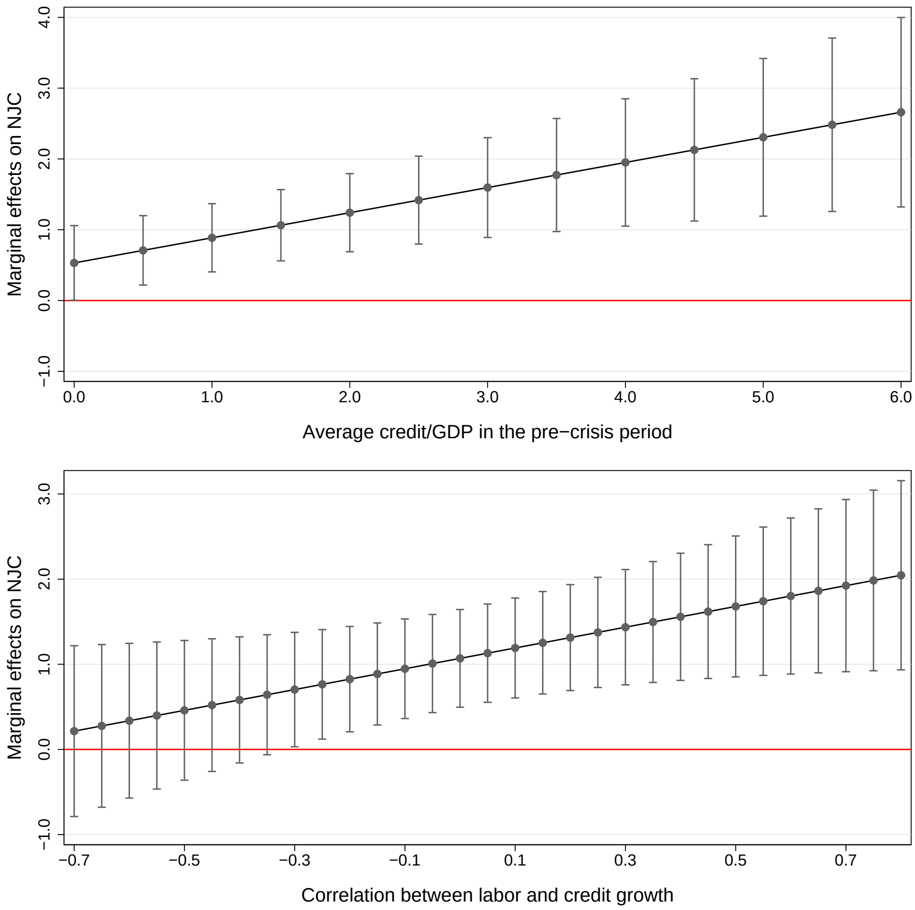


FIGURE 3.8: This figure illustrates the marginal effects at the 95% confidence level of Equation (3.7). In the first panel the marginal effects are retrieved from a regression with an interaction of Δ Log foreign funding and $Credit/GDP_j$ which represents the pre-crisis average of the ratio of total credit to GDP in each municipality j. In the second panel the marginal effects are obtained from an interaction with $Corr(\Delta Credit, \Delta NJC)_j$ which corresponds to the average historical correlation (2005-2008) between the month-month change in Log aggregated credit and the month-month change in Log net job creation per 1000 inhabitants in the municipalities in the sample. The estimates come from Table B.VIII in Appendix B.

3.5 Conclusion

We document how the turbulence of international interbank markets after the collapse of Lehman Brothers affected the Brazilian financial system. Using an identification setup similar to Khwaja and Mian (2008), we find robust evidence of a bank-branch lending channel, such that local municipal branches associated with parent banks that suffered decrease of foreign interbank funding after September 2008 significantly reduced their credit. The pass-through of the foreign funding shock to local credit markets was particular pronounced for foreign-owned banks, evidently because foreign banks were particularly sensitive to the financial performance of their bank holding companies abroad. Moreover, we document spillover effects of access to the TAF program during the crisis; bank affiliates in Brazil whose parent banks reported greater access this program were less affected by the foreign funding shock.

The results regarding the existence of a bank lending channel corroborate findings by Khwaja and Mian (2008), Schnabl (2012), and Ongena et al. (2015). Extending those studies, our results shed light on the specific role played by foreign banks in shaping the cross-border transmission of shocks by explicitly observing banks' activity in foreign interbank markets during the crisis. Moreover, our analysis of a lending channel within the network of regional bank branches in a large emerging country provides new insights on how a shock can be transmitted through retail banking networks to the real economy. Brazilian municipalities that hosted more affected branches saw a decline in job creation and GDP after the Lehman Brothers collapse of 2008.

Our results thus suggest that a funding shock generated abroad can be transmitted through banks' branch network across borders and thereby affect regional economic outcomes. This result in turn suggests effective ways to achieve a better balance between the benefits and risks of banking globalization.

Appendix B

B.I Data construction

Bank-level data were retrieved from banks' call reports, collected and published by regulatory authorities in Brazil. This data set consists of information on banks' balance sheets and income statements on a monthly basis, reported in local currency. The data were downloaded from the website of the Brazilian Central Bank at different moments between 2014 and 2015. After downloading the information, the data were adjusted, translated, and labeled to ensure their consistency. Mandatory reporting by banks ensures comprehensive coverage of all financial institutions with a banking license in Brazil. Non-bank financial institutions without a banking license are not included in the call reports.

To account for valuation effects and facilitate interpretations, we converted the data from the nominal local currency to real U.S. millions of dollars as of December 2013, by collecting end-of-month data on the respective exchange rates from the website of the Federal Reserve Bank of St. Louis. From the same source, we obtained end-of-month U.S. inflation data, which we used to compute a dollar deflator, for which the 100% level is set at December 2013. The original data also were extended by including information on banks' ownership status, collected mainly from the banks' websites and from Claessens and Van Horen's (2014) Banks Ownership Database.

B.II Tables and figures

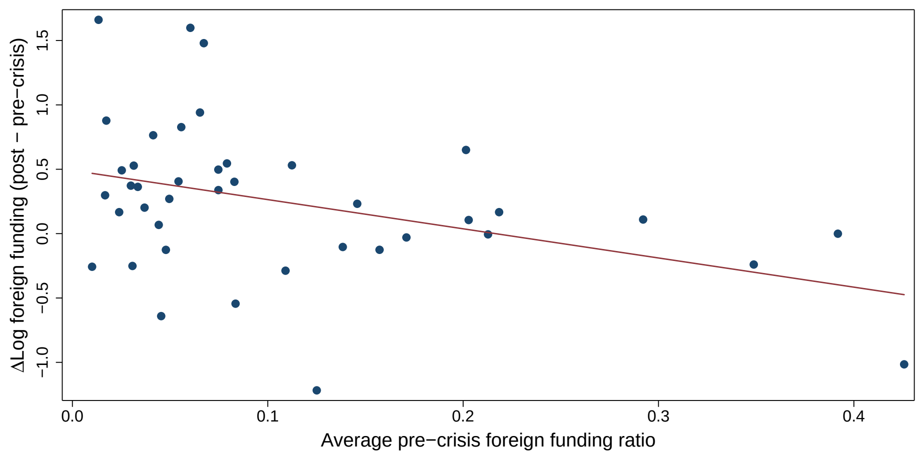


FIGURE B.I: This figure illustrates the relationship between the change in log foreign funding between the pre- and post-crisis periods and the pre-crisis ratio of foreign funding to total assets for the banks in the sample. The change in foreign funding is computed as the log difference of average foreign funding in the periods between January 2007-August 2008 and September 2008-December 2010. The pre-crisis ratio is the average monthly ratio reported in the sample. The negative relationship between the two variables is statistically significant at the 1% level.

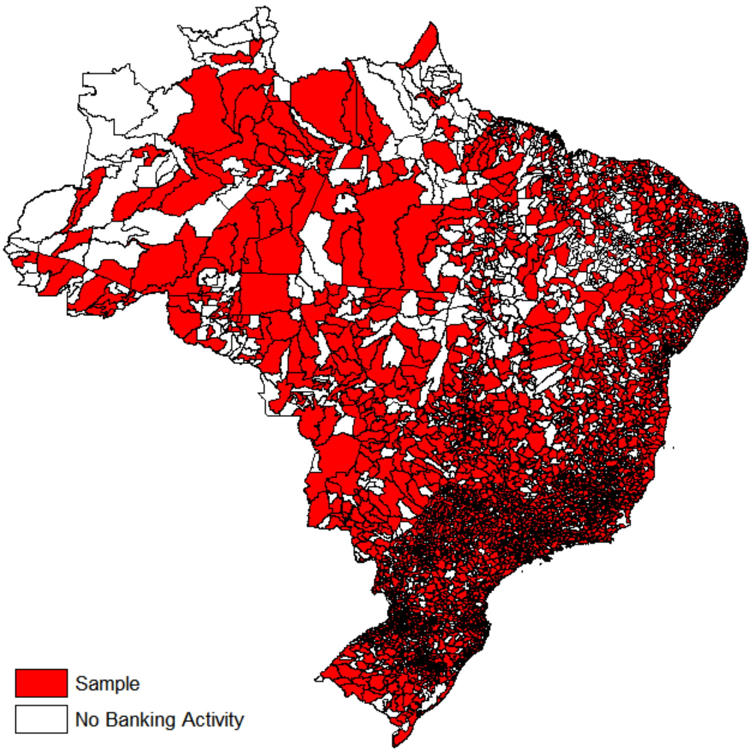


Figure B.II: This figure depicts the geographical distribution of the baseline sample. Regions in red represent municipalities reporting banking activity through local bank branches between 2007 and 2010. The regions in white are those in which no banking activity is reported. For each municipality in the sample, the monthly call reports of all individual active branches were collected. Overall, banks report being active in 3,242 of 5,570 municipalities in Brazil. This corresponds to 58% of total municipalities, or 87% of Brazilian GDP in 2008.

Table B.I: Alternative shock definitions and placebo tests.

	(1) Shock Def. Δ 9m6-8m9	(2) Shock Def. Δ 10m12-9m12	(3) Shock Def. Av.%Δ 8m9-9m6	(4) Shock Def. Crisis 07m6-08m8
ΔLog foreign funding	3.061**	−0.305	2.550*	−0.036
	(1.564)	(0.793)	(1.411)	(0.091)
Headquarter level				
Size (log Assets)	0.026	0.051	0.022	−0.010
	(0.023)	(0.032)	(0.024)	(0.014)
Capital Ratio	0.751	0.258	0.610	0.161
	(1.425)	(1.804)	(1.468)	(0.536)
Liquidity Ratio	−0.523	−0.829**	−0.575	0.038
	(0.359)	(0.393)	(0.358)	(0.227)
Deposit Base	0.729	0.239	0.798	0.110
	(0.727)	(0.736)	(0.825)	(0.209)
Credit Risk	−1.908***	−1.812**	−1.772***	0.348
	(0.626)	(0.734)	(0.651)	(0.223)
Foreign	−0.058	−0.068	−0.037	0.042
	(0.092)	(0.125)	(0.090)	(0.034)
State-owned	0.354***	0.371***	0.328***	−0.007
	(0.078)	(0.088)	(0.085)	(0.033)
Branch level				
Size (log Assets)	0.026	0.034	0.028	−0.005
	(0.028)	(0.027)	(0.029)	(0.013)
Liquidity Ratio	−0.347	−0.328	−0.354	−0.423**
	(0.710)	(0.711)	(0.716)	(0.200)
Deposit Base	−0.017	0.022	−0.006	0.094*
	(0.082)	(0.094)	(0.083)	(0.052)
RoA	3.350***	3.876***	3.330***	0.878**
	(1.107)	(1.032)	(1.148)	(0.391)
Obs.	6632	6632	6632	6632
R-squared	0.394	0.375	0.391	0.250

Notes: This table reports the results of estimating Equation (3.1) by changing the definition of the foreign funding shock. Column (1) reports the results of defining the shock as the change in log foreign liabilities during the peak-to-trough period within the crisis (September 2008 to June 2009). Column (2) tests the alternative hypothesis of the shock being driven by changes in foreign liabilities during the post-crisis period (December 2009 to December 2010). The regression reported in Column (3) defines the funding shock as the average 12-month growth rate in foreign liabilities during the peak of the crisis. Column (4) reports the result of changing the crisis period to generate a falsification test. The (virtual) crisis is set between June 2007 and August 2008, and the pre-crisis period is defined between January 2007 and July 2007. All regressions include regional fixed effects; standard errors are clustered at the bank headquarter level. For a detailed definition of all variables, see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

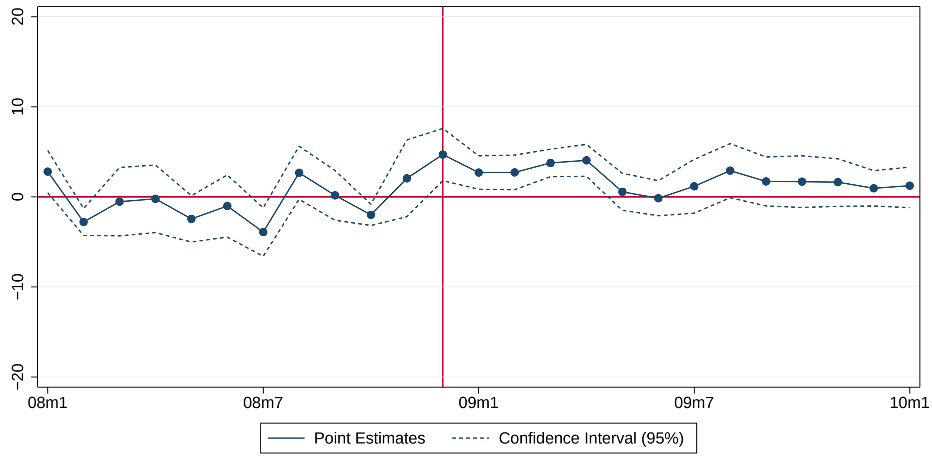


FIGURE B.III: This figure illustrates the estimated coefficients when running the regression from Table 3.3, Column (1), for multiple, alternative time windows. Each coefficient represents a point estimate with their respective confidence intervals for regressions; the shock is defined as the change in log foreign liabilities between three months before and three months after each date. The vertical line represents December 2008, capturing the effect of the change in foreign liabilities between September 2008 and March 2009.

Table B.II: Interaction models (A).

	Quadratic		Interbank	
	OLS (1)	FE (2)	OLS (3)	FE (4)
Δ Log foreign funding X Bank trait	−0.249**	−0.363***	−0.338**	−0.332**
	(0.121)	(0.126)	(0.153)	(0.138)
Δ Log foreign funding	0.528***	0.523***	0.294***	0.210***
	(0.124)	(0.121)	(0.058)	(0.076)
Bank trait			−0.311***	−0.265**
			(0.104)	(0.102)
Headquarter level				
Size (log Assets)	−0.025	0.064**	−0.001	0.074**
	(0.016)	(0.032)	(0.019)	(0.034)
Capital Ratio	−1.656***	−0.893	−0.986*	−0.190
	(0.534)	(0.637)	(0.544)	(0.667)
Liquidity Ratio	−0.920**	−0.416	−0.531	−0.019
	(0.352)	(0.404)	(0.338)	(0.433)
Deposit Base	−0.343	−0.176	−0.425*	−0.248
	(0.271)	(0.316)	(0.233)	(0.339)
Credit Risk	−1.680***	−2.126***	−1.394***	−1.673***
	(0.331)	(0.395)	(0.207)	(0.295)
Foreign	0.255***	0.471***	0.169***	0.368***
	(0.046)	(0.076)	(0.059)	(0.090)
State-owned	−0.014	0.016	−0.068	−0.016
	(0.051)	(0.053)	(0.059)	(0.076)
Branch level				
Size (log Assets)	0.046*	−0.090**	0.047**	−0.061*
	(0.027)	(0.034)	(0.021)	(0.032)
Liquidity Ratio	0.587	−0.177	0.834**	0.102
	(0.363)	(0.491)	(0.362)	(0.445)
Deposit Base	0.315***	0.296***	0.731***	0.654***
	(0.063)	(0.068)	(0.110)	(0.129)
RoA	−0.211	−0.165	−0.807*	−0.388
	(0.627)	(0.507)	(0.452)	(0.778)
Constant	0.768**		0.062	
	(0.345)		(0.386)	
Obs.	6632	6632	6632	6632
R-squared	0.196	0.447	0.272	0.479

Notes: This table reports regression results variants of Equation (3.1) in which ΔLog foreign funding is interacted with other bank traits. Columns (1) and (2) report the results of a quadratic regression in which ΔLog foreign funding enters the model as a quadratic term. Columns (3) and (4) report a regression in ΔLog foreign funding is interacted with the average pre-crisis ratio of net interbank assets to total assets at the branch level. While regressions are reported as either OLS or FE estimation, standard errors are clustered at the headquarter level. For a detailed definition of all variables see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table B.III: Instrumental variable model.

	Full Sample		< 25th percentile	
	First stage	IV FE	First stage	Reduced Form
	(1)	(2)	(3)	(4)
ΔLog foreign funding		0.127***		
		(0.046)		
Foreign funding / Assets	−6.088***		−18.517	9.941
	(2.005)		(11.993)	(8.563)
Headquarter level				
Size (log Assets)	0.032	0.044***	−0.025	0.141***
	(0.042)	(0.008)	(0.052)	(0.044)
Capital Ratio	3.040	−0.028	10.479***	−2.491
	(2.773)	(0.393)	(1.971)	(1.788)
Liquidity Ratio	3.546***	−1.154***	1.290***	0.791
	(0.771)	(0.179)	(0.287)	(0.606)
Deposit Base	−0.804	0.309**	−3.750	1.286
	(1.166)	(0.153)	(2.414)	(1.463)
Credit Risk	1.886	−1.723***	−0.144	−1.679*
	(1.409)	(0.178)	(0.960)	(0.888)
Foreign	0.195	−0.067**		
	(0.244)	(0.026)		
State-owned	−0.018	0.338***	−0.239**	0.355***
	(0.205)	(0.021)	(0.110)	(0.079)
Branch level				
Size (log Assets)	−0.014	0.037***	0.025	0.096***
	(0.016)	(0.006)	(0.021)	(0.017)
Liquidity Ratio	−0.983	−0.163	0.084	−1.821***
	(0.642)	(0.216)	(0.667)	(0.564)
Deposit Base	0.048	0.026	0.003	−0.365***
	(0.101)	(0.034)	(0.010)	(0.130)
RoA	3.818***	3.440***	0.998***	1.777**
	(1.012)	(0.290)	(0.339)	(0.895)
Obs.	6632	6632	1878	1878
R-squared	0.722	0.396	0.983	0.593

Notes: This table reports the results of estimating Equation (3.1) using an instrumental variables (IV) model. Banks' average pre-crisis foreign funding to total assets ratios are used as instruments of ΔLog foreign funding. Column (1) reports the first stage of the IV model, whereas Column (2) reports the second stage of the estimation when using the FE specification. All further regressors of the structural equation are used when estimating the predicted value of ΔLog foreign funding. Columns (3) and (4) replicate the analysis for the subsample of banks reporting a foreign funding ratio below the 25th percentile of the headquarter banks distribution. In all regressions standard errors are clustered at the headquarter level. For a detailed definition of all variables see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table B.IV: Interaction models (B).

	Foreign ownership		State ownership	
	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)
Δ Log foreign funding	0.000	0.003***	−0.023	0.110
X Bank trait	(0.001)	(0.001)	(0.091)	(0.105)
Δ Log foreign funding	0.004***	0.002***	0.350***	0.289***
	(0.000)	(0.000)	(0.034)	(0.029)
Bank trait	0.039*	0.050**	0.258***	0.444***
	(0.021)	(0.020)	(0.022)	(0.019)
Headquarter level				
Size (log Assets)	−0.016*	0.071***	−0.017*	0.071***
	(0.009)	(0.008)	(0.010)	(0.009)
Capital Ratio	−1.336***	−0.273	−1.311***	−0.522**
	(0.332)	(0.226)	(0.310)	(0.225)
Liquidity Ratio	−0.677***	0.200	−0.615***	−0.299
	(0.173)	(0.147)	(0.205)	(0.205)
Deposit Base	−0.418***	−0.030	−0.403***	−0.265***
	(0.138)	(0.128)	(0.125)	(0.097)
Credit Risk	−1.214***	−1.250***	−1.143***	−1.673***
	(0.140)	(0.118)	(0.308)	(0.295)
Foreign			0.041	0.061**
			(0.027)	(0.029)
State-owned	0.256***	0.458***		
	(0.025)	(0.018)		
Branch level				
Size (log Assets)	0.043***	−0.090***	0.043***	−0.085***
	(0.005)	(0.012)	(0.005)	(0.012)
Liquidity Ratio	0.448*	−0.249	0.445*	−0.205
	(0.265)	(0.221)	(0.255)	(0.233)
Deposit Base	0.335***	0.312***	0.334***	0.331***
	(0.025)	(0.032)	(0.024)	(0.029)
RoA	−0.238	−0.376	−0.232	−0.427*
	(0.223)	(0.257)	(0.217)	(0.248)
Constant	0.547***		0.521***	
	(0.186)		(0.164)	
Obs.	6632	6632	6632	6632
R-squared	0.188	0.435	0.188	0.433

Notes: This table reports regression results variants of Equation (3.1) in which ΔLog foreign funding is interacted with other bank traits. Columns (1) and (2) report a regression in ΔLog foreign funding is interacted with the foreign ownership dummy, whereas Columns (3) and (4) replicate this exercise using a government ownership dummy. While regressions are reported as either OLS or FE estimation, standard errors are clustered at the headquarter level. For a detailed definition of all variables see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

TABLE B.V: FBHC traits by shocks' size.

	Mean	sd	Min	Max	Shock size Yes	Shock size No	Diff.
ΔCapital Ratio	0.0091	0.0149	-0.0119	0.0255	0.0132	0.0049	0.0083*
ΔLiquid Assets Ratio	0.0102	0.0379	-0.0311	0.0500	0.0120	0.0085	0.0035
ΔDeposits Ratio	0.0149	0.0372	-0.0542	0.0698	0.0187	0.0106	0.0081
ΔRoA	0.0037	0.0084	-0.0027	0.0330	0.0027	0.0048	-0.0021
TAF Ratio	0.3162	0.5648	0.0000	1.7182	0.2908	0.3417	-0.0510
TAF Index	0.1967	0.3232	0.0000	1.0000	0.1217	0.2825	-0.1608*

Notes: This table reports descriptive statistics fro variable at the level of FBHCs. It further reports the means and differences in means for each variable for the subsamples of banks affected and not by the funding shock. The sample consists of the 16 foreign-owned banks observed in the baseline sample. Variables in changes are computed as first-differences between 2009 and 2008 (end of year). Banks affected by large shocks are those reporting a change in Log foreign liabilities between the pre- and post-crisis periods below the sample median. * denotes statistical significance by normalized differences (Imbens and Wooldridge, 2009). Variables are winsorized at the 1st and 99th percentiles.

Table B.VI: The effect of FBHCs' performance.

	ΔCapital Ratio (1)	ΔLiquid Assets Ratio (2)	ΔDeposits Ratio (3)	ΔRoA (4)
ΔLog foreign funding	−44.079***	5.157*	4.265	−52.398
X FBHC trait	(16.290)	(3.078)	(5.721)	(43.592)
ΔFBHC trait	−2.931	0.549	2.589	−29.925
	(5.300)	(3.479)	(3.128)	(18.822)
ΔLog foreign funding	0.718**	0.160	0.215**	0.478***
	(0.339)	(0.215)	(0.109)	(0.134)
FBHC-level				
Size (log Assets)	−0.023	−0.010	−0.070	−0.056
	(0.036)	(0.016)	(0.044)	(0.048)
Capital Ratio	0.463	0.517	−2.314	23.640***
	(7.562)	(7.719)	(7.835)	(8.933)
Liquidity Ratio	0.937	−0.351	3.274***	4.385*
	(0.655)	(0.824)	(1.105)	(2.482)
Deposit Base	1.672	5.629	−0.421	−13.958***
	(5.801)	(9.450)	(5.391)	(4.428)
Headquarter level				
Size (log Assets)	−0.098	−0.005	0.098	−0.252**
	(0.098)	(0.073)	(0.136)	(0.127)
Capital Ratio	0.157	−2.813	−0.026	3.176
	(2.236)	(2.710)	(1.940)	(3.117)
Liquidity Ratio	−0.628	0.634	−0.391	3.766*
	(1.646)	(2.464)	(1.799)	(2.007)
Deposit Base	0.782	−0.791	−0.426	1.457
	(0.777)	(0.739)	(0.671)	(1.083)
Credit Risk	−0.968	−1.503	−2.425**	−0.107
	(1.033)	(0.972)	(1.035)	(1.127)
Branch level				
Size (log Assets)	0.111***	0.115**	0.115***	0.116***
	(0.040)	(0.048)	(0.042)	(0.044)
Liquidity Ratio	2.687	2.627	2.314	3.000*
	(1.840)	(1.847)	(1.911)	(1.730)
Deposit Base	−0.105	−0.135	−0.133	−0.096
	(0.188)	(0.175)	(0.175)	(0.188)
RoA	7.529***	7.276***	7.766***	7.620***
	(1.671)	(1.763)	(1.659)	(1.725)
Obs.	545	545	545	545
R-squared	0.675	0.676	0.681	0.676

Notes: This table reports the results of estimating Equation (3.4) for different measures of FBHCs performance around the crisis. As interaction terms with ΔLog foreign funding we use the change in the capital-asset ratio (Column (1)), the change in the ratio of liquid to total assets (Column (2)), the change in the ratio of deposits to total assets (Column (3)) and the change in the ratio of net returns to total assets (Column (4)). All regressions include regional fixed effects, standard errors are clustered at the headquarter bank level. For a detailed definition of all variables see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table B.VII: The effect of FBHCs' TAF access.

	TAF Ratio (1)	Av. TAF Index (2)	Max. TAF Index (3)
ΔLog foreign funding X FBHC trait	−0.788**	−2.208**	−1.346**
	(0.339)	(0.984)	(0.683)
ΔFBHC trait	−0.167	−1.064**	−0.660**
	(0.144)	(0.418)	(0.265)
ΔLog foreign funding	0.272***	1.001***	0.762***
	(0.088)	(0.274)	(0.202)
FBHC-level			
Size (log Assets)	−0.031	−0.018	−0.006
	(0.033)	(0.024)	(0.020)
Capital Ratio	10.806*	21.631***	11.700**
	(6.013)	(5.065)	(5.046)
Liquidity Ratio	2.200**	2.572***	1.023**
	(0.936)	(0.916)	(0.397)
Deposit Base	−6.286*	−12.257***	−4.613
	(3.242)	(1.760)	(3.216)
Headquarter level			
Size (log Assets)	−0.064	−0.389***	−0.269***
	(0.089)	(0.111)	(0.063)
Capital Ratio	2.515	−0.593	−2.421
	(2.211)	(1.735)	(1.671)
Liquidity Ratio	2.135	2.565	0.883
	(1.651)	(1.838)	(1.719)
Deposit Base	0.689	0.672	−0.065
	(0.524)	(0.567)	(0.524)
Credit Risk	−0.744	−2.877***	−3.382***
	(0.732)	(0.825)	(0.888)
Branch level			
Size (log Assets)	0.113***	0.119***	0.119***
	(0.043)	(0.040)	(0.040)
Liquidity Ratio	3.026*	2.677	2.672
	(1.700)	(1.934)	(1.939)
Deposit Base	−0.098	−0.146	−0.147
	(0.186)	(0.181)	(0.181)
RoA	7.596***	7.523***	7.447***
	(1.706)	(1.702)	(1.714)
Obs.	545	545	545
R-squared	0.675	0.681	0.680

Notes: This table reports the results of estimating Equation (3.5) for different measures of FBHCs access to TAF liquidity during the post-crisis period. As interaction terms with ΔLog foreign funding we use the average TAF ratio (Column (1)), the TAF index computed from the average TAF ratio (Column (2)) and the TAF index computed from the maximum TAF ratio in the post-crisis period (Column (3)). All regressions include regional fixed effects, standard errors are clustered at the headquarter bank level. For a detailed definition of all variables see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

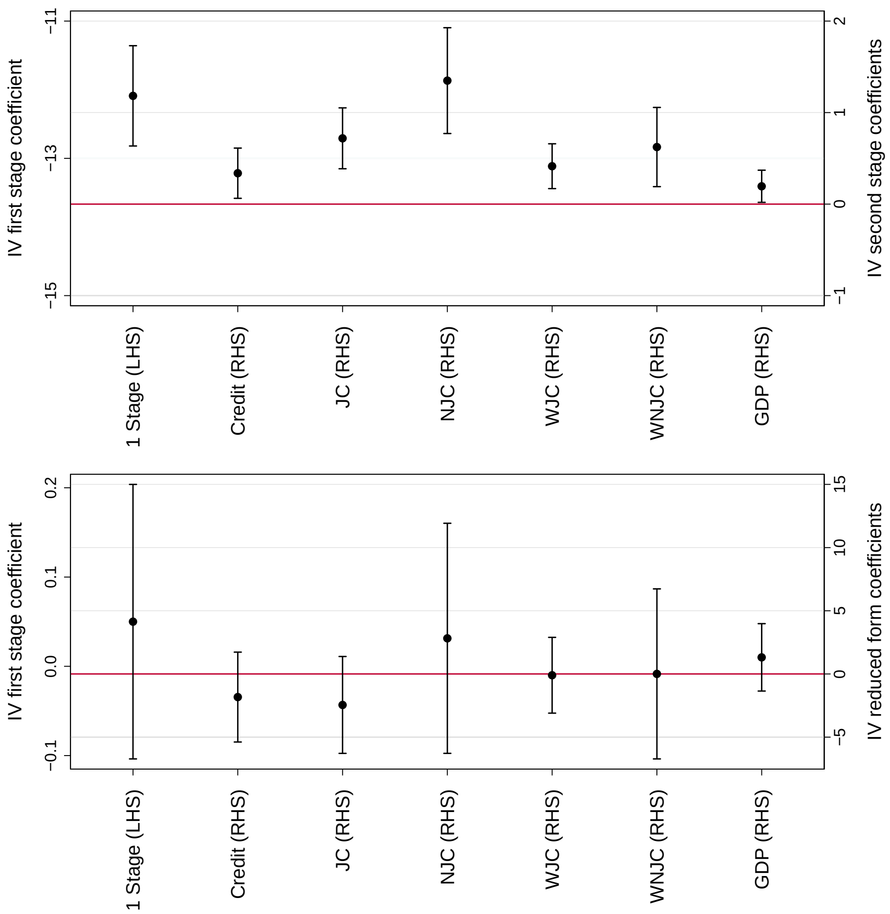


Figure B.IV: This figure illustrates the estimated coefficients with their respective confidence intervals at the 90% confidence level when we employ an IV regression setup to Equation (3.7). In particular, ΔLog foreign funding is instrumented by the pre-crisis market-share weighted average foreign funding ratio at the municipality-level. The scale on the left hand side represents the estimated coefficients for the first-stage regressions, whereas the scale on the right hand side depicts the estimated coefficients for the second-stage regressions. The upper-panel estimates Equation (3.7) for the full sample, while the bottom-panel reports regressions on the sub-sample of municipalities with a foreign funding ratio below the 25th percentile of the sample distribution. Each estimated coefficient represents a single regression in which a real economic outcome variable is estimated as a function of ΔLog foreign funding. The economic outcome variables are credit growth (Credit), job creation growth (JC), net job creation growth (NJC), the growth rate of job creation and net job creation per 1000 inhabitants (WJC and WNJC, respectively) and GDP growth (GDP).

Table B.VIII: Effect of ex-ante municipalities' vulnerabilities.

	(1) Credit to GDP	(2) Log GDP	(3) Foreign Share	(4) Av. Correlation (ΔCred, ΔNJC)
ΔLog foreign funding	0.616*	0.827***	0.735**	0.996***
	(0.314)	(0.289)	(0.300)	(0.346)
Vulnerability-Variable	−0.027**	0.000	−2.779***	−0.186**
	(0.012)	(0.000)	(0.796)	(0.089)
ΔLog foreign funding × Vulnerability-Variable	0.292**	0.003	12.628***	1.256*
	(0.144)	(0.002)	(4.458)	(0.719)
Headquarter level				
Size (log Assets)	−0.091*	−0.090*	−0.129**	−0.124**
	(0.052)	(0.053)	(0.056)	(0.060)
Capital Ratio	3.344*	2.554	2.698	3.443*
	(1.792)	(1.757)	(1.784)	(2.082)
Liquidity Ratio	−5.309***	−4.738***	−4.367**	−6.230***
	(1.776)	(1.752)	(1.787)	(2.124)
Deposit Base	2.279**	1.622	2.235**	2.927**
	(1.062)	(1.027)	(1.071)	(1.150)
Credit Risk	2.885	4.268	5.439*	6.038
	(3.291)	(3.240)	(3.271)	(4.069)
Foreign	−0.967**	−0.861**		−1.179***
	(0.402)	(0.399)		(0.428)
State-owned	−0.048	−0.071	−0.260	−0.501
	(0.480)	(0.481)	(0.486)	(0.581)
Branch level				
Size (log Assets)	−0.014	0.017	0.001	0.004
	(0.031)	(0.024)	(0.031)	(0.031)
Liquidity Ratio	19.247***	18.582***	17.440***	22.562***
	(5.472)	(5.418)	(5.396)	(6.639)
Deposit Base	0.606*	0.423	0.443	0.381
	(0.339)	(0.326)	(0.330)	(0.370)
RoA	−11.462**	−10.441**	−11.031**	−11.884**
	(5.203)	(4.983)	(5.249)	(5.449)
Municipality-level				
Size (GDP)		−0.010	−0.008	−0.005
		(0.009)	(0.009)	(0.009)
Credit/GDP Ratio	0.045**		0.029	0.020
	(0.022)		(0.021)	(0.021)
Constant	−0.060	0.005	−0.010	−0.034
	(0.105)	(0.109)	(0.109)	(0.107)
Obs.	1768	1768	1768	1768
R-squared	0.044	0.040	0.046	0.051

Notes: This table reports the results of estimating Equation (3.7) including an interaction term between ΔLog foreign funding and four alternative variables describing ex-ante vulnerabilities at the municipality level. The interacted variables are either the average pre-crisis credit to GDP ratio (Column (1)), the log GDP as of 2007 (Column (2)), the average pre-crisis market share of foreign banks (Column (3)) and the average historical correlation (2005-2008) between the month-on-month changes in log aggregated credit and log net job creation per 1000 inhabitants. The dependent variable captures the log change in net job creation per 1000 population between the pre- and post-crisis periods. For a detailed definition of all variables see Table 3.1. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Chapter 4

Banks closing their water gates? Liquidity adjustments to interbank shocks and the role of central bank interventions

Abstract: *The global financial crisis highlighted banks tendency to hoard liquid assets when aggregate dry-ups in interbank liquidity occur. Using novel Brazilian data, we explore whether idiosyncratic shocks to interbank funding at the level of banks' headquarters occurred during the crisis lead regional bank branches to increase their demand for liquid assets. This approach proposes a novel rationale for liquidity hoarding, which emerges from a combination of idiosyncratic funding shocks and frictions in banks' internal capital markets. We provide robust evidence that the shocks trigger a liquidity hoarding reaction by branches, with significant spillovers on credit supply. Notably, liquidity hoarding also affects the pass-through of central bank unconventional interventions to credit supply, reducing the effectiveness of policy actions during crisis times.*

4.1 Introduction

The availability of liquid assets play a key part in financial intermediation. Banks' inherent objective of transforming liquid liabilities withdrawable on demand into relatively iliquid assets offered to borrowers makes them vulnerable to sudden restrictions in the availability of funding (e.g., Diamond and Dybving, 1983). Considering the importance of credit lines and other forms of loan commitments in modern banking (e.g., Avery, 1991), achieving this objective becomes specially challenging in times of funding constraints. This inbuilt fragility of banks' asset transformation function requires the build-up of liquidiy buffers banks can rely on in the case of liquidity mismatches. Liquidity hoarding, a drastic increase in banks' liquid assets holdings, can emerge then as a natural reaction in contexts of financial distress (e.g., Gale and Yorulmazer, 2013).

Consistent with this hypothesis, recent studies have put much emphasis on understanding how liquidity hoarding by banks can result from market-wide disruptions in interbank funding.[1]Exploring this link has become pertinent considering the importance of interbank financial contagion in explaining the spreading of liquidity risk during the 2008-2009 global financial crisis and the European sovereign debt crisis (see Freixas et al., 2011). Even though this question has been mainly addressed theoretically (see for example Acharya and Skeie, 2011 and Gale and Yorulmazer, 2013), a few papers provide empirical evidence on how aggregate interbank market shocks can prompt banks to increase liquid asset holdings with consequences for overall financial stability (most notably Acharya and Merrouche, 2013 and Heider et al., 2015).

In this paper I contribute to understand the link between interbank market shocks and liquidity hoarding by arguing that even in the absence of a market-wide interbank market freeze, liquidity hoarding can emerge as a consequence of bank-specific idiosyncratic disruptions in interbank funding supply. Specifically, I ask whether idiosyncratic interbank funding shocks lead banks to increase their liquid assets holdings and whether this in turn can be associated with real economic effects via reductions in credit supply. In contrast to previous studies I investigate these questions by tracing the effect of interbank funding shocks at the headquarter-bank level on liquidity and lending decisions at the level of individual regional bank branches. I therefore explicitly investigate how financial frictions in internal capital markets can drive liquidity hoarding even when aggregate interbank markets remain functioning and well-funded.

I find robust evidence that regional branches from banks affected by idiosyncratic interbank funding shocks increase their liquid asset holdings and

[1]More generally, economic theory has link liquidity hoarding also with other sources of liquidity risk. For instance liquidity hoarding has been understood as a precautionary device when banks are threatened by market exclusion (Allen and Gale, 2004b), when counterparty risk in a banking network increases (Acharya and Skeie, 2011) or when Knightian uncertainty in the market becomes struggling (Caballero and Krishnamurthy, 2008).

reduce lending compared to similar branches from not affected banks. However, there are notable heterogeneous effects depending on branches ex-ante liquidity risk as well as on headquarter banks' access to unconventional interventions by the central bank activated during the sample period. The contribution of this finding is twofold. First, in opposite to previous studies, I show that idiosyncratic interbank funding shocks can lead to liquidity hoarding as well as to subsequent restrictions in credit supply even without the occurrence of an aggregate market freeze. Second, liquidity hoarding emerges in this setup primarily as a result of frictions in banks' internal capital markets within their network of regional branches, a channel notably neglected by the literature on liquidity hoarding. Moreover, by identifying a liquidity channel of interbank funding shocks my analysis stresses the importance of liquidity risk for banking regulation. More specifically, my results support the adoption of regulatory liquidity requirements such as the ones suggested by the Basel Committee on Banking Supervision and by the European Banking Authority.

A novel feature of this paper is the use of an identification strategy that relies on three main building blocks in order to isolate both a liquidity and a lending channel of interbank funding shocks. First, I adapt an algorithm proposed by Cavallo et al. (2015) to identify dates at which specific bank headquarters are affected by interbank funding shocks in the absence of a market-wide interbank market disruption. I use the fact that only some banks are affected by shocks to compare liquidity and credit growth in the shocks' aftermath between affected and non-affected banks over an event timeline. By combining the use of idiosyncratic shocks distributed over time together with actual-date fixed effects I can isolate the ex-post effect of shocks on liquidity and credit growth.

Next, I avoid concerns of reverse causality by separating the corporate level at which a shock takes place from the one at which outcomes realize. I do this by adding to the baseline sample of banks their corresponding regional bank branches. Thus, whereas shocks are computed at the level of bank headquarters, liquidity and lending outcomes are tracked on a monthly basis at the level of individual bank branches. The rather small size of a single regional branch relative to a bank's headquarter makes it unlikely that liquidity and lending adjustments by a branch might drive the interbank funding shocks that hit parent banks as a whole. Still, I provide preliminary tests consistent with the implicit assumption of the funding shocks being supply-driven and not caused by changes in banks' own funding preferences.

Finally, I compare liquidity and lending outcomes by branches from shock-affected banks with the ones by branches from non-affected banks operating within the same region using a within-borrower difference-in-difference estimation. In the vein of Khwaja and Mian (2008) and Schnabl (2012), I include regional-month fixed effects to avoid concerns of liquidity and credit growth being driven by borrowers' demand adjustments. This empirical setup allows to interpret the results as supply-driven, providing evidence on the channels through which interbank funding shocks affect the real economy.

I conduct the analysis by exploiting a novel manually-collected data set that covers detailed balance-sheet information of all banks operating in Brazil together with their individual bank branches located in Brazilian municipalities on a monthly basis. This unique data set enables to investigate the occurrence of interbank funding shocks between 2007 and 2009 in an important segment of the local interbank market. In particular I look at an item in banks' balance sheets defined as "borrowing and onlending from other participants of the banking sector", which captures local unsecured OTC operations between Brazilian banks with a maturity of more than 90 days. Importantly, this segment of the market did not suffer a contraction in the aggregate during the global financial crisis, but rather bank-specific episodes of sudden disruptions in the availability of funding. These data allow to track the effect of shocks over a 24-month time window by fulfilling the identification conditions outlined above.

My main finding is that financial stress emerging from idiosyncratic interbank funding shocks is channeled via internal capital markets towards regional branches, triggering a liquidity reallocation process in which liquid assets holdings rise while lending shrinks. This effect lasts for around 20 months after the shock beings and it represents economically a sizable adjustment in branches' balance sheets. My empirical results suggest that precautionary liquidity hoarding can be triggered as a reaction to financial stress within internal capital markets in a banking conglomerate, with real consequences for financial stability in the credit market. This finding highlights the importance of bank-specific aspects of interbank market stress. In fact, my analysis points out that even without large scale market-wide disruptions in interbank funding bank-specific events can bring about adjustments in banks' preferences towards liquidity with consequences for financial stability.

The estimation is robust to collapsing the time dimension into single pre- and post-shock periods as well as to estimating liquidity and lending for different time windows. When I randomize banks' assignment into shock-affected and non-affected groups the effect vanishes. Concerning the role of banking globalization I find that banks' foreign exposures do not affect the extent of the shocks' effects, stressing the bank-specific and local nature of the funding shocks I analyze. I also exploit the heterogeneity of branches' ex-ante liquidity risk in order to further investigate the role of internal capital markets in driving my results. I find that the effect of funding shocks on liquidity and lending increases along the distribution of branches' liquidity risk, measured either as ex-ante funding concentration or ex-ante exposure to intra-group funding.

In a final extension, I test whether non-conventional liquidity interventions by the Brazilian Central Bank (BCB) activated during the sample period affect my results. These interventions relied mostly on resources obtained from US Dollar swap arrangements between the U.S. Fed and the BCB and were implemented similarly to the TAF and LTRO programs in the U.S. and Europe respectively. Despite its importance, these interventions have been scarcelly evaluated in the literature (see Heider et al., forthcoming, for a notable exeption). By carefully addressing the endogeneity of central bank liquidity provision, I find that the effect of shocks on lending wears off for branches whose headquarters had a wider access to BCB unconventional interventions relative to the size of shocks. However, the results also suggest that liquidity hoarding incentives lead branches to store in form of liquid assets a significant share of this liquidity assistance.

This study refers primarily to a strand in the banking literature that empirically addresses the liquidity hoarding phenomenon. To the best of my knowledge this is the first study that identifies a liquidity hoarding channel of interbank funding shocks propagated via internal capital markets. Previously, Cornett et al. (2011) and Berrospide (2013) provided evidence of liquidity hoarding by US banks during the 2008-2009 global financial crisis. They show that ex-ante liquidiy risk in the form of loan commitments and expected losses from securities write-downs explain banks' liquidity hoarding in the crisis. While Acharya and Merrouche (2013) relates the emergence of liquidity hoarding in the U.K. to the functioning of the local interbank markets, Fourel et al. (2013) and Gabrieli and Georg (2014) have addressed the emergence of liquidity hoarding in banking networks after market-wide shocks strike.

This paper also relates to a paralell literature focused more generally on the lending channel of interbank market disruptions. While I focus the analysis on domestic idiosyncratic interbank funding shocks with cross-regional spillovers via branches, previous studies have mainly looked at this phenomenon from a cross-country perspective. For instance, Aiyar (2012) shows that interbank funding from abroad lead to lending restrictions in retail banking in the U.K. during the global financial crisis. Similar effects of foreign interbank shocks on local lending are found by Ongena et al. (2015) and Buch and Goldberg (2015) for multi-country settings. Allen et al. (2014) and De Haas and Lelyveld (2014) explicitly address the role of internal capital markets for cross-country financial contagion. Other papers have addressed consequences of interbank shocks different than the liquidity or lending channels. For instance, Afonso et al. (2011) and Afonso and Song Shin (2011) show that banks become more risk averse when faced to interbank funding shocks. More closer to my granular approach to interbank shocks is Pérignon et al. (2016), where bank-specific shocks in the European market for wholesale certificates of deposits are identified. I'm not aware of other studies identifiying a (retail) lending channel of domestic interbank funding shocks.

Finally this paper relates to the nascent literature on the effects of unconventional central bank interventions. In opposite to previous studies I evaluate liquidity interventions in an emerging country for which the global financial crisis aroused exogenously. Liquidiy injections have been analyzed for the U.S. by Chodorow-Reich (2014a) and Di Maggio et al. (2015) finding some mitigating impact during the crisis on banks and households respectively. ECB interventions have been analyzed at the macro-level by Casiraghi et al. (2013), Crosginani et al. (2015), Andrade et al. (2015) and García-Posada and Marchetti (2015), whereas Carpinelli and Crosignani (2015) show at the bank level that ECB interventions mitigated the effect of foreign funding shocks in Italy.

The paper is organized as follows. Section 4.2 discusses the identification strategy and describes the data set. Sections 4.3.1 and 4.4 report the baseline results and the evaluation of central bank interventions respectively. Section 4.5 concludes.

4.2 Identification and data

This section presents the empirical setting used to investigate the effect of bank-specific funding shocks on liquidity and credit growth by bank branches. I start by describing the empirical models used for the analysis and describe then the data set. Finally I address the assumptions underlying the estimation and present some preliminary evidence on the effect of shocks.

4.2.1 Identification strategy

Theoretical motivation. I start from the premise that with frictionless interbank markets banks can always obtain sufficient funding and liquidity risk is negligible. In this context interbank markets can become a mechanism to efficiently allocate liquidity across financial institutions (Allen and Gale, 2004b). However, frictions in the form of informational asymmetries and adverse selection can generate a link between interbank market exposure and banks' liquidity risk. When counterparty risks are difficult to assess, the shadow price of giving up liquidity in the form of interbank loans rises, affecting banks' access to interbank funds. If these frictions exist, the interbank market becomes a mechanism through which liquidity risk is transmitted across banks (Freixas et al., 2011). Liquid assets hoarding emerges then as a reaction to frictions in the interbank market combined with large ex-ante interbank exposures (Gale and Yorulmazer, 2013).

This general setup is similar when regional bank branches are the ones affected by an interbank funding shock that hits their headquarter bank. In this case a single branch, exposed to internal funding from within the banking conglomerate it belongs to, fears the loss of access to funds obtained via internal capital markets. Branches might then change their preferences towards holding more liquid assets if the interbank funding shock at the headquarter level is associated with an increasing cost of obtaining liquidity. Moreover, in the event of further restrictions in internal funding, an illiquid branch would be bearing a larger cost if it is induced to fire sales. The literature refers to this rationale as a precautionary motive for liquidity hoarding (Gale and Yorulmazer, 2013; Acharya and Merrouche, 2013).

The incompleteness of branches' markets for funding is also a reason that might lead branches to hoard liquidity when their headquarters face funding shocks. As discussed by Allen and Gale (2004a) and Allen and Gale (2004b), when liquidity cannot be freely allocated across the banking sector individual institutions might choose an inefficiently high level of liquidity. In my example, the increase in counterparty risk in a context of financial fragility, together with branches' financial dependence and organizational subordination to their headquarters, restrict their funding market. In this sense liquidity hoarding can be triggered by precautionary motives combined with a lack of alternatives when the main funding channel becomes disrupted.

This discussion highlights the mechanisms predicting the occurrence of liquidity hoarding when an interbank funding shock strikes. If banks' headquarters are affected by a shock we could expect branches to increase their preference for liquid assets and correspondingly to restrict their lending activity. Moreover, this effect should be concentrated in branches with a higher ex-ante liquidity risk as well as in branches more dependent from their headquarters. However, these predictions only hold if the interbank shock is not driven by ex-ante liquidity adjustments at the level of a whole banking conglomerate or if the increase in liquidity reflects rather asymmetric credit-demand shocks between branches affected and not by a shock. I address the implications of these theoretical predictions when discussing the identification strategy below.

Empirical Models. I propose an empirical model aimed at addressing whether idiosyncratic interbank funding shocks at the headquarter level trigger a liquidity hoarding reaction by bank branches. The identification strategy is as follows. First, I exploit the fact that headquarters are affected by shocks at different dates to create an event timeline set at 0 at the date when each headquarters is affected by a funding shock. I then create a balanced panel in which each headquarter reports 49 monthly observations lasting from $\tau = -24$ to $\tau = 24$. Alternative time windows are considered in subsequent extensions of the baseline model. The use of an event timeline together with actual-date controls should avoid concerns of the analysis being driven by market-wide macroeconomic factors.

Second, a natural concern with the identification is the potential endogeneity of ex-post liquidy growth. A positive association between being shock-affected and liquidity growth might reflect that, when facing fragile economic conditions, banks decide to reduce their demand for interbank funding. This would mean that the observed funding shocks are demand-driven, reflecting weak fundamentals in a bank's business environment that might be correlated with the demand for liquid assets. I address this concern by separating the corporate level at which the shock takes place from the one at which outcomes are realized. I compare single branches operating in a given municipality whose headquarters are affected and not by a funding shock. In doing so I reasonably claim that the individual behavior of a branch representing a marginal share of a banking conglomerate's total assets is unlikely to drive the occurrence of an interbank funding shock at the headquarter level. Moreover, the implementation of an event timeline to compare branches from different banks should alleviate concerns about macroeconomic dynamics driving the results.

Third, I rely on the fact that not all banks suffer from a funding shock during the sample period and that, by construction, I observe a pre-shock period of two years for each bank. This provides two dimensions of analysis: the pre-post adjustment of branches after the shock and the comparison of this adjustment between branches affected and not by a shock. This leads me to compare branches both in terms of their own changing behavior over time and in terms of their comparative adjustment relative to similar unaffected institutions. In order to exploit the event-timeline, I assign a virtual shock to non-affected headquarters. As explained below, these virtual shocks occurr at the month where non-affected headquarters report the highest likelyhood of being affected by an actual shock. I conduct this analysis by controling for a set of variables capturing the assets and liabilities structure of both headquarters and branches.

Finally, the use of the municipalities as branches' relevant markets allows to implement a within borrower identification that controls for common credit-demand shocks affecting branches. Even if the shocks occurr exogenously from the branches' decisions on liquidity, it might be the case that shock-affected branches are simultaneously facing large negative credit-demand shocks. Since credit demand remains unobserved, the identification of the effect of funding shocks on liquidity would be biased. I address this concern by relying on previous contributions using within borrower estimations to isolate supply shocks in the banking sector (Khwaja and Mian, 2008; Schnabl, 2012). Concretely, I exploit municipality-month fixed effects that absorb common trends in credit demand affecting all branches within a given municipality. Following the relevant literature, I argue that by introducing this fixed-effects structure, supply-driven adjustments in liquidity and lending can be isolated from demand considerations.

I formalize the identification strategy with the empirical model represented in Equation (4.1):

$$\Delta Liquidity_{i,m,\tau} = \alpha_0 + \beta_1 \left[Shock_{i,\tau} \times Affected_i\right] + \beta' Bank_{i,m,\tau} + \mu_{m,t} + \gamma_{i,m} + \varepsilon_{i,m,\tau} \quad (4.1)$$

Equation (4.1) estimates the change in log liquid assets (originally in real U.S. millions) in a branch of bank i located in municipality m at time τ.[2] The changes are computed on a month-on-month basis in order to reduce concerns about autocorrelation of the error term. To ensure consistency, standard errors are clustered at the headquarter level.

The main variable of interest is the interaction term $Shock_{i,\tau} \times Affected_i$ that provides the structure of a difference-in-difference estimator to the model. This variable allows to interpret the coefficient β_1 as the difference in the average log change of liquidity after the shock between branches affected and not by the event. I define the variable $Shock_{i,\tau}$ as a time-variant dummy that equals 1 for the period between $\tau = 0$ and $\tau = 24$ and 0 for $\tau < 0$. The variable $Affected_i$ is a time-invariant dummy that equals 1 for branches belonging to headquarters facing an interbank funding shock at some point during the sample period and 0 otherwise.

The main control variables are a vector of headquarter- and branch-specific characteristics $Bank_{i,m,\tau}$ and branch fixed-effects ($\gamma_{i,m}$) to control for unobservables. The municipality-month fixed-effects $\mu_{m,t}$ capture common demand shocks at specific periods affecting all banks within a given municipality m as discussed above. I impose this fixed-effects structure in order to interpret the results as supply-driven adjustments in the growth

[2] Note that throughout the paper liquid assets are defined as the sum of cash assets and interbank (sight) deposits withdrawable on demand. In Section 4.3.2 Equation (4.1) is estimated for the two sub-categories of liquid assets considered for the analysis.

rate of liquidity. Moreover, $\mu_{m,t}$ also absorbs contemporaneous time trends at the country-level.

The vector $Bank_{i,m,\tau}$ is composed by a number of headquarter and branch-specific traits capturing the main characteristics of banks' balance-sheets. At the headquarter level I follow the established literature by including the size of the balance sheet measured as the log of total assets, the capital to assets ratio, the liquid to total assets ratio, the deposits to total assets ratio, the ratio of non-performing loans to total assets (as a measure of bank risk) and a foreign ownership dummy that equals one if a bank is foreign-owned. Here I follow the established definition of considering a bank being foreign-owned if at least 50% if its shares are owned by a company headquartered abroad. This latter information was retrieved from banks' websites and from the Claessens and Van Horen (2014) Bank Ownership Database. At the branch level I control for size, measured as the log of total assets, and for liquidity and deposit ratios computed in the same vein of the headquarters' sample. I also control for the ratio of net returns to total assets to proxy for the quality of branches' credit portfolio.

The research question outlined in the introduction implies evaluating a potential crowding-out effect of liquidity hoarding on lending triggered by interbank funding shocks. If branches are induced to increase their demand for liquid assets, we could expect this to have a detrimental effect on the creation of new loans. I therefore extend the model in Equation (4.1) in order to investigate the existence of a lending channel of interbank funding shocks transmitted via internal capital markets from headquarters to branches. This second empirical model is formalized in Equation (4.2):

$$\begin{aligned} \Delta Credit_{i,m,\tau} = &\alpha_0 + \beta_1 \left[Shock_{i,\tau} \times Affected_i\right] + \beta' Bank_{i,m,\tau} \\ &+ \mu_{m,t} + \gamma_{i,m} + \varepsilon_{i,m,\tau} \end{aligned} \tag{4.2}$$

Equation (4.2) follows Cornett et al., 2011 in replicating Equation (4.1) by including as the dependent variable the month-on-month log change in total outstanding credits at the branch level. Equations (4.1) and (4.2) allow linking the potential liquidity hording reaction of branches to the expected drop in credit supply as a consequence of headquarters' interbank funding shocks.

4.2.2 Data

Data construction. To implement the identification strategy, I construct a unique manually collected data set that combines data on banks' headquarters as well an on their complete network of individual branches in Brazil. These data trace branches and headquarters balances sheets and income statements on a monthly basis for a period between January 2005 and January 2012. I manually added a branch level indentifier linking branches with their headquarters. The data provide me with an identification of the municipality where each branch operates. The information is aggregated at the municipality-level for each bank, resulting in the data being structured at the bank-branch-month level.

The data is obtained from regulatory call reports collected by the BCB.[3] I first obtained separated information on unconsolidated variables at the headquarter level. Second, I collected call reports on all individual branches of these banks in each municipality. I manually checked banks' names in both samples in order to generate a match. Since my main analysis is at the branch level, the sample underrepresents investment banks without a network of municipal branches spread throughout Brazil. The call reports are obtained for all institutions with a banking license in the country so that no size limit is imposed. The particular focus on retail banking makes the sample less representative in the major cities, which operate as regional financial centers in the country and have a larger precense of investment banks. Still, the sample is well distributed across the Brazilian geography: out of the 27 federal states the sample represents over 80% of total banking

[3]This data source has been previously used by Coleman and Feler, 2015 to investigate the effects of the global financial crisis on lending by state-owned banks in Brazil. However, their data set has a lower degree of granularity, with the branch variables aggregated for all banks at the municipal-level.

assets in 26 states, with the sole exception of Sao Paulo (67%), where most investment banks are headquarted.

Investigating the research question in the context of Brazil has several advantages besides of the data structure. First, the Brazilian banking sector represents one of the largest banking markets among emerging economies. At the beginning of the sample in January 2005 102 institutions with a local banking license existed, with aggregated credit accounting for 26% of the country's GDP. Second, the geographic size of the country helps to add a large heterogeneity to the empirical model, allowing to investigate the mechanisms driving the liquidity shock transmission. A key feature of the identification is that idiosyncratic interbank shocks are observed during the 2008-2009 global financial crisis. Therefore, a third aspect to consider is that the crisis befell Brazil as an exogeneous phenomenon, which was not driven by ex-ante weak fundamentals in the country. Finally, the data allow to track Brazilian banks' foreign exposures via ownership and funding. I exploit this to investigate local interbank shocks triggered by the crisis by controling for banks' direct foreign exposures.[4]

Sampling procedure. I screen the data set to make it consistent with the identification strategy. For this purpose, I impose restrictions on both the headquarters and the branches sample. The sampling procedure is as follows.

First, I require banks to be active over the whole sample period in order to make their performance comparable. This filter helps to exclude the possibility of the analysis being biased due to the impact of M&As both regionally and at the national level. Due to the relatively large sample period this adjustment leaves me with 83 out of 102 banks. Since the aim

[4]The Brazilian banking sector has a large penetration of foreign banks which represent on average 45% of total bank assets in the sample. Banking globalization is also reflected in banks' reliance on foreign funding which accounts on average for 9.7% of total interbank funding in the sample. Both foreign ownership and foreign funding were major drivers for the global transmission of financial distress during the 2008-2009 world financial crisis (see Noth and Ossandon Busch, 2016 for a discussion of this phenomenon in Latin America). Therefore, I carefully discuss the implications of banking globalization when discussing the results.

is to identify idiosyncratic funding shocks, a natural concern is that shocks might be driven by banks' own demand for funding. By excluding M&As from the sample, I ensure that sudden drops in interbank borrowing balances will not be driven by banks being forced to switch their funding structure after being overtaken by another bank.

Second, I filter out banks with missing values in the measure of interbank borrowing relevant for the identification of shocks. If there is to be a bias from demand-driven reductions in interbank funding, this is more likely to stem from banks infrequently borrowing via interbank markets. If banks are historically active in this market it would be unlikely to see interbank funding being suddently stoped due a bank's own changing funding preferences. This adjustment reduces the number of banks to 54.

This latter adjustment is also important due to more mechanical reasons. As explained below, I identify shocks by comparing banks historical growth rates of interbank funding with the growth rates reported during the crisis period. Therefore, analyzing banks only intermittently active in the interbank market would impose a serious restriction to the algorithm I use to pin down the funding shocks. Furthermore, this sampling procedure is likely to produce conservative estimates of the effect of funding shocks on liquidity and lending, since drastic restrictions leading banks to exit the interbank market are excluded from the analysis. The focus will be therefore in the intensive margin of interbank funding shocks. With these restrictions the working sample consists of 45 banking conglomerates representing on average 68% of aggregated total assets and 73% of aggregated outstanding credit in the Brazilian banking sector during the sample period. The sample covers 87% of total interbank funding on average, capturing banks that represent the largest players in the local market.

Finally, I impose two restrictions at the regional level that are needed to ensure the consistency of the analysis. First, I drop branches with missing values in the bank traits used as control variables to make the branches comparable over the whole dimension of the analysis. Second, I keep only municipalities with at least one branch affected and one not affected by an interbank funding shock at the headquarter level. This filter is important for two reasons: first, I need to be able to compare affected and non-affected branches at the municipal-level in order to deliver consistent results. Second, observing at least two branches per municipality-time observation is needed in order to implement the prefered fixed effect estimation described in Section 4.2.1. These filters reduce the sample from 4232 branches in 1321 municipalities to 3642 branches in 1062 municipalities. These branches represent on average 68% of total branches assets in Brazil.

4.2.3 Identifying interbank funding shocks

Interbank borrowing definition. I use an item of banks liabilities' structure called "borrowing and onlending from other participants of the banking sector" (hereinafter referred to as interbank borrowing) to identify shocks. From the definition provided by the BCB, this variable captures funding operations with a relatively long maturity (> 3 months) conducted exclusively between local banks. There is no central clearing infraestructure for this market in Brazil, with operations being conducted primarily in an uncollateralized and over-the-counter market.

Interbank borrowing is, after interbank deposits, the second largest category of interbank liabilities used by Brazilian banks. The data distinguish between interbank deposits, interbank borrowing, interbank borrowing from abroad, liabilities from derivatives and interbank relations. These categories are depicted in Figure 4.1 as a share of total interbank liabilities. Interbank deposits account on average for around 50% of interbank liabilities, followed by interbank borrowing. Foreign funding, derivatives and interbank relations considered together account for the remaining 25% of banks' interbank operations. Interbank relations accounts for small interbank operations such as debts payables, related obligations and other operations with correspondents.

Thus, interbank borrowing excludes interbank deposits, foreign funding, derivatives and other small components of interbank funding. It also excludes borrowing from local official institutions such as the BCB, either

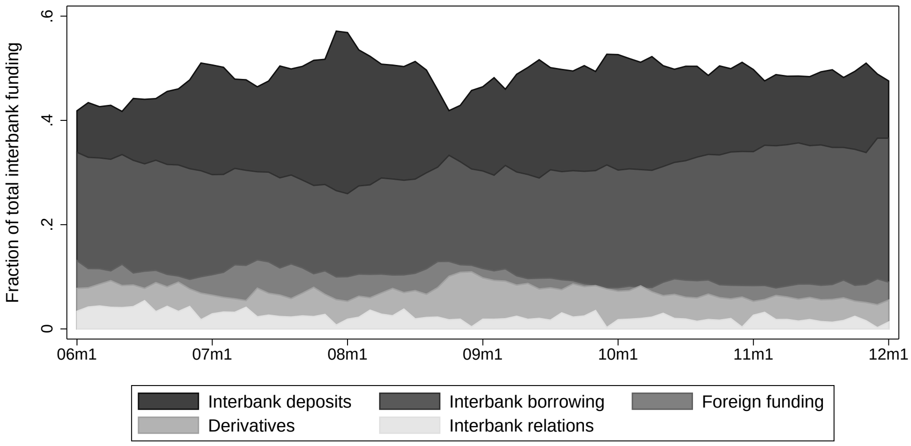


FIGURE 4.1: This figure shows different categories of interbank liabilities as a share of the total. The variables are aggregated from the bank level data in the sample for the period from January 2006 to January 2012. In order of magnitude the reported categories are interbank deposits, interbank borrowing, borrowing from abroad, liabilities from derivatives and interbank relations. This latter category corresponds to the sum of minor interbank operations such as resources in transit and debts payable. The variable "interbank borrowing" corresponds to the one used for the analysis of interbank shocks in the paper.

through direct contracts or Repo operations. The data allow me only to observe balances outstanding, so that funds raised in the primary or secondary market cannot be distinguished. All in all interbank borrowing represents on average 16% of total bank liabilities over the sample period.

Interbank borrowing presents a number of advantages when it comes to identify idiosyncratic shocks around the global financial crisis. First, as reported in Figure 4.1, interbank borrowing represents a large component of banks' interbank operations. This supports the hypothesis that disruptions in this market are likely to have important consequences for intra-group liquidity dynamics. Second, Figure 4.1 stresses that in the aggregate interbank borrowing did not loss its share in aggregated interbank liabilities relative to other funding sources after September 2008. Below, I will further investigate the stability of interbank borrowing around the global financial crisis.

Interbank funding shocks. I now turn to identify months at which headquarter banks are affected by idiosyncratic interbank funding shocks. I aim at generating a taxonomy of these shocks, including their size, duration and distribution over time. I first discuss the algorithm used to identifiy the

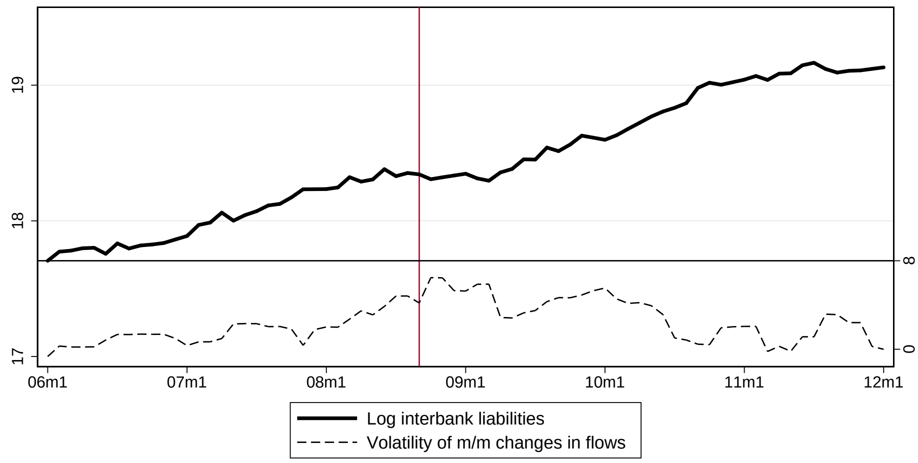


FIGURE 4.2: This figure shows the time series of log interbank borrowing, the item used to identify bank-specific interbank funding shocks. This variable is reported in log of US$ millions. The dotted line in the bottom panel shows the volatility of monthly changes in aggregated interbank borrowing flows in the Brazilian banking system. The volatility is computed as the 12-month standard deviation of changes in flows within rolling time windows. The vertical line is set at September 2008 to mark the date at which the collapse of Lehman Brothers occurred.

shocks and then provide descriptive statistics that compare banks affected and not by a shock.

I first define a shock-searching time window in which we could expect banks to be affected by interbank borrowing shocks. For this purpose, I explore the performance of the interbank market on Figure 4.2. This figure plots the log of aggregated balances in the banking sector (upper panel) together with a time series of the volatility of monthly changes in interbank borrowing flows (bottom panel). Figure 4.2 shows that, while interbank borrowing remained relatively stable after September 2008, the underlying volatility of flows started to pick up as early as mid 2007, coincidentally with the first signs of financial distress in the U.S. The volatility remains at high levels until the beginning of 2010, when it subsequently decreases. This is evidence that even with stable aggregate liquidity in the market, banks became ingreasingly cautious when assessing the credit worthiness of their local counterparties in Brazil.

This phenomenon is not exclusive to Brazil, being in line with established rationales explaining the spreading of interbank markets distress during the crisis. A theoretical explanation on this regard is discussed by Acharya et al. (2011). Empirically, Acharya and Merrouche (2013) show that increased uncertainty about own banks' asset values led to adverse selection problems affecting the supply of interbank loans in the U.K. More generally Brunnermeier (2009) and Stiglitz (2010) have suggested that uncertainty about counterparty risk was a key driver of financial distress across global interbank markets during the crisis.

In the vein of this literature, I argue that banks' reluctancy to inject liquidity into the local interbank market limited the supply of interbank loans to banks in Brazil. This mechanisms could have been agumented by borrower banks' credit-portfolio risks (Caballero and Krishnamurthy, 2008), by funding maturity missmatches (Diamond and Rajan, 2009) or by lender banks' flight-to-liquidity (Allen and Gale, 2004b). Since banks' in the sample are simoultaneously lenders and borrowers in the local market, I remain agnostic about the relative strenght of these channels in my setup, a question that lies beyond the scope of my study. However, I will formally address the role of different forms of banks' ex-ante exposures in affecting intra-group liquidity allocation when discussing the results.

By combining this theoretical framework together with the analysis of Figure 4.2, I define a shock-searching time window between June 2007 and December 2009. This window leaves me with sufficient time before and after the occurrence of shocks in order to observe banks' adjustments over time. Shocks are identified by adjusting an algorithm proposed by Cavallo et al. (2015) to identify sudden stops in capital flows at the country level.

I begin by computing the change in log interbank borrowing, ΔIB_{it} as the 12-month variation in log outstanding interbank balances, so that $\Delta IB_{it} = IB_{i,t} - IB_{i,t-12}$. I choose this time structure in order to ensure that the resulting time series are not being affected by seasonal effects. Since the data set starts in January 2005, the resulting variable ΔIB_{it} runs between January 2006 and December 2012, which is the period used for the subsequent analysis.

I next define a criteria that sets the definition for the interbank shocks. For this purpose I first demean ΔIB_{it} by substracting the sample mean

$\Delta\overline{IB}_{jt\forall j\neq i}$ at time t computed for all banks but i. I call this demeaned growth rate $\Delta\widetilde{IB}_{it} = \Delta IB_{it} - \Delta\overline{IB}_{jt\forall j\neq i}$.[5] Following Cavallo et al. (2015), I then compute as an interbank funding shock the first date at which the following condition holds:

$$\Delta\widetilde{IB}_{it} \leq \frac{\sum_{t=-12}^{12} \widetilde{IB}_{it}}{12} - 2\sigma_{it} \tag{4.3}$$

In accordance to Equation (4.3), I define a shock as the moment at which $\Delta\widetilde{IB}_{it}$ falls at least two standard deviations below its own 12-month historical mean. If this condition holds, the beginning (end) of a shock is set at the month when $\Delta\widetilde{IB}_{it}$ falls below (exceeds) one standard deviation from its historical mean. For a given month t, the standard deviation σ_{it} is also computed over the previous 12 months.

The restriction imposed in Section 4.2.2 regarding the existence of a balanced panel for ΔIB_{it} becomes clearer: it allows to discard the possibility of my identification of shocks being affected by factors not related to the suppply of interbank loans available from each bank's own perspective. Demeaning ΔIB_{it} is important to ensure the consistency of the statistical moments retrieved from the adjusted Cavallo et al. (2015) algorithm. For instance, computing the 12-month mean and standard deviation directly from ΔIB_{it} would lead me to generate non-stationary time series due to the existence of unit roots and deterministic trends. By using $\Delta\widetilde{IB}_{it}$, I obtain time series that fluctuate around 0, avoiding time trends. This should underpin the consistency of the estimates retrieved from the adjusted Cavallo et al. (2015) algorithm.

I run the algorithm for the 2005-2012 time series of IB_{it} for each of the 45 banks in the sample. Formally, I consider a bank as shock-affected if at least once in the period from June 2007 to December 2009 a shock is identified. I consider the first shock identified during this period as the relevant one for the analysis.

[5] In Section 4.3.2 I alternatively compute $\Delta\widetilde{IB}_{it}$ by using a multifactor residual model (Pesaran, 2006; Buch et al., 2009). In this alternative definition ΔIB_{it} is proxied by the residual of bank-specific regressions of ΔIB_{it} on a set of macroeconomic factors.

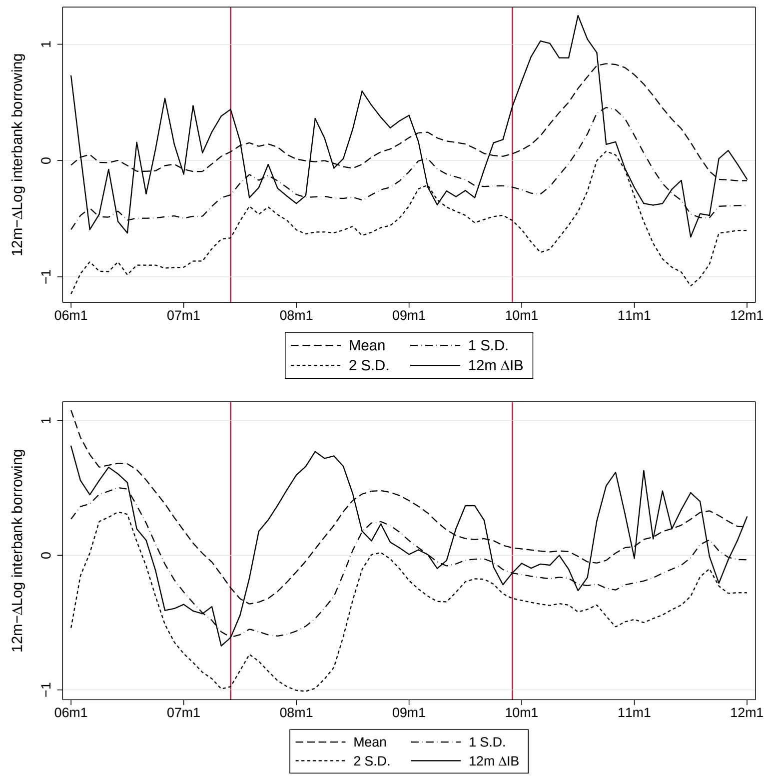


FIGURE 4.3: The figure depicts the criteria used to define an interbank funding shock for two banks in the sample. The upper graph shows the demeaned 12-month change in log interbank borrowing for Banco Rendimento S.A., a local bank in Brazil. The dotted lines represent, from top to bottom, the average growth rate of interbank funding during the last 12 months and the one and two standard deviations below that average over the same period, respectively. A shock is defined to exist if the actual growth rate at a given month exceeds the threshold-line of two standard deviations, i.e. if the growth rate is equal or lower than two standard deviations below its historical mean. The bottom graph replicates the exercise using as an example the case of Banco Société Générale Brazil, the local affiliate of a French-owned bank.

To illustrate the algorithm, Figure 4.3 depicts two examples of banks affected and not by an interbank shock. The first example corresponds to Banco Rendimento S.A., a domestically-owned bank (upper graph). In March 2009 $\Delta\widetilde{IB}_{it}$ falls below the threshold defined by Equation (4.3), indicating a funding shock. The rather unusual occurrence of a shock is confirmed by the fact that only once in 6-years time series $\Delta\widetilde{IB}_{it}$ falls below the threshold. Out of the sample of 45 banks 27 report an interbank funding shock. I refer to these banks as shock-affected banks. Following my definition, the shock of Banco Rendimento S.A. beginns in February 2009 and lasts until July 2009.[6]

Shock-affected banks face shocks that last on average for 4.6 months with a peak-to-trough drop in interbank borrowing of 26.3% on average. Table C.I in Appendix C provides a comprehensive list of all shock-affected banks including the date, size and duration of the identified funding shocks. The estimated shocks are also well distributed along the shock-searching time window, with shocks occurring at different dates between 2007 and 2009 (see Figure C.I in Appendix C).

The bottom graph in Figure 4.3 depicts the case of the Brazilian subsidiary of Société Générale. This bank does not report a funding shock at no point during the sample period. Although there are a number of fluctuations above and below zero, $\Delta\widetilde{IB}_{it}$ never falls below the threshold from Equation (4.3). This example illustrates the case of banks for which $\Delta\widetilde{IB}_{it}$ mainly comoves with the market. The 18 non-affected banks are used in Equations (4.1) and (4.2) as a control group to assess the effect of interbank funding shocks on liquidity and lending by banks' branches. In order to implement the analysis over the event-timeline, I assign a virtual shock to non-affected banks set at the month when $\Delta\widetilde{IB}_{it}$ reaches its closest value to the threshold from Equation (4.3). At these dates, non-affected banks are more likely to experience a shock, allowing for a more conservative comparison over the event-timeline with the group of affected banks.

4.2.4 Descriptive statistics and estimation assumptions

Descriptive statistics. Table 4.1 reports descriptive statistics for the final sample. This consists of 45 bank headquarters and 3642 bank branches operating in 1062 municipalities fullfilling the identification's requirements. The first four columns report information on the whole sample. Thereafter the mean value for each variable in the pre-shock period is reported for the group of shock-affected banks (column "Shock Affected: Yes") and for

[6]This example illustrates how the adjusted Cavallo et al. (2015) algorithm allows to generate a taxonomy of shocks. In this case the shock lasts for 5 month and has a peak-to-trough size of US\$134 mill. between the pre-shock and the minimum balance of IB_{it} during the shock. This shock is sizeable, representing 35% of the average total pre-shock interbank liabilities of Banco Rendimento S.A.

TABLE 4.1: Descriptive statistics of the bank sample.

	Statistics				Shock-affected		
	Mean	SD	Min	Max	Yes	No	Diff
Δ Log Liquidity	0.0121	0.0793	-0.8624	0.8756	0.0123	0.0131	-0.0007
Δ Log Credit	0.0201	0.0930	-0.2067	0.3568	0.0264	0.0226	0.0037
Headquarter level							
Size (log US Mill.)	11.6641	1.1772	8.2925	12.9551	11.5916	11.1495	0.4421*
Capital / Total Assets	0.0732	0.0404	0.0364	0.2535	0.0715	0.0759	-0.0044
Liquidity / Total Assets	0.2082	0.0920	0.0461	0.4176	0.2154	0.1501	0.0654*
Deposits / Total Assets	0.5583	0.0963	0.2772	0.7683	0.5695	0.5554	0.0141
NPL / Credit	0.1715	0.0696	0.0387	0.2819	0.1700	0.1601	0.0099
Foreign Ownership	0.1662	0.3722	0.0000	1.0000	0.2651	0.0021	0.2629*
Branch level							
Size (log US Mill.)	3.2904	1.4491	0.7926	8.4762	3.0273	3.1900	-0.1627
Liquidity / Total Assets	0.0389	0.0628	0.0011	0.2880	0.0529	0.0234	0.0295*
Deposits / Total Assets	0.3642	0.2231	0.0095	0.8158	0.3461	0.3055	0.0906
RoA	0.0354	0.0431	-0.0212	0.1897	0.0521	0.0164	0.0357*

Notes: Descriptive statistics for bank traits. The variables Δ Log Liquidity and Δ Log Credit are computed as monthly changes. The branch and headquarter level summary statistics in columns 5 and 6 are computed as of the pre-shock period for the group of affected and non-affected banks. The last column shows the difference in means between affected and not affected banks. Shock-affected banks are those for which the algorithm described in Section 3 indentifies a shock to interbank borrowing. * indicates whether the difference is significant by normalized differences (Imbens and Wooldridge, 2009). Source: banks' call reports, authors' calculations.

non-affected banks (column "Shock Affected: No"). The last column tests for the difference in means between both groups of banks in the pre-shock period. I test for the statistical significance of these differences by means of the Imbens and Wooldridge, 2009 test on normalized differences. This procedure reveals that shock-affected branches had a larger liquidity ratio and were more profitable in terms of RoA in the pre-shock period. Their headquarters were also larger and reported higher liquidity ratios compared to the sample of non-affected branches.

Table 4.1 also shows that it is more likely to find foreign-owned banks in the subsample of shock-affected banks. This observation is relevant because it might hide some information about the reason why only some banks are being affected by shocks. For instance, the plunge in global interbank markets might have increase foreign banks' rollover risk, leading other participants in the interbank market to tight their lending conditions. I empirically address the implications of banking globalization for my analysis in Section 4.3.2. The number of banks and branches per shock and foreign ownership status are reported in Table C.II in Appendix C.

The explanatory variables report reasonable sizes for a banking sector in an emerging country. The average deposit base is somewhat larger at the branch level (36%) compared to headquarters (20%), signalizing the fact that parent banks are more likely to have access to the interbank market and central bank liquidity.

Identification assumptions. Table 4.1 also tests for the presence of pre-shock trends in the output variables that might bias the analysis. A common ex-ante trend in the output variables for affected and non-affected banks is a key underlying assumption of difference-in-difference estimations as the ones described in Equations (4.1) and (4.2). The first two rows in Table 4.1 report descriptive statistics for the monthly changes in log liquid assets and log credit. I do not find evidence of these variables being statistically different from each other in the pre-shock period for the subsamples of affected and non-affected banks.

To ensure that the identification is in fact clean from pre-existent trends, I extend the previous analysis by computing time-varying averages of liquidity and credit growth relative to $\tau = 0$ for the two groups of banks. These averages are computed in two levels: first, as an average of all branches from the same bank, and second, as an average of banks affected and not by a shock. A graphical inspection of this exercise confirms that branches from the two groups of banks behaved similarly in terms of the variables of interest in the pre-shock period.[7]

The latter exercise sheds also light on my research question. By non-parametrically exploring the data, I find that credit growth plunges while liquidity growth peaks after $\tau = 0$ for shock-affected branches compared to the control group. Liquidity growth is somewhat more volatile, with the increase in liquid assets growth becoming clearly visible around 4 months after the shock starts. This preliminary result, explored in detail in Section 4.3.1, also highlights the unexpected nature of shocks from branches' perspective.

[7]These results are reported in Figure C.II in Appendix C.

A final pre-test is used to support the assumption of the funding shocks not being driven by pre-existent changing preferences of banks' headquarters. In doing so I seek to confirm that the shock is not reflecting banks' ex-ante intention to switch their funding sources. To address this concern, I test whether the interest rates paid by banks for interbank borrowing increase in the 6 months before the shock strikes. If my assumption of shocks being supply-driven is true, I would expect the lending conditions to tighten before lenders come to the point where they decide to drastically reduce their supply of credit. Formally, I test the following empirical model:

$$Borrowing\,Rate_{i,\tau} = \alpha_0 + \theta_1 \left[Affected_i \times Time_\tau\right] + \mu_i + \gamma_t + \varepsilon_{i,\tau} \tag{4.4}$$

I compute a proxy of banks' interbank funding costs called *Borrowing* $Rate_{i,\tau}$ by dividing the monthly expenses in interest payments due to interbank borrowing by the balances of interbank borrowing outstanding.[8] In Equation 4.4 the variable of interest is $Affected_i \times Time_\tau$, an interaction term between a dummy equal to 1 for affected banks and 0 otherwise ($Affected_i$), and a time dummy for each period between $\tau - 6$ and $\tau - 1$, where $\tau \epsilon \{1, ..., 6\}$.[9] I further fill the model with bank (μ_i) and actual date (γ_t) fixed effects.

The results from Equation 4.4 (reported in Table C.III in Appendix C) show that θ_1 becomes positive and statistically significant three months before the occurrence of the shock. From that point on the coefficient starts to increase both in size and explanatory power. Before the shock strikes, at $\tau = 0$, shock-affected banks report a threefold larger $Borrowing\,Rate_{i,\tau}$ than in the previous months relative to the control group. This suggests that the identified funding shocks are not driven by banks' changing preferences

[8] A drawback of this proxy is that I cannot distinguish the exact interest payments per interbank loans category. Still, since interbank borrowing represents the largest share of interbank loans, I would expect the proxy to capture whether the borrowing costs increase in the months prior to the shock relative to the ammounts outstanding. A similar test is used by Pérignon et al. (2016) to argue that bank-specific funding shocks in the European certificates of deposits market are mainly supply-driven.

[9] For the control group I set the beginning of the shock 2 months before the actual occcurrence of the virtual shock, which is the average for shock-affected banks.

towards alternative funding sources.[10]

4.3 Results and robustness tests

4.3.1 Baseline results

Table 4.2 reports the results of estimating Equations (4.1) and (4.2) using the sample of Brazilian banks and bank branches. Columns (1) to (3) show the results when estimating liquid assets' growth, whereas Columns (4) to (6) estimate the effect of the funding shock on credit growth. The pattern that emerges is consistent with my hypothesis as well as with the preliminary findings from Section 4.2.4: branches from shock-affected banks tend to increase liquidity and reduce lending after the shock compared to the control group of branches from non-affected banks. The fact that these findings are obtained by looking at a 24-months time window provides evidence for the long-lasting impact of large disruptions in interbank market as it has been previously found in the literature (see for example Ananda et al., 2011).

Table 4.2 shows three types of estimations for each of the dependent variables. First, Columns (1) and (4) estimate the models without further explanatory variables or fixed effects in order to check whether a general association between the difference-in-difference estimator and branches' outputs can be found in the data. Then Columns (2) and (5) add the explanatory variables defined in Section 4.2. Finally, Columns (3) and (6) include the set of branch and municipality-month fixed effects. This battery of fixed effects is attempted to exclude the possibility of the results being driven either by unobservable characteristics at the branch level, by aggregated month-specific trends affecting all branches or by municipality-specific time trends. This latter set of fixed effects allows to interpret the results as being

[10]Despite this finding, it could be argued that shocks reflect a changing preference towards alternative interbank funding sources. I believe that this is not a plausible concern in my setup. First, if, for instance, interbank deposits become more attractive, this should be true for all banks in the sample. This would lead to an aggregate adjustment in the outstanding volumes of interbank borrowing in the banking system, what is not observed in the data. Second, if market conditions lead banks to prefer other funding sources shocks would be identified around the same months. This is inconsistent with the fact that shocks are distributed across the 24 months of the shock-searching time window.

TABLE 4.2: Effect of interbank shocks on liquidity and credit growth.

	Liquid Assets Growth			**Credit Growth**		
	(1)	(2)	(3)	(4)	(5)	(6)
Shock X Affected	0.012***	0.015*	0.019**	−0.012***	−0.014***	−0.036***
	(0.004)	(0.008)	(0.009)	(0.001)	(0.001)	(0.012)
Shock	−0.007**	−0.007	−0.007	0.001	0.000	0.014
	(0.003)	(0.005)	(0.006)	(0.001)	(0.001)	(0.010)
Affected	−0.002	0.000		0.004***	0.016***	
	(0.003)	(0.012)		(0.001)	(0.001)	
Headquarter controls						
Size (log US Mill.)		0.005	−0.031		0.006**	0.025*
		(0.003)	(0.022)		(0.003)	(0.014)
Capital / Total Assets		−0.017	−0.326**		0.066	−0.340
		(0.140)	(0.160)		(0.130)	(0.241)
Liquidity / Total Assets		−0.053	−0.250***		−0.026	−0.126
		(0.049)	(0.077)		(0.045)	(0.097)
Deposits / Total Assets		−0.039	−0.076		−0.036	−0.253***
		(0.046)	(0.109)		(0.043)	(0.071)
NPL / Credit		0.012	0.019		−0.027	−0.283
		(0.068)	(0.074)		(0.069)	(0.181)
Foreign Ownership		−0.003			−0.021*	
		(0.017)			(0.012)	
Branch controls						
Size (log US Mill.)		−0.004***			0.002***	0.041***
		(0.001)			(0.001)	(0.011)
Liquidity / Total Assets		0.133***	0.516**		−0.009	−0.017*
		(0.052)	(0.224)		(0.007)	(0.008)
Deposits / Total Assets		−0.014**	−0.065***		0.016*	0.053**
		(0.007)	(0.017)		(0.009)	(0.020)
RoA		−0.210	−0.277		−0.087	−0.190**
		(0.194)	(0.166)		(0.074)	(0.089)
Constant	0.015***	0.007		0.023***	−0.043	
	(0.002)	(0.048)		(0.001)	(0.046)	
Branch FE	No	No	Yes	No	No	Yes
Time FE	No	No	Yes	No	No	Yes
Region/Time FE	No	No	Yes	No	No	Yes
Obs.	178458	178458	158704	178458	178458	158704
R-squared	0.068	0.156	0.364	0.034	0.178	0.404

Notes: This table reports the results of estimating Equations (4.1) and (4.2) for different especifications. In Columns (1) to (3) the dependent variable is the monthly change in log liquid assets, whereas in Columns (4) to (6) the dependent variable is the monthly change in log outstanding credit. The explanatory variable $Shock_{i\tau} \times Affected_i$ represents the main variable of interest that can be interpreted as a difference-in-difference estimation of the differential growth rates in the shock period for the group of branches whose parent banks are affected by an interbank shock. Columns (1) and (4) report baseline estimates without fixed effects or control variables. Columns (2) and (5) include the full set of explanatory variables and Columns (3) and (6) add the full set of fixed effects at the branch, month and municipality-month level. All regressions are estimated by clustering standard errors at the parent-bank level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%.

supply-driven in the vein of Khwaja and Mian, 2008 and Schnabl, 2012. The identified pattern in liquidiy and credit growth holds across the different estimations reported in Table 4.2. These results evidence that branches from shock-affected banks built up liquidity as a consequence of increased funding risk. This liquidity adjustment is then associated with a reduction in credit supply.[11]

Depending on the specification, liquidity growth is, on average, between 1 and 2 percentage points (p.p.) larger in the shock period for the group of affected branches. This effect is economically sizable when compared to the average monthly change in log liquid assets (around 1 p.p.). When I non-parametrically compute β_1 for the average affected branch in the sample, I find that the model from Column (3) explains around 75% of its difference-in-difference variation. Therefore more than two third of the (average) observed differece between branches affected and not by the shock is attributable to the interbank funding shock faced by their headquarters.

The differential impact of the interbank shock results more clear by observing the negative sign on the coefficient of $Shock_{i\tau}$ that captures the changing pattern in liquidity growth after τ=0: whereas affected branches increase liquidity growth, branches in the control group actually decrease their liquid holdings. This result stresses the bank-specific nature of the shocks computed in Section 4.2.3. If I would have captured a market-wide disruption in interbank funding the coefficient on $Shock_{i\tau}$ would have been positive, signilizing that liquidity adjustments co-move between affected and non-affected branches. The results from Table 4.2 clarifiy that this is not the case.

Regression results from estimating Equation 4.2 (Columns (4) to (6) in Table 4.2) provide evidence of a crowding-out effect of liquidity hoarding on credit supply. From the FE estimation on Column (6) it follows that shock-affected branches report 5.1 p.p. of lower ex-post credit growth as a consequence of the shock. This effects is economically significant compared to an average credit growth of 2.0 p.p. in the sample, being equivalent to

[11]It should be noted that in Table 4.2 the number of observations is not equal across the different estimations. Concretely, the fixed effects model reduces the number of observations from 178458 to 158708. This gap is generated because imposing month fixed effects makes the panel unbalanced over the event-timeline, since by construction shocks occurr at different dates represented with τ=0. I choose to report both the results with the balanced event timeline (49 observations per branch) as well as with the unbalanced fixed effects especification to ensure that the results are not driven neither by demand-related factors or by an assymetric structure of actual time series as it could be the case in the unbalanced panel. Note also that 2 banks report only 47 and 48 observations per branch respectively, because of being affected by a shock in November and December 2007.

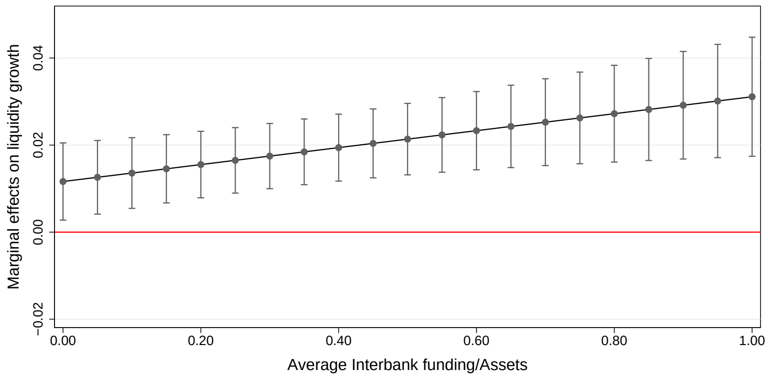
53% of sample's standard deviation in credit growth. I also find that this effect represents a 73% of the non-paremetric difference-in-difference credit growth for the average affected branch. Therefore, as in the case of liquidity growth, a significant share of ex-post credit growth is attributable to the shocks.

This finding is in line with Cornett et al. (2011), where a similar relationship between liquidity hoarding and credit supply is found to be triggered by the global financial crisis in U.S. commercial banks. In opposite to this latter study, my analysis highlights that periods where banking institutions hoard liquidity do not need to be triggered by system-wide funding disruptions. My results also stress that frictions in local internal capital markets combined with liquidity adjustments can have consequences in terms of financial stability in credit markets. This is especially relevant considering the regional markets where branches operate. The lack of alternative funding sources for local borrowers together with the long lasting effect of the shock, is likely to lead to large restrictions in the availability for credit with a subsequent impact on local real economies.

4.3.2 Robustness and underlying mechanisms

Ex-ante liquidity risk exposures. From the discussion on the previous sections, we would expect the effect of the funding shocks to be augmented by branches' ex-ante liquidity risk exposures. This would imply that pre-existent frictions in internal capital markets restricted branches' ability to replace interal funding from within the banking conglomerate after a shock. I therefore test, in what follows, the sensibility of estimating Equations (4.1) and (4.2) to including measures of branches' ex-ante liquidity risk.

I first measure liquidity risk as the average ratio of branches' interbank borrowing to total assets during the 6 months prior to the shock. I refer to this variable as $Lrisk_{i,m}$. Even though I cannot observe billateral positions vis-à-vis banks headquarters, I do observe the aggregated liabilities obtained by each branch in the wholesale market. To the extent that branches are likely to obtain a large share of this funding from related institutions, I



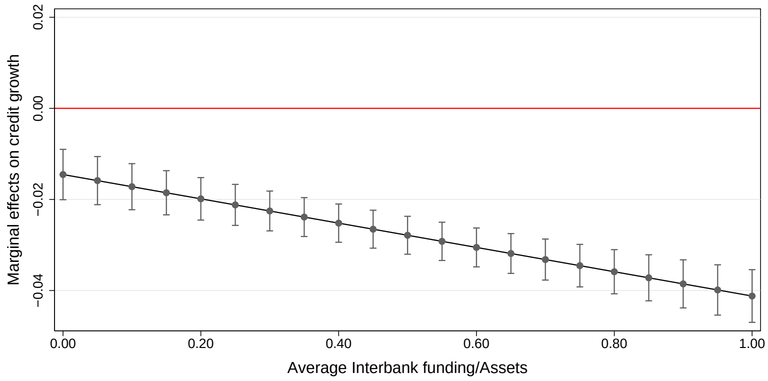


FIGURE 4.4: This figure illustrates the marginal effects at the 95% confidence level of a nonlinear extension of Equations (4.1) and (4.2), in the form of $\Delta Liquidity_{i,m,\tau} = \alpha_0 + \beta_1[Shock_{i,\tau} \times Affected_i \times Lrisk_{i,m}] + ...$ and $\Delta Credit_{i,m,\tau} = \alpha_0 + \beta_1[Shock_{i,\tau} \times Affected_i \times Lrisk_{i,m}] + ...$ respectively. The regressions from which the marginal effects are computed are based on the FE specification from Columns (3) and (6) in Table 4.2, including the full set of control variables, municipality-month fixed effects and clustering standard errors at the parent-bank level. The figure shows that the baseline effects of the shock on liquidity and lending were more pronounced for branches with a larger pre-shock interbank funding exposure as measured by the average ratio of interbank liabilities to total assets during the 6 months prior to the shock. The underlying estimation is reported in Table C.IV in Appendix C.

would expect $Lrisk_{i,m}$ to be positively correlated with β_1 in Equation (4.1).[12] $Lrisk_{i,m}$ ranges from 0 to 1, where 1 represents a branch whose funding structure is fully concentrated in interbank borrowing. $Lrisk_{i,m}$ averages 0.34, consistent with branches relying primarily on core deposits as a funding source. Previous literature has found similar measures of funding exposure to have an impact on banks performance.[13]

[12] If β_1 is either orthogonal or positively correlated with $Lrisk_{i,m}$, branches with high $Lrisk_{i,m}$ would adjust liquidity and lending to a smaller extent than other branches.

[13] For example, Demirgüç-Kunt and Huizinga, 2010 show for a sample of European banks that a higher concentration in wholesale funding was associated with increased volatility of stock returns and a narrower distance to default in the aftermath of the global financial crisis. More generally Rajan, 2006 discusses how banks' increasing reliance on wholesale funding over the past decades has make their balance sheets more vulnerable in a crisis scenario.

I test the impact of liquidity risk on my baseline estimation by adding to Equations (4.1) and (4.2) an interaction term between the baseline difference-in-difference estimator $Shock_{i,\tau} \times Affected_i$ and $Lrisk_{i,m}$. Based on my prefered FE estimation, Figure 4.4 depicts the marginal effects of $Shock_{i,\tau} \times Affected_i$ on liquidity (upper panel) and lending (bottom panel) growth along the distribution of $Lrisk_{i,m}$. The results show that ex-ante liquidity risk increases the liquidity hoarding reaction by branches. In fact, the effect of the shock on liquity and credit growth becomes smaller at very low degrees of liquidity risk.

Alternatively, I define $Lrisk_{i,m}$ as the average ratio of branches' net interbank assets to total assets during the 6 months prior to the shock. I expect this variable to capture whether a given branch was a net lender or borrower in the interbank market at the moment when the shock occurs. The results, reported in Table C.IV in Appendix C, are consistent with the findings in Figure 4.4: The effect on liquidity and credit growth concentrates in branches that were net-borrowers in the interbank market prior to the shock. Finally, when defining $Lrisk_{i,m}$ as the average pre-shock funding concentration (as measured by a Herfindahl Index on branches liabilities' structure), I confirm that the effect is driven by higher levels of overall funding concentration (see results in Table C.IV).

These results contribute to understand the mechanisms of how interbank exposures translate into financial stability disruptions, as it has been previously theoretically analyzed by Huang and Ratnovski, 2011 and Acharya and Skeie, 2011. Consistent by previous literature (e.g. Houston and James, 1998; Houston et al., 1997; Boutina et al., 2013), I find evidence that internal capital markets affect the transmission of bank liquidity shocks. My results add to this literature by providing evidence of a liquidity hoarding reaction by branches driven by their ex-ante liquidity exposures towards their banking conglomerates.

Cross-border financial contagion. Banking globalization played a major role in shaping the cross-border transmission of the global financial crisis.

As it has been stressed by Cetorelli and Goldberg (2011) and Buch and Goldberg (2015) this channel was particularly harmful for emerging countries, for which the crisis aroused exogenously from their own banking sectors' perspective. With this evidence at hand, a natural concern is whether my results are not merely reflecting banks' own exposures to global interbank markets. This represents a potential omitted variable bias that cannot be fully addressed by simply relying on the foreign ownership control variable introduced in Equations (4.1) and (4.2).

Potentially, banks' foreign exposures could have increased their rollover risk in the crisis, causing other banks in Brazil to cut their local interbank lending and ultimately triggering the shocks I identify. These exposures might operate via organizational links between foreign banks in Brazil and their bank holding companies abroad (see Noth and Ossandon Busch, 2016) or more directly via banks reliance on interbank funding from abroad, as in Aiyar (2012) and Ongena et al. (2015).[14]

I test for the implications of banking globalization as follows. First, I compute two measures of both *de jure* and *de facto* banking globalization. In the former case I rely on the foreign ownership dummy described in Section 4.2. As a *de facto* measure I compute the average ratio of interbank borrowing from abroad to total assets during the 6 months before τ=0 at the headquarter level.[15] For simplicity, I refer to these variables indistinctly as $Fexposoure_i$.

Formally, I estimate Equations (4.1) and (4.2) by performing a "horse race" between the baseline difference-in-difference estimator and the interaction between $Fexposoure_i$ and $Shock_{i,\tau}$. Since we learned from the discussion above that foreign exposure is likely to interact with the variable

[14]This concern is specially important considering that foreign banks are overrepresented in the subsample of shock-affected banks (see Table 4.1). Out of the 27 affected banks 10 are foreign owned, whereas only 4 out of 18 banks are foreign owned in the subsample of non-affected banks.

[15]In Brazil bank branches are not allowed to obtain directly funding from abroad. Therefore the variable used for his exercise is only available at the headquarter level. To facilitate the analysis I compute banks' foreign funding exposure as a dummy equal to one if a bank reports an average share of foreign interbank borrowing before to total liabilities between τ=-6 and τ=-1 above the sample median. Banks in the sample report an average ratio of foreign interbank borrowing to total assets of 9.7%.

$Affected_i$, I also include a triple interaction term defined as $Shock_{i,\tau} \times Affected_i \times Fexposure_i$. This controls for potential nonlinear effects of the interbank funding shocks along the distribution of $Fexposure_i$. The results, reported in Table C.V in Appendix C, show that my main findings remain unaltered, regardless of the inclusion of $Fexposure_i$ in either form. All in all, these results further stress the local nature of the interbank funding shocks captured in Section 4.2.3.

Alternative specifications. I test the sensitivity of my baseline results to different specifications of Equations (4.1) and (4.2). Table C.VI reports the results of these tests, which are based on the prefered fixed-effects estimation.

I first collapse the event-time window into two single observations per branch, before and after τ=0 respectively. As noted by Bertrand et al. (2004), difference-in-difference estimators relying on panel date are likely to suffer from serial correlation. In this case one might argue that the large time series considered for each branch might lead the individual output and control variables to be correlated with itself over time. Even though I address this concern by clustering standard errors at the headquarter level, an even more conservative approach could consist in omitting the panel structure from the analysis by computing each variable as an average during the pre- and post-shock periods. Columns (1) and (2) in Table C.VI show the estimates using this approach for liquidity and credit growth respectively. The main findings from Table 4.2 remain unaltered.

Second, I perform a placebo test by assigning the treatment status to banks headquarters by means of a random function. If my results are in fact driven by bank-specific shocks that do not simultaneously co-move with aggregate market volatility, we should expect a randomization of the shock definition to yield no statistically significant results. The results, reported in Columns (3) and (4) in Table C.VI, confirm that this is indeed the case: neither liquidity nor credit can be explained by the difference-in-difference estimator once the definition of which banks are affected by a shock is randomly defined. This test underpins the idea of the interbank funding shocks

I identify being bank-specific.

I also test the extent to which my results are valid under different lenghts of the shock period. So far the analysis has focused on rather medium term consequences of the shocks within a 2-years time range. I therefore test in Columns (5) and (6) in Table C.VI whether the results hold when the shock period is reduced to 1 year. We do not observe qualitative differences with the baseline results. This analysis is further extend by including an interaction term of $Shock_{i,\tau} \times Affected_i$ with each of the event-time periods for $\tau > 0$ in the model. This analysis yields time-varying coefficients that estimate the differential effect of the interbank funding shock at each specific point in time. The results, reported in Figure C.III in Appendix C, show a negative "on impact" effect of the shock on liquidity growth, with liquidity hoarding emerging as a rather medium-term adjustment. The effect on credit growth is consistently negative throughout the shock period.

When estimating further alternative specifications of Equations (4.1) and (4.2) the results remain unchanged. For instance, I replaced the control variables by their 12-month lags and clustered standard errors at the municipal-level, instead of at the bank-level. I also replaced the dependent variables by the change in liquidity and credit volumes weighted by lagged total assets, following Cornett et al. (2011). These results are reported in Table C.VII in Appendix C. When testing the sensitivity of the estimation to different categories of liquidity, I find the baseline result to be driven by adjustments in cash-holdings and not so by interbank deposits' growth. When estimating Equation (4.2) for different credit segments, I find statistically significant effects on commercial and consumer loans. I do not find evidence of the mortgages supply being affected by the shocks (see Table C.VIII in Appendix C).

Finally, I address concerns about the measure of demeaned interbank borrowing growth, $\Delta\widetilde{IB}_{it}$, being contaminated with macroeconomic trends. One might argue that the shock definition cannot ensure that $\Delta\widetilde{IB}_{it}$ is not driven by specific macroeconomic factors affecting the ocurrence of shocks at given times. I address this concern by estimating time-series regressions for interbank borrowing growth of each bank on observed and unobserved macroeconomic variables lagged in one month.[16] I follow a multifactor residual approach (Pesaran, 2006; Buch et al., 2009; Vannoorenberghe, 2012) and use the residual of each regression as a proxy for $\Delta\widetilde{IB}_{it}$. I run the shock-identification algorithm on this proxy and replicate the results from Table 4.2 in Table C.IX in Appendix C. This parametric estimation of $\Delta\widetilde{IB}_{it}$ confirms my baseline results.

4.4 Central bank liquidity injections

To limit the effects of interbank market stress, central banks worldwide implemented unconventional liquidity interventions after September 2008. Instead of focusing on rather short-term interbank lending via repo operations, these unconventional interventions were defined as term interbank funding with longer maturities, aimed at stabilizing banks' funding structures and restoring credit supply. Similar unconventional interventions were implemented in Brazil after September 2008. These inverventions are likely to affect my baseline analyis: a wider access to unconventional interventions by banks headquarters could have reduced branches' incentives to hoard liquidity. Alternatively, liquidity hoarding incentives might have rendered unconventional interventions ineffective by leading branches to store this extra liquidity in form of liquid assets. This final section evaluates whether central bank unconventional interventions were able to offset the effect of interbank funding shocks.

[16]Following Buch et al. (2009) I use the following local and foreign macroeconomic control variables on a monthly basis (sources are in parenthesis): Brazil Economic Activity Index growth as a proxy for GDP growth (BCB), change in unemployment rate (Brazilian Institute of Geography and Statistics, BIGS), change in the monetary policy SELIC rate (BCB), change in the average overnight interbank rate in Brazil (BCB), change in the IMF Commodity Price Index (IMF), net exports growth rate (BIGS), TED Spread (St. Louis Fed) and U.S. Industrial Production Index growth rate (St. Louis Fed). Also following Pesaran (2006) and Buch et al. (2009) I use as a proxy for unobserved macroeconomic variables the sample means of the following bank-level variables: ratio of liquid to total assets, ratio of debt to equity, credit growth rate, total assets growth rate and interbank borrowing growth rate. For each bank i these variables are computed as the sample average of all other banks.

4.4.1 Liquidity interventions by the Brazilian Central Bank

Similar to the Term Auction Facility program implemented by the U.S. Fed, the interventions of the BCB were not part of normal monetary policy operations but rather a fundamental part of a crisis management policy toolbox. Unconventional interventions were implemented in paralell to a relaxation of monetary policy, with the short-term interest rate falling from 13.75% before the crisis to 8.75% by mid 2009. In contrast to other measures, unconventional interventions were specifically targeted to address banks medium-term liquidity restrictions. This highlights the importance of considering the role of unconventional interventions for the analysis.

The BCB announced in September 2008 several measures to tackle the consequences of the crisis. These measures used resources from foreign currency reserves (some 200 US$ bill. by August 2008) and from temporary reciprocal currency arrangements or swap lines between the U.S. Fed and the BCB (up to 30 US$ bill.).[17] These resources, which were important to support banks' hedging operations, were transmitted to the banking sector via foreign currency being sold in the spot market and, important for my analysis, via open market operations. These latter mechanism involved resources accounting for some US$ 12 billions by mid 2009 (BCB, 2010). The data allow me to track at the headquarter level the balances outstanding vis-á-vis this liquidity facility.

Figure 4.5 plots the time series of banks' aggregated balances vis-á-vis the BCB. Banks' balances peak in the hight of the crisis by mid 2009. The volumes in Figure 4.5 are coincident with the resources that were made available by the BCB. The item of the balance sheet reported here is labeled as

[17]The Board of Governors of the Federal Reserve System arranged these swap lines with a number of central banks in emerging countries announcing that: "the Federal Reserve, the Banco Central do Brasil, the Banco de Mexico, the Bank of Korea, and the Monetary Authority of Singapore are announcing the establishment of temporary reciprocal currency arrangements. These facilities, like those already established with other central banks, are designed to help improve liquidity conditions in global financial markets and to mitigate the spread of difficulties in obtaining U.S. dollar funding in fundamentally sound and well managed economies (extracted from https://www.federalreserve.gov/newsevents/press/monetary/20081029b.htm, releaed on October 29, 2008.).

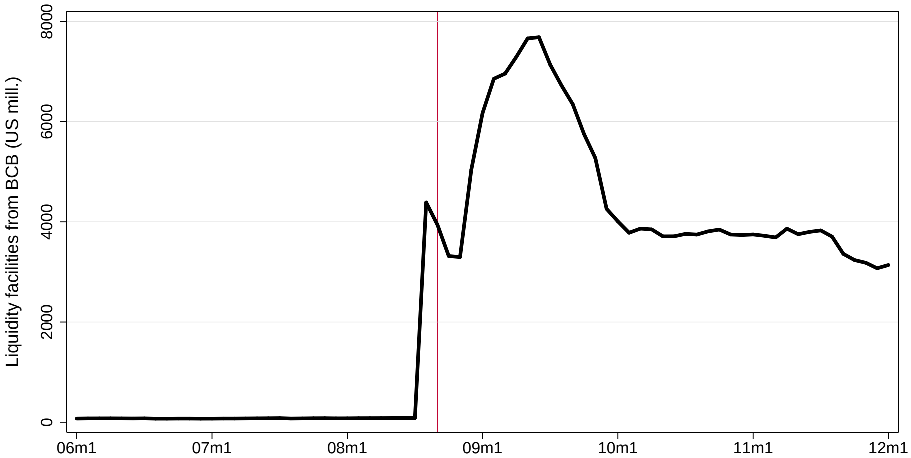


FIGURE 4.5: This figure shows the aggregated time series of outstanding balances of all banks in the sample vis-á-vis extraordinary liquidity facilitiies at the Brazilian Central Bank. Balances are expressed in US$ millions. The vertical line is set at September 2008, the month at which Lehman Borthers collapsed.

"Borrowing from local official institutions" whose main component is defined as *"Central Bank - Financial Assistance and Special Programs"*.

4.4.2 Do liquidity interventions offset the effect of funding shocks?

I test the influence of headquarters' access to BCB unconventional interventions during the crisis on the baseline estimated coefficients. First, I compute an index of bank-specific access to central bank liquidity which (CBI_i) defined as:

$$CBI_i = \frac{1}{\Delta Shock_i} \cdot \frac{CBL_i}{TL_i} \tag{4.5}$$

In Equation (4.5) CBI_i equals the average post-shock ratio of central bank liabilities from unconventional interventions (CBL_i) to total liabilities (TL_i). This average is computed over the 6 months after τ=0 in order to assess the contemporaneous effect of BCB liquidity on branches' adjustments. I further weight this ratio by the size of the respective shock as measured by the peak-to-trough log change in interbank borrowing during the funding shock $(\Delta Shock_i)$.[18]

[18]As stressed by Carpinelli and Crosignani (2015), a fundamental identification challenge is that banks can choose how much to borrow from the BCB. I claim this to be a minor concern in my setup. First, the use of an event-timeline together with the fact that

Even though CBI_i should increase if access to BCB liquidity is large relative to the shock's size, Equation (4.5) remains difficult to intepret. I therefore use feature scaling to normalize CBI_i in order to bring its values to a range between 0 and 1, where 1 represents a relatively large access to BCB liquidity relative to the shock's size. I define this normalized index $\widetilde{CBI}_i$ as:

$$\widetilde{CBI}_i = \frac{CBI_i - Min(CBI_i)}{Max(CBI_i) - Min(CBI_i)} \tag{4.6}$$

$\widetilde{CBI}_i$ captures the size of each bank's access to unconventional interventions in the time immediately after being affected by an interbank funding shock. On average, BCB liquidity accounted for 6.3% of total liabilities between τ=1 and τ=+6. The access to liquidity was heterogeneous across banks, a plausible observation if we take into account that shocks occurred not necessarily at a time when these resources were already available. In line with this $\widetilde{CBI}_i$ reports an average of 0.65 and a median of 0.34, evidencing a relatively skeewed distribution.

Replicating the approach followed in Section 4.3.2 to test nonlinear effects of shocks, I investigate whether the impact of $Shock_{i,\tau} \times Affected_i$ varies along the distribution of $\widetilde{CBI}_i$. I implement this analysis by including a triple interaction term in Equations (4.1) and (4.2) between the difference-in-difference estimator and $\widetilde{CBI}_i$. I then plot the marginal effects on liquidity and credit growth for different values of $\widetilde{CBI}_i$.

The result is reported in Figure 4.6. First, we confirm that the shocks are associated with an overproportional increase in liquid assets growth (upper panel) and a decrease in credit growth (bottom panel) by branches of shock-affected banks, even after controlling for $\widetilde{CBI}_i$. Second, we observe that the explanatory power of the difference-in-difference estimator for liquidity

liquidity access occurs at a different corporate level than the outcome variables should alleviate concerns of reverse causality. Second, by weighting the unconventional intervention balances by the shocks' size I estimate a model that compares shock-affected banks facing a similar shock size but with a differential access to BCB liquidity. This provides a crucial source of further heterogeneity. Finally, as discussed below, my results contradict the prediction that credit growth should be weaker for large-access banks, due to their potential self-selection into the unconventional intervention program.

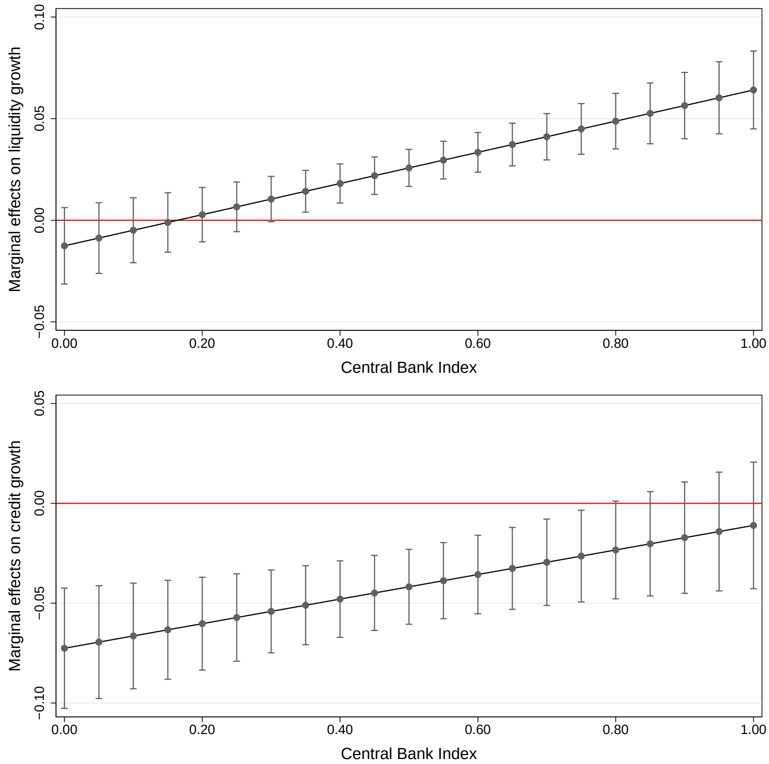


FIGURE 4.6: This figure illustrates the marginal effects at the 95% confidence level of a nonlinear extension of Equations (4.1) and (4.2), in the form of $\Delta Liquidity_{i,m,\tau} = \alpha_0 + \beta_1[Shock_{i,\tau} \times Affected_i \times \widetilde{CBI}_i] + ...$ and $\Delta Credit_{i,m,\tau} = \alpha_0 + \beta_1[Shock_{i,\tau} \times Affected_i \times \widetilde{CBI}_i] + ...$ respectively. The regressions from which the marginal effects are computed are based on the FE specification from Columns (3) and (6) in Table 4.2, including the full set of control variables, municipality-month fixed effects and clustering standard errors at the headquarter level. The regression coefficients are reported in Table C.X in Appendix C.

growth increases along $\widetilde{CBI}_i$: Branches whose headquarter banks report a larger access to BCB unconventional interventions relative to the shock's size, increase their liquid assets by more.[19] Third, the effect on credit growth decreases along $\widetilde{CBI}_i$, evidencing an offsetting effect of the interventions on credit supply.[20] Consider a shock-affected bank below the sample median of $\widetilde{CBI}_i$. My results suggest that by realizing a $\widetilde{CBI}_i$ above the sample

[19]This result is similar to Carpinelli and Crosignani (2015), who find that ECB liquidity injections induce Italian banks to restore credit supply but also to increase their holdings of liquid government bonds during the European Sovereign Debt Crisis.

[20]In Table C.X in Appendix C I extend this analysis. First, I use the simple ratio of BCB liquidity to total liabilities instead of $\widetilde{CBI}_i$ for completeness. I would expect this result to be bias, since this ratio is affected by the fact that shock-affected banks are more likely to demand BCB liquidity (Carpinelli and Crosignani, 2015). I find that the liquidity hoarding effect is larger for large-access banks, although this does not translate into differential effects on lending. Second, I estimate this extension by defining a dummy equal to 1 for banks with $\widetilde{CBI}_i$ above the sample median and 0 otherwise. The results reported in Figure 4.6 hold. This should aleviate concerns of the skewness of the $\widetilde{CBI}_i$-distribution affecting my results.

median, a branch of that bank would have increase liquid assets and credit growth by 0.04 and 0.05 p.p. respectively (see Table C.X). Thus, a larger access to unconventional interventions relative to the shock is transmitted almost symetrically into more liquid assets and more credit supply at the branch level.

These findings provide new evidence on the effect of unconventional monetary interventions. Complementing the studies by Carpinelli and Crosignani (2015) and Casiraghi et al. (2013) for developed countries, I evaluate the transmission of these interventions via internal capital markets when idiosyncratic funding shocks occurr. Even though my findings also support the effectiveness central bank interventions in restoring credit growth, I also show that this effect partially leaks via banks increased demand for liquid assets. My findings are also in line with theoretical predictions by Freixas et al. (2011) regarding the importance of confronting distributional liquidity shocks -in opposite to aggregate shocks- with targeted liquidity injections.

4.5 Conclusion

This paper investigates how idiosyncratic shocks to interbank funding ocurring at the level of bank headquarters are transmitted to liquidity and lending decisions at the level of individual bank-branches in Brazil. My results provide robust empirical evidence on a liquidity hoarding reaction by branches, which can be linked to branch level disruptions in credit supply. In contrasts to the dominant view that treats interbank funding shocks as an aggregated phenomenon, my analysis emphasizes that granular shocks can also be important drivers of financial contagion. The analysis also shows that unconventional interventions activated during the sample period by the Brazilian Central Bank partially offset the effect of shocks on lending growth. However, unconventional interventions had a twofold effect: it reduces the negative effect of shocks on credit growth and it increases branches' liquid asset holdings. I conclude that the effect of these interventions on credit growth is diminished by branches' liquidity hoarding reaction to interbank shocks.

Two central contributions arise from this analysis. First, even in the absence of an aggregate market freeze, idiosyncratic interbank funding shocks can trigger a liquidity hoarding reaction by banks, with spillovers on credit supply. Second, liquidity hoarding can emerge from frictions in internal capital markets between a bank's headquarter and its regional branches. This is the first paper exploring this specific channel of financial contagion as a driver of liquidity hoarding.

These results call for a more ample consideration of the nature of interbank funding shocks, as well as for a reevaluation of traditional policy tools used to cope these events. Specifically, the fact that interbank dry-ups can have real economic effects via liquidity hoarding, even in the absense of aggregate shocks, supports the introduction of Liquidity Coverage Ratios (LCR). LCR might underpinn regulators in asessing idiosyncratic liquidity risks, reducing the incentives to drastically increase the demand for liquid assets when banks face interbank funding shocks.

Appendix C

C.I Data construction

Bank-level data were retrieved from banks' call reports, collected and published by regulatory authorities in Brazil. This data set consists of information on banks' balance sheets and income statements on a monthly basis, reported in local currency. The data were downloaded from the website of the Brazilian Central Bank at different moments between 2014 and 2015. After downloading the information, the data were adjusted, translated, and labeled to ensure their consistency. Mandatory reporting by banks ensures comprehensive coverage of all financial institutions with a banking license in Brazil. Non-bank financial institutions without a banking license are not included in the call reports.

To account for valuation effects and facilitate interpretations, I converted the data from the nominal local currency to real U.S. millions of dollars as of December 2013, by collecting end-of-month data on the respective exchange rates from the website of the Federal Reserve Bank of St. Louis. From the same source, I obtained end-of-month U.S. inflation data, which I used to compute a dollar deflator, for which the 100% level is set at December 2013. The original data also were extended by including information on banks' ownership status, collected mainly from the banks' websites and from Claessens and Van Horen's (2014) Banks Ownership Database.

C.II Tables and figures

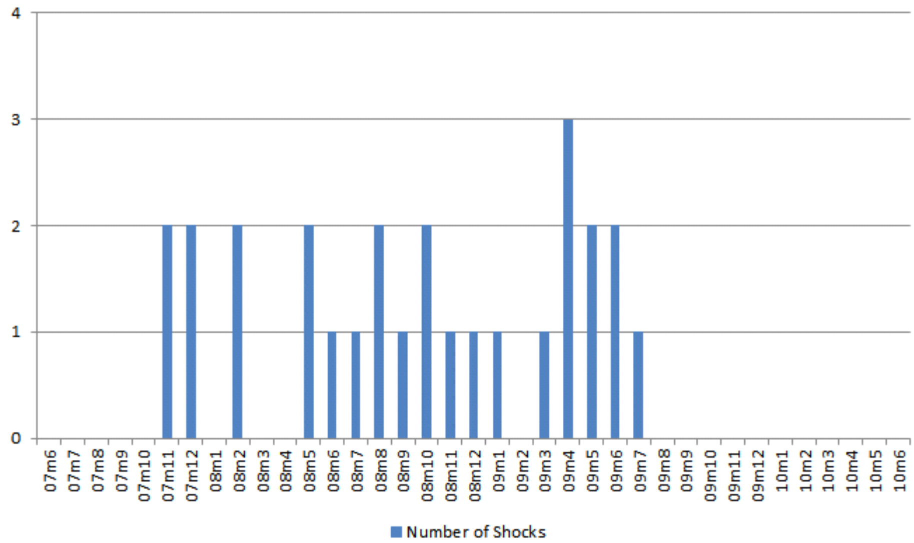


FIGURE C.I: This figure shows the time distribution of identified shocks within the shock-searching time window (07m6-09m12). This figure includes only shock-affected banks and excludes the virtual shocks assigned to non-affected banks.

Table C.I: List of shock-affected banks.

Bank	**Date**	**Ex-ante interbank funding ratio**	**Duration in months**	**Shock Size**
Banco ABC Brasil	Jan 09	9.6	8	27.5
Banco de la Nacion Argentina	Apr 09	13.9	6	35.8
Banco do Brasil	Oct 08	5.8	2	10.7
Banco BBM	Jun 09	6.2	5	39.1
Banco BNP Paribas Brasil	Jul 09	8.8	3	66.3
Banco do Estado do Espirito Santo	Dec 07	6.6	2	14.4
Banco Bonsucesso	Sep 08	5.5	5	56.3
Banco de la Provincia de Buenos Aires	Jun 09	12.8	8	48.4
Banco Citibank	Feb 08	7.9	8	61.4
Banco Fibra	Nov 07	6.3	8	11.7
Banco Guanabara	Apr 09	12.1	4	10.7
HSBC Bank Brasil	Mai 09	5.7	8	46.5
Banco Industrial e Comercial	Nov 08	10.8	3	10.2
Banco Indusval	Jun 08	7.7	9	4.7
Banco Itau	Apr 09	5.3	3	24.9
Banco Paulista	Dec 07	5.3	3	21.4
Banco Pine	Mai 09	8.1	6	25.7
Banco Pottencial	Aug 08	8.2	6	15.7
Banco Rabobank Brasil	Nov 07	20.0	7	12.5
Banco Rendimento	Feb 08	6.2	4	30.4
Banco Ribeirao Preto	Mar 09	11.4	7	18.1
Banco Rural	Mai 08	8.8	5	14.1
Banco Santander Brasil	Oct 08	5.8	2	19.8
Banco Sumitomo Mitsu Brasileiro	Dec 08	9.6	6	69.6
Banco Tokyo-Mitsubishi	Mai 08	14.3	4	21.3
Banco Triangulo	Aug 08	6.2	5	8.4
Banco Votorantim	Jul 08	6.3	2	12.5

Notes: This table reports the list of shock-affected banks as identified in Section 4.2.3 in the paper. The table includes the name of the respective bank, the date at which the shock was identified, the ex-ante interbank funding ratio in as an average during the 6 months before the shock, the duration of the shock in months and the size of shocks.

Table C.II: Sample by shock-status and ownership.

	Panel A: Parent banks sample				**Panel B: Branches sample**		
	Affected	Non-affected	Total		Affected	Non-affected	Total
Foreign	10	4	14	Foreign	599	134	733
Local	17	14	31	Local	1672	1237	2909
Total	27	18	45	Total	2271	1371	3642

Notes: This table reports the number of banks (Panel A) and branches (Panel B) included in the final sample. Banks and branches are divided into foreign and domestically owned and into affected and not affected.

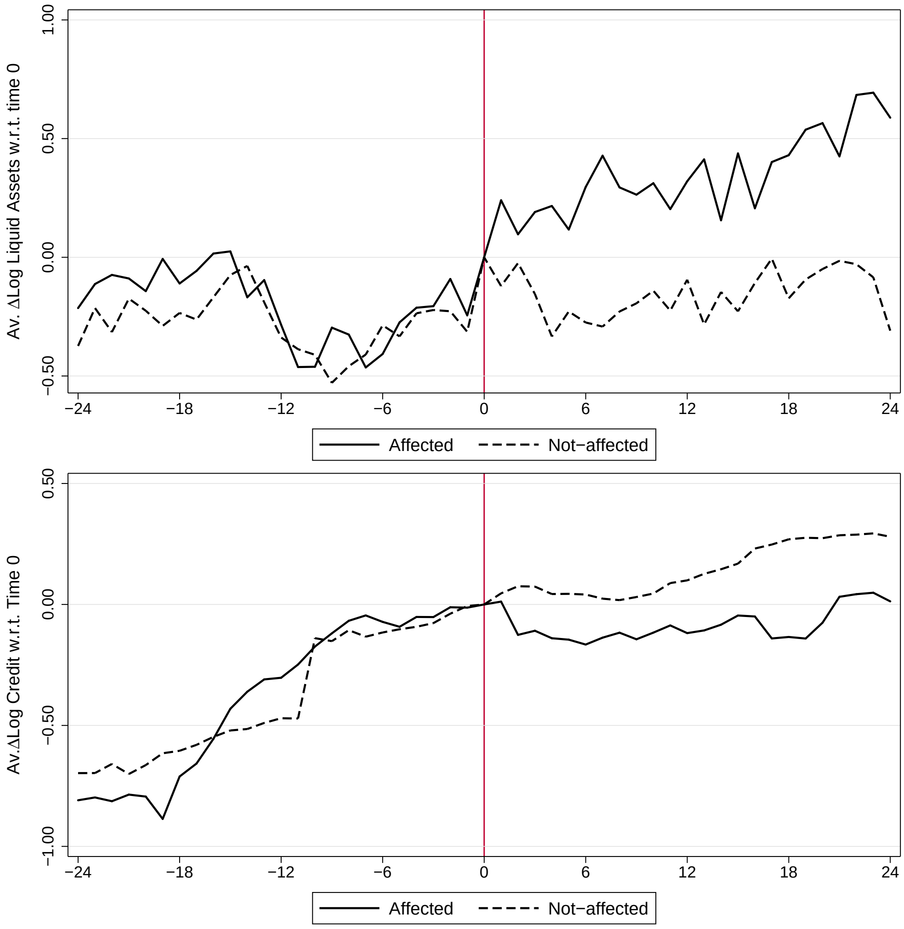


FIGURE C.II: Proportional change in (log) outstanding credit with respect to the time of the bank-specific shock (τ=0). The upper graph displays average liquid assets growth by all banks in the sample distinguishing between shock-affected and non-shocked banks. The bottom graph displays credit growth. Growth rates are computed as changes in logs with respect to outstanding balances as of τ=0. For each group of banks these growth rates are computed, first, as the average of all branches of a bank and then, as the average of all banks within the categories of affected and not affected.

TABLE C.III: Pre-shock interest rates' adjustment.

	Dependent variable: Interest expenses to interbank borrowing	
	(1)	(2)
	Baseline	FE
$\tau - 1$	3.029***	1.526**
	(0.658)	(0.727)
$\tau - 2$	1.799***	0.508
	(0.658)	(0.763)
$\tau - 3$	1.276*	0.130
	(0.658)	(0.832)
$\tau - 4$	0.651	0.264
	(0.658)	(0.878)
$\tau - 5$	0.356	−0.069
	(0.658)	(0.969)
$\tau - 6$	−0.214	−0.064
	(0.658)	(1.010)
Constant	1.303	
	(0.797)	
Observations	336	336
R-squared	0.0362	0.276

Notes: This table shows estimates of Equation 4.4 for the six months prior to the beginning of a funding shock. The reported estimates correspond to the coefficient β_1 in the equation. The regression in Column (2) includes bank and actual-date fixed-effects. Standard errors which are reported in parentheses are clustered at the bank level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

Table C.IV: Effect of ex ante liquidity risk.

	Interbank funding		Net interbank funding		Funding concentration	
Dependent Variable:	**ΔLiq**	**ΔCred**	**ΔLiq**	**ΔCred**	**ΔLiq**	**ΔCred**
	(1)	(2)	(3)	(4)	(5)	(6)
Shock X Affected X Lrisk	0.019**	−0.027***	−0.010**	0.006*	0.043**	−0.055***
	(0.010)	(0.005)	(0.005)	(0.003)	(0.022)	(0.011)
Shock X Affected	0.012**	−0.015***	0.023***	−0.032***	0.043***	−0.008
	(0.005)	(0.003)	(0.005)	(0.002)	(0.011)	(0.005)
Shock X Lrisk	0.006	−0.010***	−0.002	0.009***	−0.011	0.006
	(0.007)	(0.003)	(0.005)	(0.002)	(0.016)	(0.007)
Shock	−0.008**	0.013***	−0.007**	0.012***	−0.013	0.009***
	(0.003)	(0.002)	(0.003)	(0.001)	(0.009)	(0.003)
Headquarter controls						
Size (log US Mill.)	−0.030	0.026*	−0.031	0.027*	−0.031	0.026*
	(0.024)	(0.014)	(0.024)	(0.014)	(0.023)	(0.013)
Capital / Total Assets	−0.403**	−0.235	−0.403**	−0.244	−0.403**	−0.294
	(0.178)	(0.205)	(0.174)	(0.208)	(0.182)	(0.230)
Liquidity / Total Assets	−0.278***	−0.122	−0.282***	−0.120	−0.298***	−0.128
	(0.096)	(0.093)	(0.095)	(0.093)	(0.098)	(0.096)
Deposits / Total Assets	−0.113	−0.173***	−0.099	−0.191***	−0.134	−0.233***
	(0.132)	(0.052)	(0.128)	(0.054)	(0.120)	(0.058)
NPL / Credit	0.049	−0.304	0.050	−0.313	0.051	−0.300
	(0.084)	(0.186)	(0.082)	(0.187)	(0.074)	(0.189)
Branch controls						
Size (log US Mill.)	0.014	0.041***	0.013	0.042***	0.014	0.041***
	(0.010)	(0.011)	(0.010)	(0.012)	(0.010)	(0.012)
Liquidity / Total Assets	0.543**	−0.014*	0.542**	−0.013*	0.544**	−0.012
	(0.234)	(0.007)	(0.234)	(0.007)	(0.234)	(0.008)
Deposits / Total Assets	−0.077***	0.047**	−0.076***	0.046**	−0.064***	0.038*
	(0.020)	(0.021)	(0.020)	(0.021)	(0.018)	(0.020)
RoA	−0.310*	−0.194**	−0.305*	−0.203**	−0.315*	−0.201**
	(0.170)	(0.083)	(0.170)	(0.086)	(0.171)	(0.086)
Obs	158704	158704	158704	158704	158704	158704
R-squared	0.372	0.409	0.372	0.409	0.372	0.409

Notes: This table reports the results of estimating Equations (4.1) and (4.2) for alternative especifications of the respective models. In regressions (1), (3) and (5) the dependent variable is liquidy growth, whereas in regressions (2), (4) and (6) the dependent variable credit growth. The explanatory variable $Shock \times Affected$ represents the main variable of interest that can be interpreted as a difference-in-difference estimation of the differential growth rates in the shock period for the group of branches whose parent banks are actually affected by an interbank shock. Regressions (1) and (2) interact $Shock \times Affected$ with the average pre-crisis ratio of interbank funding to total assets at the branch level. Regressions (3) and (4) interact $Shock \times Affected$ with the average pre-crisis ratio of net interbank assets to total assets at the branch level. Regressions (5) and (6) interact $Shock \times Affected$ with the average pre-crisis normalized Herfindahl-Index computed over the branches' funding structure. Larger values of this index indicate a higher degree of funding concentration of a given branch. The variable $Lrisk$ represents each of the aforementioned liquidity risk measures. All regressions include the full set of fixed effects at the branch, month and municipality-month level. Standard errors are clustered at the headquarter level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%.

TABLE C.V: Banking globalization and shocks' transmission.

	Foreign Ownership		Foreign Funding	
Dependent Variable:	**ΔLiquidity**	**ΔCredit**	**ΔLiquidity**	**ΔCredit**
	(1)	(2)	(3)	(4)
Post-shock X Affected X Fexposure	0.068	−0.004	−0.009	-0.012
	(0.060)	(0.025)	(0.022)	(0.022)
Post-shock X Affected	0.020**	−0.018**	0.023**	-0.025**
	(0.009)	(0.009)	(0.010)	(0.013)
Post-shock X Fexposure	−0.070	−0.047*	−0.004	-0.021
	(0.059)	(0.026)	(0.023)	(0.018)
Post-shock	−0.007	0.012	−0.008	0.012
	(0.006)	(0.010)	(0.007)	(0.011)
Headquarter controls				
Size (log US Mill.)	−0.030	0.038**	−0.031	0.025
	(0.024)	(0.015)	(0.021)	(0.015)
Capital / Total Assets	−0.316**	−0.136	−0.329*	-0.310
	(0.155)	(0.172)	(0.166)	(0.228)
Liquidity / Total Assets	−0.249***	−0.114	−0.249***	-0.131
	(0.078)	(0.087)	(0.084)	(0.107)
Deposits / Total Assets	−0.072	−0.168***	−0.061	-0.185***
	(0.112)	(0.048)	(0.133)	(0.056)
NPL / Credit	0.017	−0.272	0.039	-0.265
	(0.072)	(0.168)	(0.072)	(0.192)
Branch controls				
Size (log US Mill.)	0.011	0.034***	0.010	0.038***
	(0.011)	(0.010)	(0.010)	(0.013)
Liquidity / Total Assets	0.517**	−0.011	0.516**	-0.013
	(0.225)	(0.007)	(0.224)	(0.008)
Deposits / Total Assets	−0.066***	0.031*	−0.066***	0.039*
	(0.017)	(0.018)	(0.018)	(0.023)
RoA	−0.279*	−0.228**	−0.284*	-0.219**
	(0.164)	(0.087)	(0.165)	(0.081)
Obs.	158704	158704	158704	158704
R-squared	0.360	0.400	0.361	0.397

Notes: This table reports the results of estimating Equations (4.1) and (4.2) for different especifications. In Columns (1) and (3) the dependent variable is the monthly change in log liquid assets, whereas in regressions (2) and (4) the dependent variable is the monthly change in log outstanding credit. The variable $Fexposure_i$ represents either a foreign-ownership dummy (Columns (1) and (2)) or a foreign funding dummy (Columns (3) and (4)), which equals 1 for headquarters with an average pre-shock ratio of foreign funding to total assets above the sample median. All regressions include the full set of fixed effects at the branch, month and municipality-month level as well as standard errors clustered at the parent-bank level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%.

TABLE C.VI: Robustness tests.

	Collapsed Time		Random shock		Short-term	
Dependent Variable:	**ΔLiq**	**ΔCred**	**ΔLiq**	**ΔCred**	**ΔLiq**	**ΔCred**
	(1)	(2)	(3)	(4)	(5)	(6)
Shock X Affected	0.015**	−0.013**	−0.011	0.036	0.041*	-0.017***
	(0.006)	(0.005)	(0.015)	(0.032)	(0.023)	(0.003)
Shock			0.012	−0.035	−0.032	0.003
			(0.014)	(0.029)	(0.020)	(0.002)
Headquarter controls						
Size (log US Mill.)	0.011	−0.028**	−0.032	0.031*	−0.023	0.018***
	(0.009)	(0.012)	(0.025)	(0.018)	(0.029)	(0.002)
Capital / Total Assets	−0.341***	0.141	−0.326*	−0.237	−0.448*	0.095***
	(0.125)	(0.151)	(0.182)	(0.142)	(0.254)	(0.031)
Liquidity / Total Assets	−0.012	−0.262***	−0.230***	−0.175	−0.236**	0.050***
	(0.050)	(0.067)	(0.083)	(0.121)	(0.092)	(0.011)
Deposits / Total Assets	0.078***	−0.215***	−0.077	−0.198**	−0.254	-0.061***
	(0.026)	(0.032)	(0.115)	(0.074)	(0.158)	(0.016)
NPL / Credit	−0.114	−0.131	−0.075	−0.153	−0.071	-0.078**
	(0.074)	(0.094)	(0.063)	(0.157)	(0.141)	(0.032)
Branch controls						
Size (log US Mill.)	0.004	0.026***	0.012	0.043***	−0.005	0.028***
	(0.007)	(0.005)	(0.010)	(0.012)	(0.015)	(0.004)
Liquidity / Total Assets	0.018	0.008	0.514**	−0.010	0.529**	-0.017***
	(0.012)	(0.013)	(0.224)	(0.008)	(0.250)	(0.004)
Deposits / Total Assets	0.000	0.032**	−0.064***	0.041**	−0.095***	0.030***
	(0.006)	(0.014)	(0.017)	(0.019)	(0.031)	(0.008)
RoA	0.005	−0.055	−0.289*	−0.182**	−0.263	-0.061***
	(0.022)	(0.046)	(0.163)	(0.084)	(0.175)	(0.017)
Obs	7284	7284	158704	158704	134754	134754
R-squared	0.573	0.715	0.352	0.404	0.359	0.521

Notes: This table reports the results of estimating Equations (4.1) and (4.2) for different especifications. In regressions (1), (3) and (5) the dependent variable is the monthly change in log liquid assets, whereas in regressions (2), (4) and (6) the dependent variable is the monthly change in log outstanding credit. The explanatory variable $Shock \times Affected$ represents the main variable of interest that can be interpreted as a difference-in-difference estimation of the differential growth rates in the shock period for the group of branches whose parent banks are actually affected by an interbank shock. All regressions include the full set of fixed effects at the branch, month and municipality-month level as well as standard errors clustered at the parent-bank level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%.

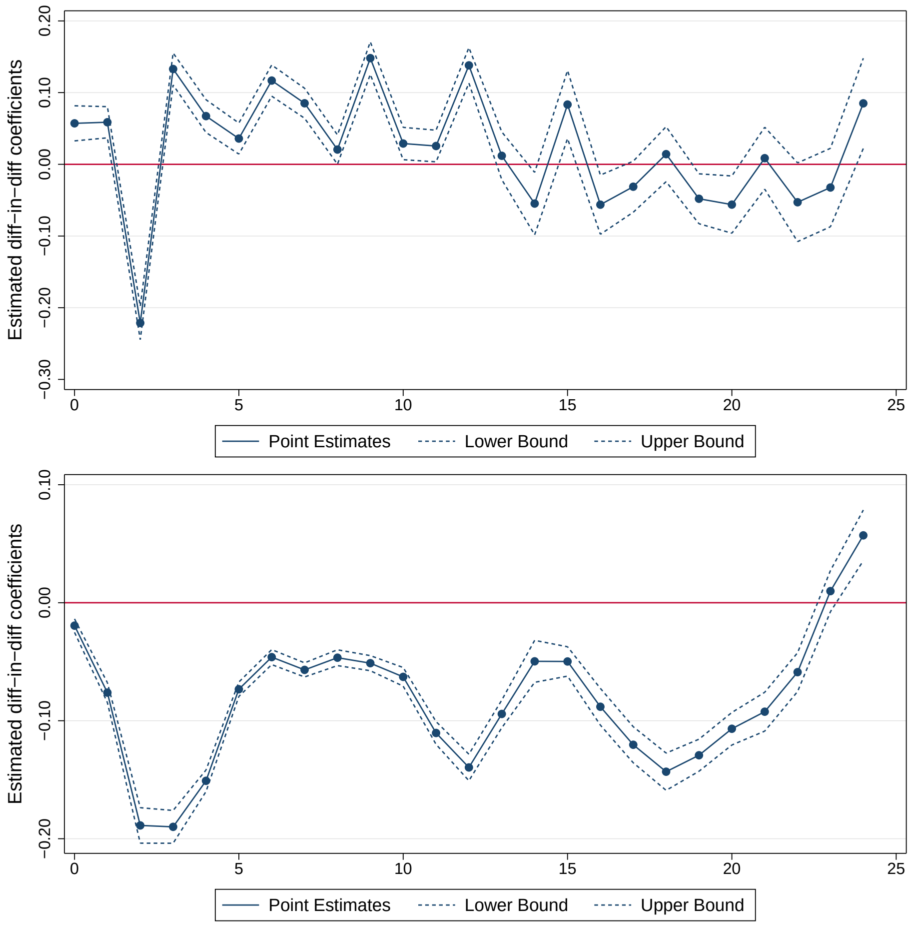


FIGURE C.III: This figure illustrates the time-variant coefficients at the 95% confidence level of the interaction term $Shock_{i,\tau} \times Affected_i$. These coefficients are estimated by extending Equations (4.1) and (4.2), in the form of $\Delta Liquidity_{i,m,\tau} = \alpha_0 + \beta_1[Shock_{i,\tau} \times Affected_i \times time_\tau] + ...$ and $\Delta Credit_{i,m,\tau} = \alpha_0 + \beta_1[Shock_{i,\tau} \times Affected_i \times time_\tau] + ...$ respectively. The regressions from which the marginal effects are computed are based on the FE specification from Columns (3) and (6) in Table 4.2, including the full set of control variables, municipality-month fixed effects and clustering standard errors at the parent-bank level. The variable $time_\tau$ represents one of the 24 event-time periods after the shock is identified. The triple interaction term identifies therefore differential effects of $Shock_{i,\tau} \times Affected_i$ at each point on the event-time window for $\tau > 0$. The figure shows that the baseline effects of the shock on liquidity and lending as discussed in the paper remain in place during most of the 24-months time window used for the analysis. Moreover Panel A highlights the negative effect of the shock on branches' liquidity growth "on impact" during the first periods after the shock.

TABLE C.VII: Alternative specifications.

	Dynamic model		Regional cluster		Relative growth	
Dependent Variable:	**ΔLiq**	**ΔCred**	**ΔLiq**	**ΔCred**	**ΔLiq**	**ΔCred**
	(1)	(2)	(3)	(4)	(5)	(6)
Shock X Affected	0.020*	−0.072***	0.019***	−0.032***	0.004***	-0.006***
	(0.012)	(0.023)	(0.004)	(0.002)	(0.001)	(0.002)
Shock	−0.014*	0.002	−0.007***	0.012***	−0.004**	0.002
	(0.007)	(0.013)	(0.003)	(0.002)	(0.002)	(0.002)
Headquarter controls						
Size (log US Mill.)	−0.027***	−0.018	−0.031***	0.025***	−0.002	-0.001
	(0.010)	(0.013)	(0.003)	(0.002)	(0.002)	(0.002)
Capital / Total Assets	−0.519***	−0.120	−0.326***	−0.297***	−0.109***	-0.058
	(0.158)	(0.122)	(0.074)	(0.041)	(0.029)	(0.051)
Liquidity / Total Assets	−0.122**	−0.008	−0.250***	−0.125***	−0.014	0.005
	(0.051)	(0.026)	(0.020)	(0.012)	(0.012)	(0.010)
Deposits / Total Assets	−0.155	−0.019	−0.076**	−0.230***	−0.004	-0.030**
	(0.175)	(0.079)	(0.029)	(0.020)	(0.011)	(0.012)
NPL / Credit	0.002	0.053	0.019	−0.313***	−0.008	0.034
	(0.140)	(0.101)	(0.056)	(0.045)	(0.016)	(0.034)
Branch controls						
Size (log US Mill.)	−0.009***	0.002	0.012***	0.042***	0.006***	0.008***
	(0.003)	(0.007)	(0.004)	(0.004)	(0.002)	(0.002)
Liquidity / Total Assets	0.050*	0.006	0.516**	−0.014*	0.052*	-0.003
	(0.027)	(0.006)	(0.260)	(0.007)	(0.029)	(0.002)
Deposits / Total Assets	−0.021	0.019	−0.065***	0.040***	0.001	-0.014
	(0.020)	(0.015)	(0.012)	(0.008)	(0.002)	(0.009)
RoA	−0.295*	−0.339*	−0.277***	−0.201***	0.011	-0.049***
	(0.173)	(0.172)	(0.047)	(0.023)	(0.011)	(0.009)
Obs	134754	134754	158704	158704	158704	158704
R-squared	0.379	0.418	0.374	0.408	0.469	0.428

Notes: This table reports the results of estimating Equations (4.1) and (4.2) for alternative especifications of the respective models. In regressions (1), (3) and (5) the dependent variable is liquidy growth, whereas in regressions (2), (4) and (6) the dependent variable credit growth. The explanatory variable $Shock \times Affected$ represents the main variable of interest that can be interpreted as a difference-in-difference estimation of the differential growth rates in the shock period for the group of branches whose parent banks are actually affected by an interbank shock. Regressions (1) and (2) replace all control variables by their 12-month lag. Regressions (3) and (4) are estimated with standard errors clustered at the municipality-level. Regressions (5) and (6) replace the month-on-month growth rates for liquidity and credit by the 12-month change in the respective variable divided by 12-month lagged total assets. All regressions include the full set of fixed effects at the branch, month and municipality-month level. Standard errors are clustered at the parent-bank level in regressions (1), (2), (5) and (6). Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%.

Table C.VIII: Results for liquidity and credit categories.

	ΔLiquidity		ΔCredit		
Dependent Variable:	**Cash**	**BD**	**Com.**	**Cons.**	**Mortg.**
	(1)	(2)	(3)	(4)	(5)
Shock X Affected	0.023**	−0.063	−0.030**	−0.007*	−0.053
	(0.011)	(0.065)	(0.013)	(0.004)	(0.049)
Shock	−0.011*	−0.143**	0.009	0.004	−0.002
	(0.006)	(0.068)	(0.011)	(0.007)	(0.008)
Headquarter controls					
Size (log US Mill.)	−0.041	−0.091	0.022	0.009	−0.039
	(0.031)	(0.081)	(0.014)	(0.006)	(0.094)
Capital / Total Assets	−0.458**	0.386	−0.326	−0.160	−0.412
	(0.179)	(1.144)	(0.242)	(0.097)	(0.494)
Liquidity / Total Assets	−0.339*	0.877	−0.152	−0.014	−0.168
	(0.169)	(0.802)	(0.113)	(0.029)	(0.302)
Deposits / Total Assets	−0.084	0.638	−0.239***	0.041	−0.149
	(0.134)	(0.429)	(0.066)	(0.051)	(0.327)
NPL / Credit	0.072	−0.293	−0.319	−0.180*	0.349**
	(0.093)	(0.539)	(0.223)	(0.098)	(0.147)
Branch controls					
Size (log US Mill.)	0.023**	0.046*	0.047***	0.035***	−0.006
	(0.009)	(0.023)	(0.013)	(0.008)	(0.019)
Liquidity / Total Assets	0.971**	0.000	−0.019	−0.062***	−0.010
	(0.480)	(0.068)	(0.017)	(0.018)	(0.019)
Deposits / Total Assets	−0.088***	−0.117	0.006	−0.054***	0.062
	(0.030)	(0.269)	(0.025)	(0.016)	(0.041)
RoA	−0.291*	0.913	−0.293***	−0.368***	−0.365***
	(0.162)	(1.755)	(0.105)	(0.091)	(0.121)
Obs	158704	158704	158704	158704	158704
R-squared	0.363	0.316	0.339	0.387	0.542

Notes: This table reports the results of estimating Equations (4.1) and (4.2) for different sub-categories of liquid assets and credit. In regressions (1) and (2) the dependent variable is month-on-month liquidy growth, whereas in regressions (3) to (5) the dependent variable month-on-month credit growth. The explanatory variable $Shock \times Affected$ represents the main variable of interest that can be interpreted as a difference-in-difference estimation of the differential growth rates in the shock period for the group of branches whose parent banks are actually affected by an interbank shock. In regressions (1) and (2) liquid assets are defined as cash holdings and bank deposits respectively. In regressions (3), (4) and (5) credit is defined as commercial credit, consumer credit and mortgage credit respectively. All regressions include the full set of fixed effects at the branch, month and municipality-month level. Standard errors are clustered at the parent-bank level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%.

TABLE C.IX: Idiosyncratic shocks estimated with a Multifactor Residual Model.

	ΔLiquidity			**ΔCredit**		
	(1)	(2)	(3)	(4)	(5)	(6)
Shock X Affected	0.034***	0.076*	0.056**	−0.025***	−0.028**	−0.024**
	(0.005)	(0.046)	(0.029)	(0.001)	(0.011)	(0.011)
Shock	−0.025***	0.018	0.036	0.011***	0.010**	0.011
	(0.004)	(0.026)	(0.045)	(0.001)	(0.004)	(0.010)
Affected	−0.040***	−0.059		0.004***	0.020**	
	(0.005)	(0.082)		(0.001)	(0.008)	
Headquarter controls						
Size (log US Mill.)		0.038	−0.027		0.006**	0.027*
		(0.026)	(0.016)		(0.003)	(0.015)
Capital / Total Assets		−1.976**	−2.600***		0.096	−0.313
		(0.886)	(0.681)		(0.141)	(0.267)
Liquidity / Total Assets		−0.574***	−1.043***		−0.025	−0.136
		(0.189)	(0.255)		(0.039)	(0.116)
Deposits / Total Assets		−0.839**	−0.459***		−0.052	−0.202***
		(0.368)	(0.106)		(0.051)	(0.055)
NPL / Credit		−0.047	−0.499**		−0.031	−0.153
		(0.496)	(0.232)		(0.059)	(0.167)
Foreign Ownership		0.177*			−0.036***	
		(0.099)			(0.012)	
Branch controls						
Size (log US Mill.)		0.039***	0.201***		0.002***	0.036***
		(0.015)	(0.053)		(0.001)	(0.011)
Liquidity / Total Assets		0.343**	0.486*		−0.011*	−0.012*
		(0.168)	(0.270)		(0.006)	(0.007)
Deposits / Total Assets		0.040	0.141***		0.016	0.047*
		(0.048)	(0.047)		(0.011)	(0.025)
RoA		0.420	0.159		−0.108	−0.249***
		(0.297)	(0.272)		(0.069)	(0.071)
Constant	0.265***	0.263		0.021***	−0.048	
	(0.004)	(0.498)		(0.001)	(0.050)	
Branch FE	No	No	Yes	No	No	Yes
Time FE	No	No	Yes	No	No	Yes
Region/Time FE	No	No	Yes	No	No	Yes
Obs.	178458	178458	158704	178458	178458	158704
R-squared	0.013	0.3217	0.472	0.033	0.3683	0.410

Notes: This table reports the results of estimating Equations (4.1) and (4.2) for different specifications. In Columns (1) to (3) the dependent variable is the monthly change in log liquid assets, whereas in Columns (4) to (6) the dependent variable is the monthly change in log outstanding credit. The explanatory variable $Shock_{i\tau} \times Affected_i$ represents the main variable of interest that can be interpreted as a difference-in-difference estimation of the differential growth rates in the shock period for the group of branches whose parent banks are affected by an interbank shock. Columns (1) and (4) report baseline estimates without fixed effects or control variables. Columns (2) and (5) include the full set of explanatory variables and Columns (3) and (6) add the full set of fixed effects at the branch, month and municipality-month level. All regressions are estimated by clustering standard errors at the parent-bank level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%.

Table C.X: Effect of BCB liquidity injections.

	Central Bank Ratio		Central Bank Index		CBI > median	
Dependent Variable:	**ΔLiq**	**ΔCred**	**ΔLiq**	**ΔCred**	**ΔLiq**	**ΔCred**
	(1)	(2)	(3)	(4)	(5)	(6)
Shock X Affected X CBI	0.823***	0.396	0.077***	0.062**	0.049***	0.054***
	(0.230)	(0.368)	(0.020)	(0.030)	(0.013)	(0.016)
Shock X Affected	−0.013	−0.067***	−0.013	−0.073***	−0.002	−0.067***
	(0.013)	(0.018)	(0.011)	(0.018)	(0.009)	(0.012)
Shock X CBI	−0.131	−0.268**	−0.023*	−0.040**	−0.016*	−0.033***
	(0.108)	(0.110)	(0.013)	(0.019)	(0.009)	(0.012)
Shock	0.015	0.041**	0.019	0.045**	0.012	0.038***
	(0.017)	(0.017)	(0.016)	(0.020)	(0.012)	(0.013)
Headquarter controls						
Size (log US Mill.)	−0.017	0.030**	−0.014	0.032**	−0.013	0.035***
	(0.020)	(0.012)	(0.020)	(0.012)	(0.021)	(0.012)
Capital / Total Assets	−0.446**	−0.395	−0.457**	−0.421*	−0.435**	−0.429
	(0.208)	(0.244)	(0.198)	(0.247)	(0.192)	(0.255)
Liquidity / Total Assets	−0.179**	−0.120	−0.179**	−0.131	−0.182**	−0.137
	(0.077)	(0.102)	(0.076)	(0.104)	(0.075)	(0.104)
Deposits / Total Assets	−0.111	−0.291***	−0.112	−0.306***	−0.100	−0.318***
	(0.106)	(0.075)	(0.096)	(0.071)	(0.094)	(0.069)
NPL / Credit	0.153	−0.292	0.178*	−0.255	0.163*	−0.241
	(0.092)	(0.233)	(0.090)	(0.235)	(0.087)	(0.227)
Branch controls						
Size (log US Mill.)	0.012	0.044***	0.011	0.043***	0.011	0.042***
	(0.009)	(0.013)	(0.009)	(0.013)	(0.009)	(0.013)
Liquidity / Total Assets	0.478**	−0.014	0.480**	−0.013	0.479**	−0.013
	(0.208)	(0.009)	(0.207)	(0.010)	(0.208)	(0.010)
Deposits / Total Assets	−0.065***	0.043**	−0.066***	0.043**	−0.067***	0.043**
	(0.019)	(0.020)	(0.019)	(0.020)	(0.018)	(0.020)
RoA	−0.246**	−0.215**	−0.253**	−0.224***	−0.249**	−0.229***
	(0.119)	(0.081)	(0.119)	(0.080)	(0.119)	(0.083)
Obs	158704	158704	158704	158704	158704	158704
R-squared	0.386	0.401	0.386	0.401	0.386	0.402

Notes: This table reports the results of estimating Equations (4.1) and (4.2) for alternative especifications of the respective models. In regressions (1), (3) and (5) the dependent variable is liquidy growth, whereas in regressions (2), (4) and (6) the dependent variable credit growth. The explanatory variable $Shock \times Affected$ represents the main variable of interest that can be interpreted as a difference-in-difference estimation of the differential growth rates in the shock period for the group of branches whose parent banks are actually affected by an interbank shock. Regressions (1) and (2) interact $Shock \times Affected$ with the average post-shock ratio of central bank liquidity to total assets. Regressions (3) and (4) interact $Shock \times Affected$ with the Central Bank Index, representing the central bank ratio weighted by the shock's size. Regressions (5) and (6) interact $Shock \times Affected$ with a dummy equal to one if a given headquarter bank reports a Central Bank Index above the sample median. All regressions include the full set of fixed effects at the branch, month and municipality-month level. Standard errors are clustered at the headquarter level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significante at the 1% level; ** at the 5%; * at the 10%.

Table C.XI: Variables definitions.

Variable	**Definition**	**Unit**
ΔCredit	monthly change in log outstanding credit	% (fraction)
ΔLiquidity	monthly change in log liquid asset (cash and bank deposits).	% (fraction)
Headquarter level		
Size	Total size of a bank's balance sheet (USD mill.)	log
Liquidity/Total Assets	Ratio of liquid to total assets.	% (fraction)
Deposits/Total Assets	Ratio of deposits (interbank, sight and saving deposits) to total assets.	% (fraction)
Capital / Total Assets	Ratio of equity to total assets	% (fraction)
Foreign	Dummy equal to 1 if a bank is owned by a company headquartered abroad.	0/1
Foreign funding ratio	Ratio fo foreign interbank liabilities to total assets.	% (fraction)
Interbank borrowing	Borrowing and onlending from banks.	log
Interbank funding rate	Ratio of total expenses due to borrowing and onlending to interbank borrowing.	% (fraction)
Central Bank Index	Av. ratio of BCB to total liabilities in the six months after a shock, weighted by the shock's size.	0-1
Branch level		
Size	Total size of a branch balance sheet (USD mill.)	log
Liquidity/Total Assets	Ratio of liquid to total assets	%(fraction)
Deposits/Total Assets	Ratio of deposits (interbank, sight and savings deposits) to total assets.	% (fraction)
RoA	Ratio of net income to total assets	%(fraction)
Shock	Dummy equal to 1 during the 24 months after a shock beginns.	0/1
Affected	Dummy equal to 1 if a branche's headquarter was shock-affected.	0/1
Herfindal Index	Av. normalized Herfindal Index of a branch funding structure (from τ=-6 to τ=-1). The index is computed over sight, savings and interbank deposits, interbank borrowing, accounts payable and other liabilities.	% (fraction)
Interbank exposure	Av. ratio of interbank borrowing to total assets (τ=-6 to τ=-1)	% (fraction)

Notes: This table provides a description of the main variables used for the empirical analysis reported in the paper. The sources are the Brazilian Central Bank, the Brazilian Institute of Geography and the Claessens and van Horen (2015) Bank Ownership Database used to create the foreign ownership dummy.

Chapter 5

Macroprudential instruments and intra-group dynamics: The effects of reserve requirements in Brazil

Abstract: *The introduction of macroprudential policies to steer credit cycles has been a central part of the post-crisis consensus on banking supervision. This paper investigates whether the combination of banks' funding structure and dynamics within a banking group affect the transmission of macroprudential policies to credit supply. Using novel bank-level data on the Brazilian banking system for the period 2008-2014, we provide robust evidence that reserve requirements imposed on banks' headquarters affect credit supply by individual regional bank branches. However, this effect crucially depends on headquarter banks' funding exposure to targeted deposits. While this result holds even conditional on the stance of monetary policy, foreign-owned banks are less prone to transmit effects of reserve requirements to their branches' credit supply. This heterogeneous effect of reserve requirements highlights the limitations of current macroprudential policy frameworks.*[*]

5.1 Introduction

The recent global financial crisis highlighted that sharp disruptions in the financial sector associated with credit supply shocks can have large negative effects on the real economy. To mitigate systemic risk in financial markets and to reduce the probability of future crises, various changes in banks' regulatory framework, including Basel III and the establishment of the European Banking Union, have been decided worldwide. This policy consensus about the reform of banking regulation has been characterized by the introduction of macroprudential policies. These measures, which have taken

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different forms, aim at reducing the risk of a build-up of systemic imbalances by steering the cycle of banks' credit supply. As it has been stressed by Aiyar et al. (2014), macroprudential policies work under the assumption that they can effectively influence credit supply by tightening or loosening banks' funding constraints. This lending channel of macroprudential policies is therefore likely to be affected by the availability of alternative funding sources.

From this idea it follows that the effectiveness of macroprudential policies is prone to be limited by the characteristics of banks' funding structures. One reason for this is that macroprudential policies target bank-specific variables like liquidity or capital to achieve their objectives (Borio and Zhu, 2012). Hence, the exposure of banks to these policy interventions is not equally distributed, which might have implications for their aggregate effects. Furthermore, the implementation of macroprudential regulation might interact with monetary policy, introducing further distortions (see IMF, 2013). While the literature suggests that bank funding structures matter for the transmission of monetary policy to credit supply (e.g. Kishan and Opiela, 2000; Holod and Peek, 2010), it is still not clear whether this is also the case for macroprudential policies. This underlines the importance of understanding how banks' funding structures can determine the conditions under which macroprudential policies render effective results.

This paper contributes to unravel the link between macroprudential policies, banks' funding structures and credit supply. We explore the question of whether the pass-through of macroprudential policies to credit supply is conditioned on the exposure of banks' funding structures to a particular macroprudential instrument. Our analysis focuses on the effect of reserve requirements on demand deposits, a type of macroprudential instrument that has been introduced in several countries worldwide. By posing this question, we conjecture that a higher reliance on demand deposits should be reflected by a stronger sensitivity of credit supply to changes in reserve requirements along the economic cycle.

We avoid concerns of reverse causality by separating the corporate level at which reserve requirements are imposed from the one at which credit realizes. For this purpose, we investigate the dynamics between banks' headquarters affected by reserve requirements and the credit supply of their individual regional bank branches (hereafter and for simplicity, we refer to banks' headquarters as parent banks). By exploiting this setting, our paper contributes to the literature by proving, to the best of our knowledge, first evidence on how parent banks' exposure to reserve requirements determines the extent of the transmission of this macroprudential policy to credit supply decisions of local branches.

We follow an identification strategy based on three main building blocks. First, we rely on data for the Brazilian banking system including the complete network of regional bank branches of each banking conglomerate operating in the country. We exploit the fact that reserve requirements are actively used by the Brazilian Central Bank to steer the local credit cycle when foreign capital shocks hit. In line with this, we reasonably claim that changes in reserve requirements are exogenous from the perspective of the regional bank branches, the level at which the analysis is performed. Second, we identify the effect of reserve requirements on branches' credit supply by exploiting that parent banks differ in their reliance on targeted demand deposits. Following similar approaches by Rajan and Zingales (1998) and Manganelli and Popov (2015), we argue that the heterogeneous effect of reserve requirements along the distribution of banks' demand deposit ratios can provide a proper identification of changes in credit supply triggered by reserve requirements. Finally, we exploit the branch-level structure in the data to isolate credit supply from credit demand. We follow the established literature (Khwaja and Mian, 2008; Schnabl, 2012) by including regional-time fixed effects in a panel model that control for contemporaneous credit demand shocks affecting all bank branches in a given region.

We implement this research design on novel, hand-collected data for the Brazilian banking system covering balance-sheet information for all active banks in the country between 2008 and 2014. These data allow us to link individual parent banks with their regional branches aggregated at the level of Brazilian municipalities. Besides of providing an excellent identification strategy, relying on these data has several advantages. First, the monthly frequency of the data allows us to properly track changes in reserve requirements and consequently credit supply. Second, by focusing on a large emerging country, we exploit the fact that interbank and securitization markets are less developed than in the industrial world. Hence, deposit funding targeted by reserve requirements remains a significant component of banks' funding structures. Third, our analysis benefits from the fact that Brazil follows a floating exchange rate regime enabling the central bank to commit itself to an inflation targeting policy framework. This allows differentiating and analyzing the interactions between conventional monetary policy and changes in reserve requirements. Finally, we can exploit the large presence of both foreign and state-owned banks in Brazil to explore whether results differ depending on banks' ownership structures, following Aiyar et al. (2014).

Our results are threefold and can be summarized as follows. First, we find robust evidence that reserve requirements affecting parent banks are transmitted into branches' credit supply. However, this result crucially depends on both parent banks' reliance on targeted demand deposits and on the current state of the economic cycle. While we find the effect of reserve requirements to be concentrated in banks largely exposed to demand deposits, this only holds during economic downturns when reserve requirements are loosened. Second, our results remain robust when investigating the implications of monetary policy for our analysis. Third, we find that bank traits capturing different dimensions of banks' ownership and funding structures affect the extent of the identified transmission channel. In particular, our baseline results are stronger for state-owned and low-capitalized banks. In contrast, we find no evidence of the effect of reserve requirements on credit supply for the subsample of branches owned by foreign banks.

This paper contributes to three main strands of literature. First, there is a newly evolving literature on the usage and effects of macroprudential policies. Claessens et al. (2013), for example, show that the effect of macroprudential regulation strongly depends on economic conditions. Using bank-level data, there exist few papers which study heterogeneous effects of macroprudential policy instruments. Aiyar et al. (2014) use a sample of UK owned banks and foreign owned branches and subsidiaries from 1998 to 2007 and find that stricter bank-specific capital regulation of domestic banks and foreign subsidiaries leaks to unregulated branches, which increase their lending. Differential responses of foreign branches versus subsidiaries located in the UK to home regulation are found by Danisewicz et al. (2015). A summary of different country studies on spillovers of prudential regulation by international banks can be found in Buch and Goldberg (2017). Two main contributions differentiate our paper from these previous studies. First, we look at a different instrument of macroprudential policy —the reserve requirements on demand deposits— in a context of an emerging country that uses this tool to steer the transmission of capital flows cycles from abroad. Second, we analyze how banks' binding funding constraints are crucial for the effectiveness of these type of macroprudential policy. In fact, our results stress that only banks largely dependent on demand deposits transmit changes in reserve requirements to credit supply, whereas the availability of alternative funding sources renders reserve requirements less effective. This important characteristic of macroprudential policies has not been addressed in the literature yet.

Complementing the above, we also add to the literature a special attention on how the intra-group ownership structure of banks affects the transmission of changes in reserve requirements to credit supply. While reserve requirements target the balance sheet of the parent bank, relevant adjustment might take place at the branch level. Early literature on the role of internal capital markets studies, for example, the effects of monetary policy (Ashcraft, 2008; Campello, 2002; Dahl et al., 2002; Houston et al., 1997; Houston and James, 1998). More recent papers analyze the transmission of shocks within international bank holding companies (Cetorelli and Goldberg, 2012a; Cetorelli and Goldberg, 2012b; De Haas and Lelyveld, 2010). We are not aware of other papers looking at the transmission of changes in macroprudential regulation via internal capital markets between parent banks and regional bank branches.

A second related literature strand analyzes the effects of macroprudential regulation and its interplay with monetary policy (IMF, 2011; IMF, 2013). This paper adds to the theoretical approach of modeling the relationship of monetary and macroprudential policy by Agur and Demertzis (2015) and the descriptive analysis on the role of monetary and macroprudential policy by Cecchetti (2016). Tressel and Zhang (2016) find that monetary policy complements macroprudential policies targeted at containing mortgage lending growth. Zdzienicka et al. (2015) analyze the difference in timing of both policies and find an immediate, but short lasting effect of macroprudential policy in contrast to an persistent long lasting effect of monetary policy targeted at containing credit and house prices. This paper directly analyzes the effect of macroprudential policy instruments on credit supply conditional on the state of monetary policy. Furthermore, we also explore potential interactions between monetary policy and macroprudential regulation changes. By extending the analysis in this way we show that the use of reserve requirements can effectively complement the role of traditional monetary policy in steering the credit cycle. This result provides a novel rationale to understand the role of reserve requirement as a macroprudential tool, especially in the context of emerging countries.

Third, we also contribute to a strand in the literature analyzing the impact of reserve requirements in Latin America. Descriptive evidence on the usage of macroprudential tools like reserve requirements in Latin American countries is provided by Montoro and Moreno (2011), Robitaille (2011) and Da Silva and Harris (2012). Glocker and Towbin (2015) estimate a structural VAR model to analyze the effect of interest rate and reserve requirement shocks on aggregate credit growth in Brazil. They find a significant contraction of domestic credit growth, an exchange rate depreciation and current account improvement as a result of increased reserve requirements. Tovar Mora et al. (2012) analyze the role of reserve requirements on aggregate credit growth using a dynamic panel VAR model for four Latin American countries and find moderate, transitory effect. In contrast to this literature, our paper analyzes the effect of reserve requirements on intra-group dynamics in a panel model by using micro-level data. This allows shedding light on heterogeneous lending responses of branches depending on the funding structure of their parent banks.

The paper is structured as follows. The Section 5.2 discusses the use of reserve requirements as a macroprudential tool. Section 5.3, we describe the data and show descriptive statistics. Section 5.4 we explain the empirical estimation approach, discuss our identification scheme, and present regression results. Section 5.5 concludes.

5.2 Reserve requirements

Reserve requirements are used as an important part of the macroprudential toolbox in Brazil and aim at maintaining overall financial stability. As such, they serve to control two dimensions of systemic risk. First, a cross-sectional dimension related to the availability of bank funding at one point in time. For example, banks' liquidity might be managed in case of a shock to a common funding source, interbank market contraction, or sudden changes capital flows. Given liquidity constraints, the easing of reserve requirements can be used to free liquidity from banks' own balance sheets. This can mitigate a potential economic downturn caused by a shortage of credit supply as a response to funding squeezes.

Second, reserve requirements also target a time dimension of systemic risk by steering the pro-cyclicality of credit growth over time. Tighter requirements restrain the amount of liquidity banks' can freely allocate. This can dampen credit growth and thus economic overheating during a boom period. The higher the requirements, the more reserves domestic banks have to hold at the central bank. On the one hand, this limits the amount of available funds that can be intermediated into loans. On the other hand, unremunerated reserve requirements act as a tax on financial intermediation in the form of forgone interest. This increases the marginal funding costs of deposits with negative effects on banks' credit supply.

This tax equivalent might pass through to lending rates in the presence of financial frictions, such as market segmentation and resource or agency costs. Depending on the market structure, reserve requirements might therefore increase the interest rate spread. This effect is strengthened when banks' market power and frictions are high. It can be weakened by a high degree of financial integration and market depth providing substitutes for deposits such as foreign or wholesale funding. Banks' reliance on funding sources not targeted by reserve requirements might thus impact on the effectiveness of macroprudential policies, a prediction that we carefully address in our empirical analysis in Section 5.4.2.

An important aspect of reserve requirements is that their use relates to a traditional policy dilemma faced by monetary policy in emerging countries. In times of a credit boom, a typical recommendation implies implementing a counter-cyclical monetary policy by raising interest rates and thus lowering demand for credit. But historically, this has not been a feasible option in emerging countries facing credit booms financed by capital inflows. The reason is that increased interest rates attract even more capital inflows, triggering a vicious circle of further increases in both local credit supply and asset prices. In such a context, imposing higher reserve requirements limits the amount of banks' liquidity that can be transformed into loans without attracting more capital inflows. This can be accompanied by an expansionary monetary policy depressing interest rates and thus further restricting incentives for capital inflows. This illustrates how the restrictions of monetary policy in emerging countries can provide a rationale to explain the use of reserve requirements as a macroprudential tool.

In the context of a global financial crisis with large capital outflows and high local inflation, the aforementioned restrictions of monetary policy are even stronger. This was the case of Brazil during the 2008-2009 global financial crisis. In this scenario, reducing the interest rate of monetary policy to boost local credit might induce further capital outflows, depreciating the local currency and therefore worsening inflation and increasing the risk of a

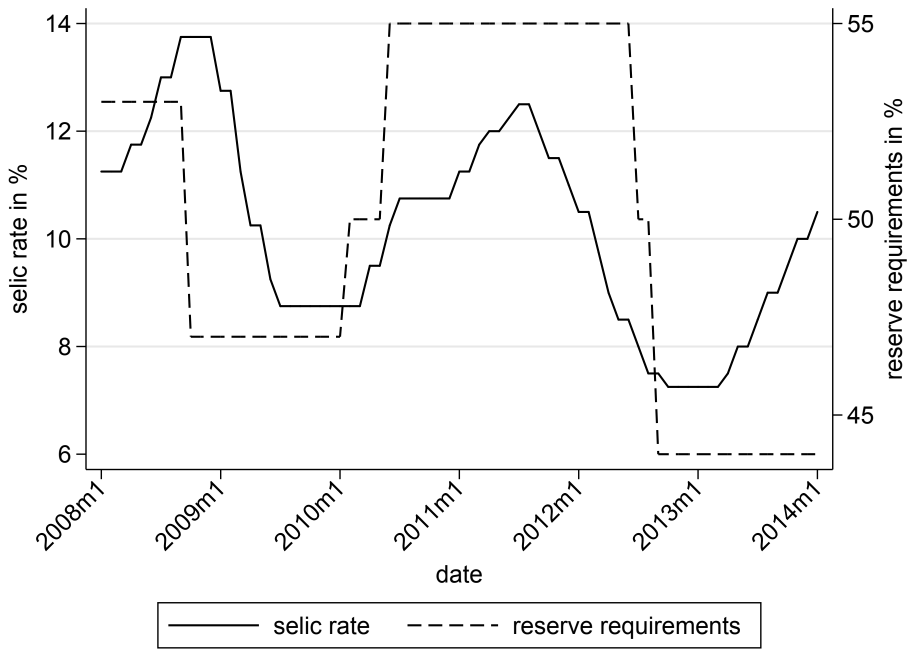

Figure 5.1: This graph describes the percentage shares of deposits that need to be held at the central bank and their movement over time. The solid line describes the pattern of the reserve requirements of demand deposits (in %), which is the policy instrument analyzed in this paper, and applied to deposits with a daily redeemability. The dashed line describes the evolution of the SELIC rate (in %), which is the policy interest rate set by the Central Bank of Brazil.

balance of payments crisis. Again, reserve requirements provide policymakers with an alternative to increase market liquidity and support domestic credit without inducing further capital outflows. As we explain below, this rationale for relying on reserve requirements to steer credit cycles is in line with the actual behavior of the Brazilian reserve requirements both before and after the global financial crisis.

The central bank of Brazil changed reserve requirements on a number of occasions around the global financial crisis (see Figure 5.1). Changes occurred with the objective of containing or stimulating credit growth when facing large capital inflows and outflows, respectively. This implies that our empirical setting offers a high degree of variation in the level of reserve requirements, which we exploit to achieve a proper identification of their effect on credit supply. Moreover this allows us to investigate whether symmetric effects of reserve requirements arise in contexts of booms and busts in capital flows. Even though we remain agnostic about potential asymmetric effects of reserve requirements along the credit cycle, the discussion above tends to suggest that their effect could be stronger in periods of crisis when monetary policy faces stronger restrictions. This question is especially relevant when considering that our sample period includes the global financial crisis, during which several emerging countries like Brazil changed reserve requirements to contain the risk of liquidity dry-ups in banking markets (see Montoro and Moreno, 2011). We thus address the differential effects of reserve requirements at different stages of the economic cycle in Section 5.4.3.

Figure 5.1 provides a general picture of the pattern of reserve requirements in Brazil during our sample period. Before the global financial crisis, the country experienced a surge in capital inflows. Thus, reserve requirements were elevated to contain the potential overheating effect on local credit markets. This trend changed after the collapse of Lehman Brothers in 2008, which induced a large contraction in global capital flows. The Brazilian central bank reacted by decreasing reserve requirements with the objective of lowering liquidity shortages and supporting credit supply when the external shock represented by the crisis was at its height.

This strategy was again reversed when the European sovereign debt crisis caused excessive capital inflows into Brazil. The reason for these capital inflows have been favorable return possibilities given low interest rates in Europe and fueled an increase in local credit provision. The central bank of Brazil increased reserve requirements as a response to this expansion in credit. These changing patterns in reserve requirements reveal a co-movement of macroprudential policy innovations with the cycle of capital flows, as to be expected from the discussion above. This supports the idea that reserve requirements were actively used during the sample period as a macroprudential measure to cope with the negative effects of both large inflows and outflows of foreign capital into Brazil.

Only at the end of our sample period, policymakers changed to make use of reserve requirements to counteract a period of depressed economic growth, which has not been accompanied by sudden capital outflows. In particular, banks were asked to pass lower reserve requirements on to customer by lowering lending rates. We control for this change in the use of reserve requirements in Section 5.4.3 by splitting the sample into different periods.

5.3 Data and descriptive statistics

We obtain bank- and branch-level data from the IWH Latin American Banking Database to create an empirical setting that allows investigating our research question.[1] This data set contains micro-level data on balance sheet and income statements at the monthly frequency for domestic banks in Brazil as well as foreign subsidiaries located in Brazil. All bank-related information is collected by the Bank of Brazil as regulatory data with mandatory reporting. We use the granularity of the data and combine data at the level of the parent bank and regional branches. All in all, our sample comprises 11106 domestic branches for the period 2008-2014. The branches are owned by 142 different domestic and foreign-owned parent banks and operate in 2470 Brazilian municipalities.

These data allow us to link individual parent banks with their regional branches aggregated at the level of Brazilian municipalities. We exploit this bank-branch setting to study how intra-group dynamics affect the transmission of changes in reserve requirements applied to parent banks to branches' credit supply. There is a large variation in the number of branches held by each parent bank as it is reported in Table D.II in Appendix D, where a group of banks in the sample is listed together with their number of branches and with information regarding their domestic or foreign ownership status. For example, Banco do Brasil, a local state-owned bank, dominates domestically in terms of the number of branches owned. The foreign bank with the largest number of branches in our sample is Banco Santander, the Brazilian subsidiary of a Spanish-owned bank. One third of parent banks in the sample are foreign banks (46 out of 142), while only 16% of branch-level observations stem from branches of foreign parent banks (1,808 out of 11,106

[1] See also Noth and Ossandon Busch (2016) for a different application of this data set.

branches are operated by foreign banks). Foreign parent banks manage, on average, 8.3% of total assets over the sample period, while the average municipality has 18% of its assets managed by a branch operated by a foreign parent bank.

These large presence of foreign-owned bank branches in our sample is important, since it allows us to explore whether changes in reserve requirements are equally transmitted to credit supply of branches owned by domestic versus foreign banks. Previous evidence suggests that macroprudential policies affect banks differently depending on their ownership. For example, Aiyar et al. (2014) show that foreign branches operating in the United Kingdom have increased lending while domestic banks and foreign subsidiaries affected by the regulation contracted their loan supply. These differential responses have consequences for the effect of macroprudential policies on the aggregate changes in credit supply. In particular, heterogeneous response of domestic and foreign-owned banks highlight the importance of cross-country co-operation on macroprudential policies. We extend our analysis to address this question in Section 5.4.3.

Another dimension of ownership which might result into differential responses across banks is state versus private ownership. This is a relevant issue in the case of Brazil. 46% of branch-level observations stem from 16 state-owned parent banks (11% of parent banks), which operate 4,831 out of 11,106 branches. State-owned parent banks manage, on average, 50% of total assets over time. The average municipality has three quarters of its assets managed by a state-owned bank.

The branch level data is complemented with monthly information on parent banks' balance sheet characteristics. We exploit parent banks' reliance on funding by demand deposits —the item of the balance sheet targeted with the highest rate by reserve requirements— to assess whether the effect of changes in reserve requirements on banks' funding structures can explain the pass-through of this policy instrument to credit supply. Since we observe monthly outstanding credit balances at the branch level, we use this data structure to ask whether branches adapt their credit supply differently as a response to changes in reserve requirements and depending on their parent banks' funding structure. A high reliance of parent banks on demand deposits, and thus increased funding constraints given tighter reserve requirements, might explain the transmission of macroprudential policies within a banking group. Descriptive statistics for all variables employed in the estimations as well as correlations are provided in Tables D.I and D.III in Appendix D respectively.[2] It can be seen that quarterly credit growth of branches is on average 2.2% and shows the highest correlation with the SELIC rate, whereas higher rates correlate negatively with credit growth.

To clean the bank level data from outliers and unreasonable values, we conduct the following adjustments. First, we restrict the sample to branches reporting at least five times over the sample period. This is important due to our focus on the intensive margin of the effect of changes in reserve requirements on credit supply. In order to properly gauge this intensive margin, we require to observe the activity of branches with a sufficient degree of frequency. Second, we correct for outliers by winsorizing all bank-level variables at the one percent level. Finally, we keep only municipalities, in which at least two different parent banks are represented via branches. This filter is important to control for time-varying common market or demand shocks affecting all branches operating in a single municipality. Following the established literature (Khwaja and Mian, 2008; Schnabl, 2012) and as explained below in Section 5.4.2, we argue that by controlling for these common shocks our results can be interpreted as supply-driven. Despite of these restrictions, our sample still represents a reasonable share of the Brazilian credit market: On average, we observe 84% of total outstanding credit and 74% of total bank assets during the sample period.

Information on reserve requirements, that is the share of deposits that parent banks have to hold at the central bank, as well as data on the policy rate "SELIC" are provided by the central bank on a monthly basis. Depending on the redeemability, different types of deposits are subject to individual rates. In this paper, we focus exclusively on changes in reserve requirements

[2]For a detailed list of variables, see the Table D.X in Appendix D.

on demand deposits because this rate aims at affecting short-term funding. This is the part of banks funding structure that is most volatile and thus bears the highest risk of causing systemic disruptions. This is also mirrored by the fact that reserve requirements on demand deposits show the highest reserve ratios compared to reserve requirements on term deposits. In robustness tests, we control for the fraction of reserves in total assets due to reserve requirements on term deposits.[3]

As we discussed above, Figure 5.1 shows the pattern of reserve requirements (solid line) and the policy rate (dashed line). Some periods are characterized by similar patterns (for example the period between 2010 and 2013). In the regression analysis, we thus verify that our results obtained for reserve requirements are not driven by changes in monetary policy. Yet, there are also deviations. Especially at the end of the sample period, reserve requirements remain at lower levels while monetary policy starts to become more restrictive. One potential reason is that during this period monetary policy is aimed at targeting (high) inflation rates while reserve requirements are lowered to stimulate credit supply and thus reverse the downward trend in economic growth. It should be noted from Figure 5.1 that a large fluctuation in the policy rates of both monetary policy and reserve requirements exist: Reserve requirements (RR) range from 44% to 55% and the policy rate (SELIC) ranges from 7.1% to 13.7% (Table D.I).[4] We exploit these fluctuations as a source of heterogeneity that can be used to differentiate between the effect on credit supply of these two types of policy innovations.

Graphically, the relationship between reserve requirements and the credit supply of branches is depicted in Figure 5.2. Reserve requirements (solid line) are depicted on the left axis. The right axis shows the average yearly change in loan supply by branches.[5] The figure shows that, in general, changes in

[3]Reserve requirements on savings deposits are constant over the sample period and show the lowest value. As they are not actively used by the policymaker, we do not consider them in the analysis.

[4]Also, it stands out that compared to, e.g., the Euro Area with reserve requirements of recently one percent on deposits with a maturity shorter than 2 years, reserve ratios are quite high in Brazil.

[5]Figure D.I in Appendix D shows the pattern of the average quarterly change in credit supply by branches. Due to the lower time frequency to compute credit growth, the pattern is more volatile.

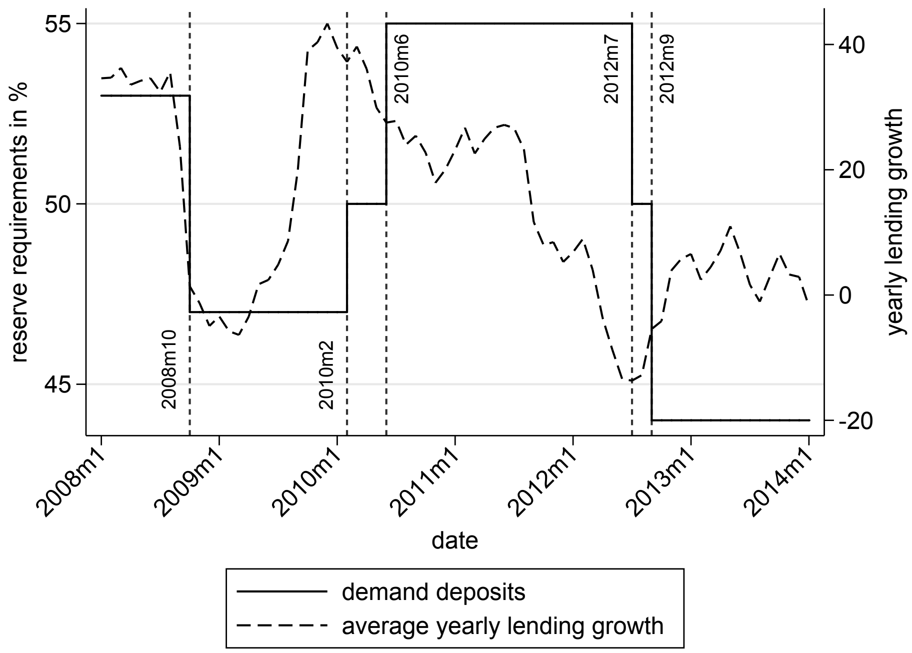

FIGURE 5.2: This graph shows the evolution of the yearly growth rate of outstanding credit (dashed line - right axis) averaged over all branches during the sample period together with the time series of the reserve requirements (solid line - left axis). The vertical dashed lines mark the months at which changes in reserve requirements occur.

reserve requirements occur with a lag to changing trends in credit supply. For example, the decline in credit growth end of 2008, due to the financial crisis, has been followed by a loosening of reserve requirements. While credit growth increased during the year 2009, a tightening in reserve requirements only occurred in 2010. Finally, during the years of the European sovereign debt crisis and globally depressed growth patterns, also annual credit growth in Brazil declined, while quarterly credit growth stayed rather stable. Reserve requirements nevertheless remained at elevated levels until mid 2012 due to increase in capital inflows.[6]

As discussed above, reserve requirements apply to parent banks' demand deposits. Thus, a tightening in reserve requirements should affect parent banks the more so, the higher their demand deposits subject to reserve requirements. Table D.IV reported in Appendix D points into the direction that parent banks with a higher demand deposit share show on average larger

[6]From a macroeconomic perspective, a similar pattern emerges when plotting the yearly change of the sum of outstanding credit across all branches vis-à-vis the reserve requirements (see Figure D.II in Appendix D).

changes in the lending of their branches. In Section 5.4.1, we exploit parent banks' reliance on demand deposits to set up an identification strategy that captures the effect of changes in reserve requirements on credit supply conditional of parent banks' funding exposure to these changes.

We believe that this approach can provide interesting policy implications: if reserve requirements are only effective given parent banks' funding structure, then macroprudential policies should be thought within a more general policy framework addressing the heterogeneous effect of these interventions. Having in mind that macroprudential policies aim at affecting aggregate developments, which however depend on adjustments of individual banks, this seems a relevant consideration. Evaluating the effect of reserve requirements depending on parent banks' funding structure remains our main focus. Yet, our analysis below also sheds lights on potential heterogeneous effects of reserve requirements conditional on parent banks' ownership status, size and capitalization.

To obtain preliminary evidence on whether parent banks' differ in their demand deposit share depending on their ownership status, size and capitalization, Table D.V in Appendix D reports summary statistics of the deposit share by different subsamples. Differences arise when comparing domestic and foreign parent banks: foreign parent banks have a lower deposit share, most likely because they have a better access to wholesale funding from abroad. Pronounced differences are revealed for state-owned versus private banks, with state-owned banks showing the highest demand deposit share. Also, smaller parent banks have a lower deposit share targeted by reserve requirements and banks with a lower equity share rely, on average, more on funding via demand deposits. Hence, there might be further bank characteristics that enforce or mitigate the transmission of reserve requirements within a banking group and we extend our baseline empirical setting in Section 5.4.3 accordingly.

5.4 Estimation approach

In the empirical analysis, we proceed in three steps to test the predictions made in the previous sections. First, in our baseline model, we estimate the effect of reserve requirements on branches' credit supply conditional on parent banks' reliance on demand deposits, that is their affectedness by the policy. This provides insights into whether macroprudential policies result into dynamics within a banking group. Second, we test whether our results remain robust when controlling for changes in monetary policy. Third, we evaluate whether parent bank characteristics as discussed above affect the pass-through of macroprudential regulation to branches' lending behavior.

5.4.1 Identification

Our identification strategy is based on three considerations related to (i) the exogeneity of reserve requirements, (ii) the heterogeneous impact of this macroprudential policy across banks, and (iii) the existence of unobserved confounding factors that might explain credit growth. These considerations are addressed as follows.

First, during our sample period, the central bank tightens and loosens reserve requirements to respond to changes in foreign capital flows. Thus, changes in the policy can be better described as a reaction to shocks from abroad rather than a reaction to banks' own performance in Brazil. This reduces concerns about reverse causality between banks' credit supply and the level of reserve requirements. Furthermore, we estimate credit supply at the level of individual bank branches by performing a within-borrower estimation, in which Brazilian municipalities are considered as the "virtual" borrowers. Narrowing-down the organizational level at which credit supply is estimated dissociates the decision level between the policymaker and banks even further, underpinning our claim that policy changes occur independently from the behavior of individual branches. It should also be noted that reserve requirement target aggregate developments in capital flows, so that the stability of specific banks is not addressed by this policy tool. All in all, the actual institutional framework, in which reserve requirements in Brazil operate, allows considering reserve requirements to be exogenous from the individual branches' standpoint.

Second, reserve requirements aim at steering the credit cycle in Brazil in the aggregate. However, we conjecture that reserve requirements should have heterogeneous effects conditional on banks' funding structure. In particular, we would expect banks with a higher exposure to demand deposits funding to be more affected by reserve requirements compared to other banks. Therefore, our analysis will be based on exploring the effect of reserve requirements along the distribution of banks' demand deposits to total assets ratio. The idea of identifying the effect of an aggregate variation by focusing on heterogeneous responses at a narrower level of observation resembles the approach by Rajan and Zingales (1998), more recently applied by Klapper et al. (2006), Manganelli and Popov (2015), or Heider et al. (2016). Besides of its methodological advantages, this type of identification is important to add to the understanding of how banks' funding restrictions influence the effectiveness of macroprudential regulation.

Third, even if we observe an effect of reserve requirements on credit growth, unobserved credit demand shocks might provide an alternative explanation to this relationship. For instance, branches from banks relatively more exposed to reserve requirements might be simultaneously affected by demand shocks explaining the observed changes in credit growth. Since we aim at interpreting our results as supply-driven, this concern needs to be formally addressed. For this purpose, we first restrict our sample to municipalities, in which at least two parent banks operate via their branches. We exploit this setting to implement a within-borrower estimation in the vein of Khwaja and Mian (2008) and Schnabl (2012). This allows us to concentrate the analysis on supply-driven adjustments by bank branches when changes in reserve requirements occur. As we explain in Section 5.4.2, this approach consists of estimating credit growth by simultaneously controlling for time-varying municipality fixed effects in a panel regression. Following the established literature, we claim that this solution reasonably addresses concerns of local changes in credit demand. Furthermore, this approach also rules out that our estimation of credit growth might reflect economy-wide fluctuations.

5.4.2 Reserve requirements and credit supply

We begin by analyzing the effect of changes in reserve requirements on branch level credit supply. For this purpose, we compute quarterly changes in outstanding credit as follows:[7]

$$\text{Credit Growth}_{b,t} = \frac{\text{credit}_{b,t} - \text{credit}_{b,t-3}}{\text{credit}_{b,t-3}} * 100 \tag{5.1}$$

In Equation (5.1) Credit Growth$_{b,t}$ is defined as the quarterly growth rate of outstanding credit (in percent) of branch b in month t. The effect of regulation on quarterly credit growth has also been analyzed by Buch and Goldberg (2017) or Ohls et al. (2017) using a similar definition of the dependent variable. This allows exploiting the high frequency of the data while taking into account that balance sheet items might not change instantaneously. In robustness tests, we check whether results differ for monthly, biannually, and yearly credit growth.

Equation (5.2) presents our baseline regression model. We aim at estimating credit growth as defined in Equation (5.1). dep.share$_{p,t-3}$ is the three month lagged ratio of demand deposits to total assets at the parent bank p that owns branch b. This ratio represents a bank's exposure vis-à-vis the reserve requirementes imposed by the central bank. This latter variable is additionally interacted with the level of reserve requirements RR_{t-3} of the previous quarter. This interaction term represents our variable of interest. If our hypothesis that reserve requirements are transmited to credit supply by parent banks with a relatively large reliance on demand deposits, then the coefficient β_2 should be negative. In line with the definition of the dependent variable, we lag all explanatory variables by three months. Due to

[7]Outstanding credit corresponds to total credit minus agricultural credit. The reason is that agricultural credit benefits from a special treatment as concerns reserve requirements, since banks can deduct those balances from the deposits subjected to the regulation.

the fixed-effects structure introduced in the model the direct effect of reserve requirements is not measurable as such. The reason is that reserve requirements are equal to all banks and are therefore captured by municipality-time fixed-effects ($\nu_{t,m}$) together with any other macroeconomic factors. The identification of the effect of reserve requirements therefore runs through the interaction term ($\text{dep.share}_{p,t-3} \times \text{RR}_{t-3}$).

$$\begin{aligned} \text{Credit Growth}_{b,t} = {} & \beta_1 \left(\text{dep.share}_{p,t-3}\right) \\ & + \beta_2 \left(\text{dep.share}_{p,t-3} \times \text{RR}_{t-3}\right) \\ & + \gamma_1 X_{b,t-3} + \mu_b + \nu_{t,m} + \varepsilon_{b,t} \end{aligned} \tag{5.2}$$

As discussed in the previous section, the underlying hypothesis to this approach is that the effectiveness of reserve requirements is likely to be heterogeneous depending on parent banks' funding structure. If a given parent bank is funded to a relatively large extent by demand deposits, then any variation in reserve requirements should have a larger impact on that bank. Equation (5.2) addresses the question of whether this heterogeneous effect of reserve requirements translates into a differential credit supply by bank branches. For completeness and to better assess the functional form of the coefficient of the interaction term, we report estimates without municipality-time fixed effects so that the baseline coefficient of RR_{t-3} becomes visible.

The variables in the vector $X_{b,t-3}$ include profitability (RoA) and size (log of total assets) of branches as well as parent banks' equity ratios. RoA proxies for the profitability of branches' asset portfolio, whereas more profitable banks might also have more market power as well as lending capacities. Following previous findings by Kashyap and Stein (1995) and Kashyap and Stein (2000) that larger banks respond differently to changes in monetary policy, we control for the size of branches. E.g., larger branches might have access to alternative funding sources or a larger flexibility to transform liquid assets into loans. This could make these branches less sensitive to reserve requirements and resulting liquidity restrictions at the parent bank level.

Motivated by our research question, we control for the parent banks' capital and funding structure. This is important given that the exposure to reserve requirements depends on the structure of the liability side of parent banks' balance sheet. As explained above, parent banks' ratio of demand deposits to total assets (dep.share$_{p,t-3}$), measures the relative exposure to the precise item in the balance sheet targeted by reserve requirements. The relevance of banks' capital ratio is highlighted by papers studying the transmission of monetary policy. For example, Kishan and Opiela (2000) find that lending by well-capitalized banks is less sensitive to changes in monetary policy, an argument that might also apply to reserve requirements. Thus, we include the equity ratio at the parent bank level. This captures parent banks' ability to offset the effect of reserve requirements by tapping non-deposit funding. It should be noted that in our sample only parent banks hold capital in their balance sheet, while branches are funded by a combination of deposit and interbank liabilities.

Other rather structural and time-invariant differences in branches and parent banks' balance-sheet characteristics are captured by branch-level fixed effects (μ_b). To reduce simultaneity concerns the aforementioned control variables enter the model as three-month lags. This time structure reflects the fact that we rely on a three month growth rate of outstanding credit as our dependent variable.[8] As previously discussed, we introduce time-municipality fixed effects ($\nu_{t,m}$) to control for credit demand in a municipality. Time fixed effects, that is a proxy for macroeconomic developments affecting all banks in Brazil, are implicitly captured by $\nu_{t,m}$. Following the standard approach in the literature, standard errors are clustered at the parent bank level. This reduces concerns of serial correlation within a banking group.

To facilitate the interpretation of our results, we demean the variables included in the interaction terms. For example, the deposit ratio of parent bank p at a given time equals its actual deposit ratio minus the average deposit ratio of all banks. We refer to these as centralized variables, which

[8] We also test the sensibility of our analysis to alternative time structures in the model in Section 5.4.3.

Table 5.1: Effect of reserve requirements on credit supply.

	(1)	(2)	(3)	(4)	(5)
(c) l.3 RR	−0.105	−0.244***	−0.199**		
	(0.107)	(0.002)	(0.018)		
(c) l.3 dep.share (p)		1.759***	1.445***	−0.003	
		(0.000)	(0.000)	(0.990)	
(c) l.3 dep.share (p) × (c) l.3 RR		−0.079*	−0.087*	−0.045**	
		(0.091)	(0.065)	(0.046)	
(c) l.3 dep.share (b)					0.121***
					(0.001)
(c) l.3 dep.share (b) × (c) l.3 RR					0.008
					(0.113)
(z) l.3 ROA (b)			0.053	−0.280	−0.373
			(0.847)	(0.333)	(0.186)
(z) l.3 log assets (b)			−4.249***	−0.753	−0.296
			(0.000)	(0.416)	(0.739)
(z) l.3 equity ratio (p)			0.840	0.066	0.043
			(0.417)	(0.888)	(0.924)
Adjusted R^2	0.038	0.067	0.080	0.531	0.532
Observations	591618	591618	591618	591618	591618
BranchFE	yes	yes	yes	yes	yes
TimeMunFE	no	no	no	yes	yes

Notes: This table reports the regression results from the estimation of equation (5.2). The dependent variable is the quarterly growth rate of outstanding credit. The sample period spans 2008-2014. Dep.share abbreviates the demand deposit share in total assets and RR correspond to the reserve requirements rate. Standard errors are clustered at the parent bank level, p-values are reported in parenthesis. Variables marked with a (c) are demeaned with their coefficients depicting the marginal effects of a deviation of one unit from the mean. Variables marked with a (z) are normalized with their coefficients depicting a deviation of one standard deviation from the mean. Variables marked with a (p)/(b) are measured at the parent bank/branch level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

are correspondingly marked with a (c) in the regression output. Coefficients of centralized variables describe the marginal effect of a unit deviation of this variable from the mean. The remaining control variables are normalized and are marked as (z). Coefficients of normalized variables represent the marginal effect of a change in one standard deviation from the mean.

Our baseline results from estimating Equation (5.2) are reported in Table 5.1. In Column (1), we only include reserve requirements as the explanatory variable, while simultaneously controlling for branch fixed effects. This regression, which is only included for completeness, shows a negative association between the level of reserve requirements and branch-level credit growth. Even though this result is not statistically significant, the sign of the coefficient for reserve requirements is in line with theoretical considerations. In Column (2), we add the interaction with the parent bank's deposit ratio while the regression in Column (3) introduces further control variables. The baseline coefficient of reserve requirements turns statistically significant, reflecting that higher reserve requirements are associated with a decrease in credit growth.

The coefficient of the interaction term ($\text{dep.share}_{p,t-3} \times \text{RR}_{t-3}$) directly addresses our research question by shedding light on whether heterogeneous effects of reserve requirements exist along the distribution of parent banks' demand deposit ratio. We find the coefficient of this interaction term to be negative and statistically significant. This means that the negative relationship between reserve requirements and credit growth becomes stronger for branches whose parent banks report a higher reliance on demand deposits targeted by reserve requirements. This confirms our hypothesis that the affectedness of the parent bank by macroprudential regulation matters for the transmission of macroprudential policies to credit growth of regional branches.

To rule out that global developments or local demand conditions drive the results, Column (4) reports the results of our preferred model as described in Equation (5.2) and including time-municipality fixed effects. Most importantly, the coefficient of the interaction term remains negative and statistically significant. Thus, branches from parent banks with a higher reliance on demand deposits are significantly more responsive to reserve requirements. The negative sign of the interaction coefficient implies that, compared to branches owned by parents banks with a lower demand deposit ratio, these branches are more likely to adjust credit supply. An important contribution of this analysis is that we look at the whole cycle of increases and decreases in reserve requirements. The results from Table 5.1 stress that even by considering this whole regulatory cycle the counter-cyclical effect of reserve requirements on credit supply is in place. In Section 5.4.3, we will assess whether our results differ when looking at periods of increases or decreases in reserve requirements.

Finally, we test the alternative hypothesis of branch-level demand deposit ratios driving the results. Testing for this alternative explanation is important, since we have argued that intra-group dynamics between a parent bank and its network of regional branches transmit macroprudential policies. This would not be the case if individual branches' exposure to demand deposit funding drives the results. In fact, this would reflect that local conditions in branches' deposit base channel the effects of reserve requirements to branches' credit supply. Alternatively, it might capture that parent banks allocate the burden of reserve requirements to branches depending on their share of demand deposit funding.

We perform a regression, in which the level of reserve requirements is interacted with the deposit ratio at the branch level. If the effects of reserve requirements transmit within a banking group depending on the affectedness of the parent bank and independent of the funding structure of branches, we should expect the coefficient on this interaction term to be not statistically significant. The results reported in Table 5.1, Column (5), show that this is indeed the case. Hence, the evidence reported in Table 5.1 supports the hypothesis that dynamics between parent banks, directly affected by reserve requirements, and branches exist. This can be interpreted as evidence that linkages within a banking group are actively transmitting the effect of reserve requirements depending on parent banks' funding structure to individual branches' credit supply. This interpretation is consistent with the fact that reserve requirements must be fulfilled at the level of parent banks. [9]

In sum, these results support the conclusion that macroprudential instruments targeting parent banks can translate into adjustments in credit supply by bank branches. As long as parent banks show a relatively large demand deposit ratio and are thus affected by reserve requirements, regulatory decisions are transmitted to credit supply of branches. This is, to the best of our knowledge, the first evidence on how dynamics in a banking

[9] We also tested whether reserve requirements affect credit growth at the parent bank level. Here it should be noted that while branches are likely to serve rather small business and households, larger borrowers are likely to be served directly from the parent bank. Similar to results shown in Table 5.1 for branches, we find a negative effect of reserve requirements on parent banks' credit growth. This effect also increases in parent banks' demand deposit ratio. The disadvantage of this approach is that we cannot control for credit demand trends that might be correlated with the effect of reserve requirements on credit supply. These results can be obtained upon request.

group affect the transmission of macroprudential policies.

At least three important implications can be derived from our analysis. First, we find that reserve requirements can be a successful tool in affecting credit growth. Hence, applied in a counter-cyclical way, this policy tool can be useful in steering the occurrence of global credit cycles in emerging countries. Second, our results show that funding structure, and thus the differential affectedness of banks by the policy, matters for the transmission of macroprudential policies. This implies that countries might benefit from a more general framework of macroprudential policies in which different tools are used to influence the behavior of different banks. Finally, our findings suggest that for the assessment of macroprudential instruments it is not sufficient to look at the behavior of parent banks as standalone entities, but responses within the whole banking group have to be considered to trace out aggregate effects.

5.4.3 Robustness tests

To evaluate the robustness of the results obtained from our preferred model as specified in Equation (5.2), we conduct a set of additional tests. First, we account for the fact that changes in reserve requirements can be accompanied by changes in monetary policy rates. To reduce omitted variable bias and to rule out that our results are driven by more expansionary or restrictive monetary policy, we extend the model accordingly. More specifically, we perform a “horse race” between our baseline interaction term $\text{dep.share}_{p,t-3} \times \text{RR}_{t-3}$ and the interaction between the deposit ratio and proxies for the stance of monetary policy.

In particular, we obtained data on the monetary base in Brazil (M0) and the SELIC rate, which represents the overnight interest rate set by the Brazilian Central Bank for monetary policy purposes. While we test for the role of M0 to provide a more complete picture of developments in monetary aggregates, we believe that the SELIC rate is particularly likely to affect our baseline analysis. The reason is that policy rates might have direct implications for banks’ refinancing costs as well as loan rates and thus affect

TABLE 5.2: Reserve requirements and monetary policy.

	Baseline (1)	M0 (2)	SELIC (3)	SELIC (4)
(c) l3.dep.share (p)	−0.003	1.214	0.049	0.115
	(0.990)	(0.856)	(0.853)	(0.659)
(c) l3.dep.share (p) x (c) l.3 RR	−0.045**	−0.045**	−0.041**	−0.040*
	(0.046)	(0.021)	(0.045)	(0.057)
(c) l3.dep.share (p) x (c) l.3 MonPol		−0.124	−0.166***	−0.178***
		(0.827)	(0.000)	(0.000)
(c) l3.dep.share (p) x (c) l.3 RR x l.3 MonPol				−0.022
				(0.219)
(z) l3.RoA (b)	−0.280	−0.366	−0.291	−0.290
	(0.333)	(0.138)	(0.318)	(0.320)
(z) l.3 log assets (b)	−0.753	−1.000	−0.791	−0.811
	(0.416)	(0.298)	(0.383)	(0.369)
(z) l.3 equity ratio (p)	0.066	0.419	0.195	0.145
	(0.888)	(0.273)	(0.661)	(0.741)
Adjusted R^2	0.658	0.678	0.658	0.658
Observations	591618	591618	591618	591618
BranchFE	yes	yes	yes	yes
TimeMunFE	yes	yes	yes	yes

Notes: This table reports results from various monetary policy interactions with our baseline model (Column (1)). The dependent variable is the quarterly growth rate of outstanding credit. The monetary policy variables include the log of the monetary base (M0, in million USD, at December 2013 prices) and the quarterly difference in the SELIC rate, which is the policy interest rate set by the Central Bank of Brazil. The variable MonPol represents either the log of the monetary base in Column (2) or the quarterly change in the SELIC rate in Columns (3) and (4). Standard errors are clustered at the parent bank level, p-values are reported in parenthesis. Variables marked with a (c) are demeaned with their coefficients depicting the marginal effects of a deviation of one unit from the mean. Variables marked with a (z) are normalized with their coefficients depicting a deviation of one standard deviation from the mean. Variables marked with a (p)/(b) are measured at the parent bank/branch level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

credit supply. Also, due to the historical co-movement between the SELIC rate and reserve requirements, our results from Table 5.1 could reflect that banks with a high deposit ratio simply respond more to changes in policy rates. If this is the case, our results would rather reproduce a lending channel of monetary policy that overlaps with reserve requirements affecting similar institutions.

We address the implications of monetary policy changes for our baseline results in Table 5.2. We first report in Column (1) results of our benchmark estimation. As a preliminary check, we include the interaction between $\text{dep.share}_{p,t-3}$ and M0, which proxies for the aggregate circulating currency in the economy.[10] The results reported in Column (2) show that even though the size of our coefficient of interest is somewhat smaller, its explanatory power remains statistically significant. This means that conditional on the

[10]M0 is measured in log of real US$ millions at December 2013 prices. The variable is lagged by 3 months like the other variables in the model. The single coefficient is absorbed by the municipality-time fixed effects.

relative size of the monetary base, variations in reserve requirements are still transmitted form parent banks' balance sheets to branches' credit supply. In Column (3), we replicate this analysis by using the quarterly change in the monetary policy rate. Our results remain in place and we can still pin down a transmission of reserve requirements to branches' credit supply.

Despite of these findings, it could still be argued that our results hide a more direct interaction between monetary policy and reserve requirements. For example, if banks with a high deposit ratio are relatively more exposed to both reserve requirements and monetary policy, a decrease in the SELIC rate in a period when reserve requirements are also decreasing can reinforce the effect that we find in Table5.1. To test for this further concern we add a triple interaction term between the SELIC rate, the level of reserve requirements and parent banks' deposit ratio. This triple interaction term should shed light on whether our baseline estimation is nonlinear along the distribution of the SELIC rate. The results reported in Column (4) in Table 5.2 show that this is not the case. While again our baseline result is confirmed, we do not find evidence of direct interactions between a lending channel of monetary policy and the transmission of reserve requirements to credit supply.

The implications of these results are twofold and can be summarized as follows: First, monetary policy and reserve requirements appear to affect bank credit via different channels. Even though a precise analysis of the lending channel of monetary policy in Brazil lies beyond the scope of our paper, our results suggest that parent banks' reliance on deposit funding targeted by reserve requirements opens a channel through which policymakers can steer the local credit cycle even in the presence of simultaneous changes in monetary policy. Second, it should be noted that our results do not suggest that the use of macroprudential policies can be a substitute for monetary policy. In fact, our analysis provides a rationale to understand the differential roles of these policy tools —financial and price stability, respectively—, an aspect that has become an important part of the post-crisis policy consensus.[11] Still, we show that reserve requirements, by targeting specific financial institutions, can provide a first line of defense when capital flow shocks affect an emerging country, helping to overcome the historical restrictions faced by monetary policy actions in these countries.

As a second robustness test, we investigate whether our baseline results vary across time. Even though an important contribution of our analysis is that we look at the complete cycle of increases and decreases in reserve requirements, zooming-in into the time dimension of our analysis can shed light about differential effects of reserve requirements across the cycle. To perform this extension, we divide the sample period into three sub-periods. Then, we run separate regressions for each of these periods based on our preferred specification. The results are reported in Table D.VI in Appendix D. The first period covers January 2008 to December 2009 including the decrease of reserve requirements aimed at unfreezing liquidity during the global financial crisis (Column (2)). The second period, from January 2010 to December 2011, captures the tightening of reserve requirements as a reaction to foreign capital inflows in the search for yield after the global financial crisis (Column (3)). The third period (January 2012 to December 2013) relates to the loosening of reserve requirements given a stagnation of capital inflows, in part driven by the end of the 2000s commodities super cycle combined with depressed economic growth. We report again our baseline results in Column (1) as a benchmark.

Even though we obtain negative coefficients on the interaction term in all these regressions, the baseline results are mainly driven by the periods in which reserve requirements are loosened. In fact, the results are stronger both during the global financial crisis and during the end of the sample period. In contrast, the coefficient on the interaction term turns statistically insignificant during the period of capital inflows that followed the global

[11] See for instance Aizenman et al. (2010) and Borio and Zhu (2012). IMF (2013) provides a thoughtful analysis prepared for the International Monetary Fund where the theoretical framework of the interactions between monetary policy and macroprudential tools is discussed.

financial crisis. This result is in line with findings by Bhaumik et al. (2011) on the asymmetric transmission of monetary policy across the economic cycle. Hence, similar asymmetries prevail for macroprudential instruments.

How can we explain the insignificant result for the period characterized by capital inflows and economic boom? Our analysis has consistently shown that banks' funding structure matters for the transmission of reserve requirements to credit supply. This test delves further into this important aspect of macroprudential policies. In periods of capital inflows, banks might have easier access to alternative funding sources that allow them to circumvent reserve requirements. The asymmetric effect of reserve requirements speaks in favor of complementing this policy tool with other measures. Countercyclical capital buffers and regulatory caps on banks' foreign funding can be thought as an alternative to enhance policymakers' capacity to steer credit growth in times of boom.

In a third robustness test, we change the calculation of the dependent variable and compute credit growth at monthly, biannually, and yearly frequencies. The lags of the explanatory variables are adjusted accordingly to the definition of the dependent variable. This helps investigating how quickly branches adjust their credit supply. Results in Table D.VII in Appendix D show that the coefficient of the interaction term is statistically significant if monthly, quarterly and biannually credit growth rates are considered (Columns (1)-(3)). We lack statistical significance when relying on year-on-year credit growth rates, possibly due to the difficulty of disentangling the effects of reserve requirements from further factors affecting credit supply when using large time spans (Column (4)).

Across all specifications, the sign of the interaction term is negative, confirming our baseline results. The sensitivity of credit supply to reserve requirements when parent banks are more exposed to reserve requirements increases (in absolute terms) when computing credit growth at lower frequencies (e.g., the coefficient is -0.015 for monthly changes but -0.044 if quarterly changes are considered). This is in line with our hypothesis that branches' credit supply adjusts rather sluggishly to changes in parent banks' funding structure induced by reserve requirements.[12]

5.4.4 Do parent bank characteristics matter for intra-group dynamics?

As we discussed in Section 5.4.1, previous studies provide evidence that the transmission of monetary policy depends on banks' liquidity and balance sheet management. To the extent that similar arguments might apply for the transmission of macroprudential policies, our results could also be weakened or strengthened depending on other bank traits. For example, we saw in Table D.IV that the deposit ratios tend to be higher for parent banks with a lower equity ratio or domestic parent banks. This raises the question whether our baseline results are not capturing an effect that actually stems from banks sharing certain characteristics that affect the transmission of reserve requirements. In what follows, we assess this question by splitting our sample by relevant bank traits and estimating Equation (5.2) separately for each of these subsamples.

We first address the question of whether the effect of reserve requirements conditional on parent banks' funding structure is similar across branches owned by domestic and foreign parent banks. Previous evidence suggests that this might be the case. Jeon and Wu (2014) show at the country level that foreign bank penetration was associated with a weaker transmission of monetary policy during the crisis. Wu et al. (2011) provide bank-level evidence pointing to the same direction. These findings might be well explained by internal capital markets providing alternative funding sources to foreign banks' subsidiaries located in Brazil, which in turn helps circumvent local policy shocks (see De Haas and Lelyveld, 2010). Moreover global banks' role in transmitting monetary policy actions across countries might lead foreign banks' subsidiaries to be less sensitive to local macroprudential policies (see Rajan, 2014; Rey, 2016). In line with this, Aiyar et al. (2014)

[12]We have also estimated our preferred model by simultaneously including the interaction term lagged by one month, three months, and six months. The sum of the coefficients of these interaction terms was negative and the F-test revealed that the terms are jointly significant. Results are available upon request.

find that foreign-owned banks located in the UK are less responsive to local macroprudential policies.

The results from estimating Equation (5.2) for the subsamples of foreign- and domestically-owned banks are reported in Columns (2) and (3) in Table D.VIII in Appendix D. We find that our baseline results mainly stem from domestic banks, while the effect of reserve requirements on branches of foreign-owned banks becomes statistically insignificant. This confirms the findings by Aiyar et al. (2014) by following a different identification approach and by looking at an emerging country. Our results stress that the interaction between macroprudential policies and banks' funding structure can explain why foreign-owned banks are less responsive to local policy actions. Moreover, the bank-branch setting in our sample implies that dynamics within a banking group matter for the transmission of reserve requirements and that these internal channels are likely to operate differently depending on the ownership status of a bank. This finding provides new insights about how international banking can deem local policy decisions in the absence of international coordination ineffective.

A complementary narrative explaining this result might consider distinguishing between private and state-owned banks. The theoretical analysis by Andries and Billon (2010) finds that state-owned banks are likely to be less responsive to changes in monetary policy due to their better capacity to obtain additional (government-sponsored) deposit funding compared to private banks. Empirical evidence also suggests that state-owned banks could react less to changes in monetary policy due to a generally less pro-cyclical credit supply (Ferri et al., 2014) and due to differences in their corporate governance compared to private banks (Bhaumik et al., 2011). The role of state-owned banks can be especially relevant in our setting considering their large presence in Brazil. Also, previous findings show that state-owned banks in Brazil are less likely to transmit funding shocks to the regions in which they operate (see Coleman and Feler, 2015).

To investigate whether it matters if a branch is owned by a state-owned parent bank, we further split between private and state-owned banks. Columns

(4) and (5) in Table D.VIII in Appendix D report the results of estimating Equation (5.2) for these two subsamples. We find that branches from state-owned banks are, conditional on their funding structure, more responsive to reserve requirements. This contrasts with the aforementioned findings of state-owned banks being less responsive to changes in monetary policy.

Two arguments might explain this different result for the case of reserve requirements. First, state-owned banks' large reliance on demand deposits (see Table D.IV) implies that reserve requirements are more likely to affect them compared to other banks. In other words, by restricting the analysis to state-owned banks, we look exclusively at the right-hand side of the deposit ratio distribution, from where we know that out baseline results originate. Second, the political economy of credit supply by state-owned banks is likely to play a role. In particular, a political decision that pushes state-owned banks to act counter-cyclically might reinforce the effect arising from their large reliance on demand deposits. This is supported by the fact that, as we showed in Table D.VI, our results are stronger during periods of economic downturn. Hence, a counter-cyclical policy action via state-owned banks might lead these institutions to transmit changes in reserve requirements to their branches' credit supply in a stronger fashion compared to other banks.

Finally, we conduct sample splits by parent bank size and equity ratio. As in the previous extensions, we rely on evidence in the literature that suggests that bank size and capitalization can be important drivers for the transmission of monetary policy to credit supply. For instance, Kishan and Opiela (2000) and Brissimis et al. (2014) show that bank size affects the transmission of monetary policy by defining the extent of banks' funding alternatives when policy shocks occur. Regarding the role of capitalization, Kashyap and Stein (2000) and Adrian and Shin (2008) show that the transmission of monetary policy can be affected by banks' equity ratios. For instance, binding regulatory capital constraints can limit the effect of monetary policy in times of financial distress by imposing a cap on banks' capacity to increase their credit supply. We conjecture that a similar rationale might apply to reserve requirements.

To investigate the role of size and capitalization we split the sample between branches owend by parent banks with high/low total assets and high/low equity ratios using the respective sample medians as a cut-off point. The results of estimating Equation (5.2) for these four different subsamples are reported in Table D.IX in Appendix D. Columns (2) and (3) show that our baseline results can be replicated within the groups of large and small banks, respectively. If anything, some evidence exists of the effect being stronger both in terms of size and statistically significance for the group of large banks. This might reflect our previous finding of state-owned banks transmitting reserve requirements to a larger extent, considering that two of the largest banks in the country are state-owned (Banco do Brasil and Bradesco).

When looking at banks with different capital ratios, we do not find large differences compared to our baseline results. The estimated coefficient for the group of banks with a relatively low capital ratio is somewhat larger compared to the group of banks with a higher capital ratio. This is in line with our interpretation that parent banks' access to alternative funding can explain the heterogeneous transmission of reserve requirements to credit supply of branches. Low capital ratio banks are likely to be more financially constrained than other institutions as well as more exposed to reserve requirements due to their reliance on demand deposit funding, which would be consistent with our result that branches of those parent banks are more responsive.

5.5 Conclusion

This paper documents how intra-group dynamics between a parent bank and its network of regional branches, combined with parent banks' funding structure, explain the transmission of macroprudential policies to credit supply. Using novel parent bank- and branch-level data for the Brazilian banking system and the period 2008-2014, we show that reserve requirements on demand deposits imposed on parent banks are transmitted into credit supply responses by individual bank branches. We rely on an identification strategy that, based on three main building blocks, carefully addresses a number of estimation concerns.

First, policy changes in reserve requirements are triggered by external conditions in global capital markets. Second, mirroring the approach by Rajan and Zingales (1998), we exploit the fact that banks are differently affected by reserve requirements depending on their reliance on demand deposits. This might lead to heterogeneous responses as regards credit supply and thus facilitates identifying effects. Third, by observing individual branches operating in Brazilian municipalities over time, we can control for municipality-time fixed effects to interpret our results as supply-driven, in the vein of Khwaja and Mian (2008).

By following this conservative estimation approach, we find that even after controlling for parent banks' and branches' main characteristics as well as for aggregate macroeconomic developments and local credit demand shocks, changes in reserve requirements applied to parent banks are transmitted into branches' credit supply. However, this transmission depends on parent banks' reliance on targeted demand deposits: A higher demand deposit ratio leads to a stronger transmission. This holds especially during periods in which reserve requirements have been loosened. The result also remains robust when controlling for simultaneous changes in monetary policy. Finally, we show that different bank traits that proxy for the availability of alternative funding sources explain our baseline finding. In particular, branches are less responsive if they belong to foreign, private and well-capitalized parent banks.

Our findings contribute to the literature by providing evidence that parent banks' exposure to macroprudential policies results into differential responses within a banking group. Two central policy implications of our analysis can be drawn. First, the aggregate outcome of reserve requirements is driven by heterogeneity of banks' responses to policy shocks. Second, our findings imply that reserve requirements operate independently from the lending channel of monetary policy. For emerging countries, in which banks' reliance on wholesale funding is smaller, our results entail that reserve requirements can complement conventional monetary policy by targeting banks relatively less exposed to interbank market funding. This provides a novel rationale to understand the interactions between macroprudential regulation and monetary policy.

Appendix D

TABLE D.I: Descriptive statistics.

branch level	Mean	S.D.	Median	Min	Max
credit growth (b)	2.171	11.490	2.920	−39.651	32.283
ROA (b)	3.255	2.992	2.475	−1.172	16.085
dep.share (b)	12.420	7.511	10.678	0.000	36.562
log assets (b)	2.848	1.321	2.809	−1.555	5.616
parent bank level					
assets (p)	1433.248	870.219	1454.277	18.884	4255.771
dep.share (p)	5.191	2.287	4.816	0.556	13.954
equity ratio (p)	7.476	3.740	6.729	2.853	31.052
em liquidity (p)	2.723	3.965	0	0	9.825
policy variables					
RR	50.241	4.406	50.000	44.000	55.000
SELIC	10.068	1.886	10.400	7.110	13.660
ln(M0)	18.972	0.191	19.008	18.641	19.335
Observations	591618				

Notes: This table shows the summary statistics of the dependent variable, credit growth, and the explanatory variables used in the analysis. The sample covers monthly data from 2008 to 2014 and contains 591618 observations from 11106 branches operated by 142 banks and located in 2470 municipalities. *Credit growth (b)* is the quarterly growth rate of outstanding credit (excluding agricultural credit). *ROA (b)* measures the return on assets on branch level and serves as a control for profitability. *dep.share (b)* abbreviates deposit share and describes the share of total assets financed by demand deposits. Size is measured by the log of total assets in million USD, (*log assets (b)*), at the branch level. *Assets (p)* at the parent bank level are denoted in million USD. The share of assets financed by demand deposits at the parent bank level (*dep.share (p)*) serves to measure exposure to changes in reserve requirements on deposits, which are levied at the parent bank level. The *equity ratio (p)* is measured at the parent bank level and serves as a control for parent bank strength. All variables are measured in percent if not stated otherwise.

Table D.II: Number of branches by parent bank.

Name	# Branches	Name	# Branches
Santander	67,321	Banco do Brasil	310,900
HSBC Bank	65,865	Bradesco	194,234
Amro Real	22,511	CEF	135,516
Sudameris	4,644	Itau Unibanco	130,054
Citibank SA	2,686	Banerisul	35,984
Bandepe	1,319	Nossa Caixa	26,836
Rabobank	1,164	Unibanco	22,782
Banif BM	758	Nordeste	20,789
BTG Pactual	616	Mercantil Brasil	16,093
BBI	569	Banespa	13,330
BNP Paribas	489	BESC	12,431
ABC	485	Amazonia	11,320
NBC	400	Banestes	8,551
JP Morgan	363	Safra	5,747
Argentina	242	Banese	4,712
Credit Suisse	242	Banpara	3,687
Tokyo Mitsubishi	242	Triangulo	3,462
BGN	226	Industrial e Comercial	3,285
Brascan	151	Rural	3,185
Deutsche Bank	138	Daycoval	2,323
JP Morgan Chase	136	Votorantim	1,869
Barclays	121	BMG	1,597
Buenos Aires	121	Sofisa	1,508
Capital	121	BEC	1,294
Cargill	121	Itau BBA	1,241
Citibank NA	121	Pine	1,175
ING	121	Bradesco Financ	1,093
John Deere	121	BRB	1,054
KEB	121	Fibra	1,024
Morgan Stanley	121	Itaubank	1,004
Societe Generale	121	Alfa	968
Sumitomo	121	Indusval	885
Uruguay	121	Industrial	659
Mais	114	Bancoob	622
KDB	92	Rendimento	547
BPN	90	BBM	527
Caixa Geral	89	Sicredi	484
Cacique	85	J Safra	423
Pecunia	85	Bonsucesso	404
UBS	80	Cruzeiro	395
Azteca	71	BVA	387
Sudameris_cominv	67	BEP	290
Natixis	66	Banestado	272
Dresdner Lateinamerika	63	Bradesco Cartoes	245
China	55	Fator	242
Agricole	54	Modal	242
Merrill Lynch	35	Maxima	240
Scotiabank	35	Luso	235
Bankboston	28	Simples	228
Western Union	28	Intermedium	219
Lloyds	19	Prosper	208
Mizuho	14	Arbi	196
Woori	13	Dibens	184
Union Brasil	12	Alvorada	183
BNY Mellon	6	BCV	182
		...	...

Notes: The table reports the number of branches by parent bank for part of the sample used for the analysis.

Table D.III: Correlation between variables of interest.

	credit growth (b)	dep.share (p)	ROA (b)	log assets (b)
credit growth (b)	1			
dep.share (b)	0.028***	1		
ROA (b)	−0.003**	0.227***	1	
log assets (b)	−0.046***	−0.219***	−0.175***	1
assets (p)	0.045***	0.009***	0.088***	0.128***
dep.share (b)	0.078***	0.436***	0.046***	0.064***
equity ratio (p)	−0.037***	0.006***	0.049***	−0.190***
RR	−0.049***	0.070***	0.036***	0.091***
SELIC	−0.037***	0.094***	0.033***	0.023***
log M0	−0.137***	−0.285***	−0.049***	0.049***
log em liquidity (p)	0.017***	−0.270***	0.141***	−0.061***
	assets (p)	**dep.share (b)**	**equity ratio (p)**	**RR**
assets (p)	1			
dep.share (b)	0.074***	1		
equity ratio (p)	−0.306***	−0.174***	1	
RR	−0.003***	0.137***	−0.001	1
SELIC	−0.219***	0.186***	0.022***	0.575***
log M0	0.377***	−0.114***	−0.075***	−0.234***
log em liquidity (p)	−0.103***	−0.115***	0.061***	−0.0311***
	SELIC	**ln(M0)**	**log em liquidity (p)**	
SELIC	1			
log M0	−0.548***	1		
log em liquidity (p)	0.0267***	−0.094***	1	

Notes: This table shows the correlation of the dependent and control variables. The Bonferroni-adjusted significance levels are depicted with stars as follows: *, p<0.10, **,p<0.05, ***,p<0.01.

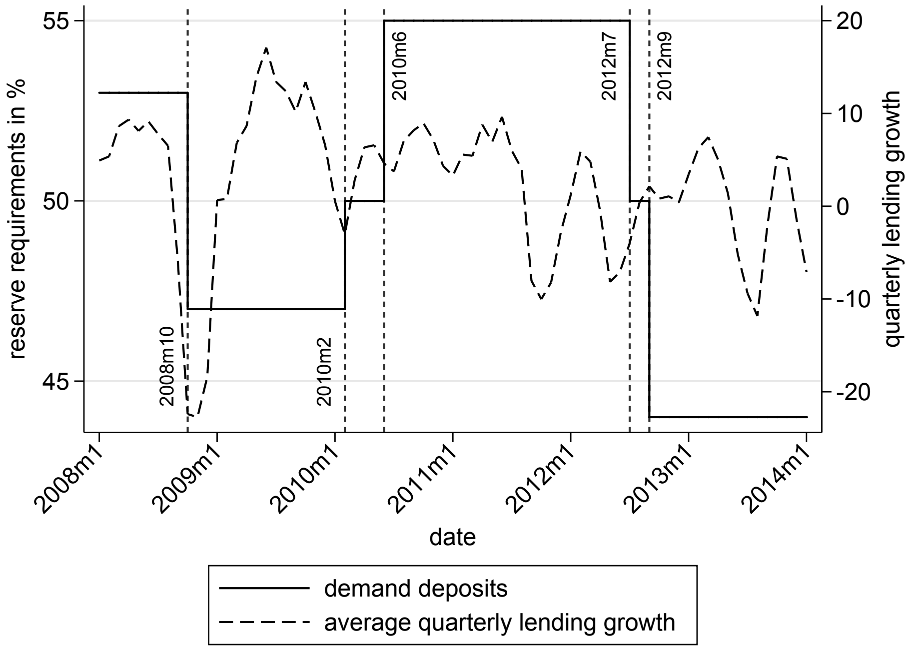

FIGURE D.I: This graph shows the evolution of the quarterly growth rate of outstanding credit (dashed line - right axis) averaged over all branches during the sample period together with the time series of the reserve requirements (solid line - left axis). The vertical dashed lines mark the months at which changes in reserve requirements occur.

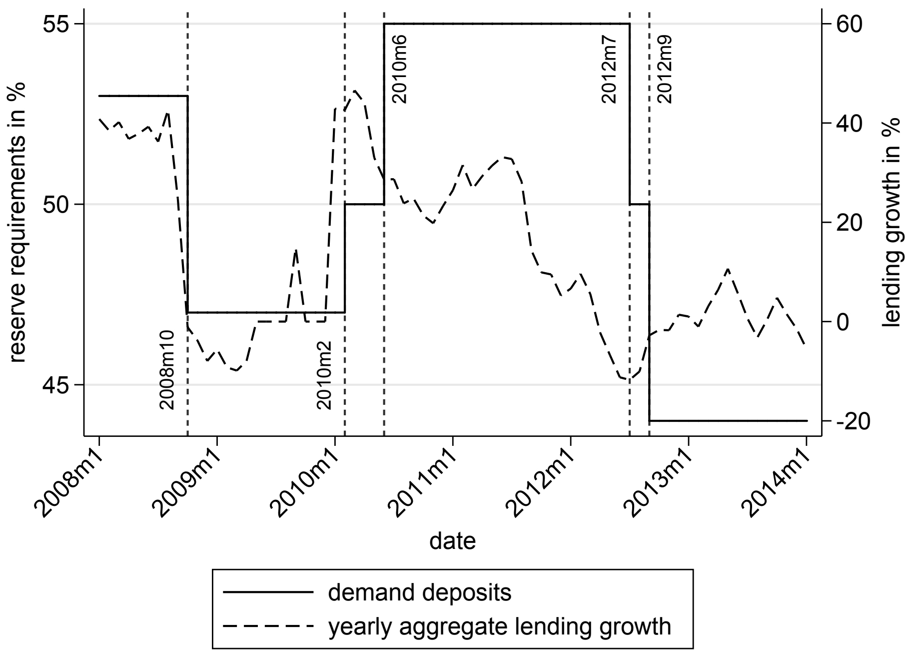

FIGURE D.II: This graph shows the evolution of the yearly growth rate of the sum of outstanding credit (dashed line - right axis) across all branches during the sample period together with the time series of the reserve requirements (solid line - left axis). The vertical dashed lines mark the months at which changes in reserve requirements occur.

Table D.IV: Credit Growth of Branches by Deposit Share of Parent Bank.

Category	Mean	S.D.	Median	Min	Max
Category	Mean	S.D.	Median	Min	Max
low dep. share (p)	2.080	11.954	2.723	-39.651	32.283
high dep. share (p)	2.313	10.726	3.149	-39.651	32.283
Total	2.171	11.490	2.920	-39.651	32.283

Notes: This table shows descriptive statistics of the dependent variable *quarterly growth rate of outstanding credit* of branches. At each point in time, we divide branches into two groups depending on the share of deposit funding of the parent bank. Branch observations are thus ordered into the category *low dep. share (p)*, indicating that the parent bank has a share of deposit funding below or equal to the median. The category *high dep. share (p)* refers to branch observations, for which the parent bank has an above median share of deposit funding.

Table D.V: Deposit Share of Parent Bank by Categories.

Category	Mean	S.D.	Median	Min	Max
domestic	5.091	2.353	4.759	0.000	13.486
foreign	4.739	1.955	4.139	0.000	14.406
state owned	6.083	2.317	6.082	0.487	13.486
private	4.136	1.858	4.180	0.000	14.406
small	4.396	1.982	4.294	0.000	14.406
large	5.960	2.406	6.108	1.547	10.913
low equity	5.504	2.338	5.827	0.000	12.010
high equity	4.450	2.104	4.332	0.000	14.406
total	5.034	2.297	4.675	0.000	14.406

Notes: This table lists descriptive statistics for the share of assets funded by demand deposits at the parent bank level in percent and weighted by the number of branches operated by the parent bank. The descriptive statistics are presented by groups of parent banks divided into domestically and foreign owned as well as state owned and private parent banks, small and large banks measured by total assets, and banks with a low or high equity ratio. Groups are split at the median of the respective variable across all banks at each point in time.

TABLE D.VI: Estimation for different sub-periods.

	baseline (1)	crisis (2)	tightening (3)	loosening (4)
(c) l.3 dep.share (p)	−0.003	0.749**	−0.272	−1.277***
	(0.990)	(0.028)	(0.721)	(0.000)
(c) l.3 dep.share (p) × (c) l.3 RR	−0.045**	−0.081***	−0.023	−0.038***
	(0.046)	(0.001)	(0.494)	(0.001)
(z) l.3 ROA (b)	−0.280	−0.268	−0.230	−0.391
	(0.333)	(0.237)	(0.469)	(0.302)
(z) l.3 log assets (b)	−0.753	2.114**	−5.447***	−7.329***
	(0.416)	(0.030)	(0.000)	(0.000)
(z) l.3 equity ratio (p)	0.066	0.639**	0.346	0.194
	(0.888)	(0.043)	(0.717)	(0.860)
Adjusted R^2	0.531	0.665	0.406	0.474
Observations	591618	188768	181411	211756
BranchFE	yes	yes	yes	yes
TimeMunFE	yes	yes	yes	yes

Notes: This table reports results from various sub-periods of our baseline estimation shown in Column (1)). The periods include the decrease of reserve requirements from 1/2008 to 12/2009, the tightening of reserve requirements during 1/2010 up until 12/2011 and the decrease in the reserve requirements from 1/2012 to 12/1013. The dependent variable is the quarterly growth rate of outstanding credit. Standard errors are clustered at the parent bank level, p-values are reported in parenthesis. Variables marked with a (c) are demeaned with their coefficients depicting the marginal effects of a deviation of one unit from the mean. Variables marked with a (z) are normalized with their coefficients depicting a deviation of one standard deviation from the mean. Variables marked with a (p)/(b) are measured at the parent bank/branch level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

TABLE D.VII: Alternative time structures.

	monthly (1)	quarterly (2)	biannually (3)	yearly (4)
(c) l* dep.share (p)	−0.070	−0.003	−0.509	−0.726
	(0.349)	(0.990)	(0.279)	(0.538)
(c) l* dep.share (p) × (c) l* RR	−0.015**	−0.045**	−0.080**	−0.089
	(0.044)	(0.046)	(0.031)	(0.166)
(z) l* ROA (b)	−0.233***	−0.280	−0.502	−1.705*
	(0.008)	(0.333)	(0.374)	(0.095)
(z) l* log assets (b)	−0.236	−0.753	−4.274*	−23.427***
	(0.429)	(0.416)	(0.077)	(0.000)
(z) l* equity ratio (p)	0.121	0.066	1.041	3.283***
	(0.447)	(0.888)	(0.193)	(0.000)
Adjusted R^2	0.432	0.531	0.576	0.595
Observations	568639	591618	509501	450989
BranchFE	yes	yes	yes	yes
TimeMunFE	yes	yes	yes	yes

Notes: This table reports results from changing the lag structure of our baseline model with quarterly credit growth as the dependent variable (showed in Column (1)). Column (2), (3) and (4) present the results for monthly, biannual, and annual credit growth with the dependent and explanatory variables being lagged one month, six months, and 12 months, accordingly. Standard errors are clustered at the parent bank level, p-values are reported in parenthesis. Variables marked with a (c) are demeaned with their coefficients depicting the marginal effects of a deviation of one unit from the mean. Variables marked with a (z) are normalized with their coefficients depicting a deviation of one standard deviation from the mean. Variables marked with a (p)/(b) are measured at the parent bank/branch level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

TABLE D.VIII: The effect of foreign- and state-ownership.

	baseline (1)	foreign (2)	domestic (3)	state owned (4)	private (5)
(c) l.3 dep.share (p)	−0.003	−0.379*	0.132	0.313	0.377*
	(0.990)	(0.098)	(0.726)	(0.128)	(0.050)
(c) l.3 dep.share (p) × (c) l.3 RR	−0.045**	−0.011	−0.046***	−0.013**	−0.010
	(0.046)	(0.226)	(0.000)	(0.027)	(0.454)
(z) l.3 ROA (b)	−0.280	0.533***	−0.553**	−0.377**	−0.353
	(0.333)	(0.000)	(0.033)	(0.012)	(0.119)
(z) l.3 log assets (b)	−0.753	−2.690***	−1.041	−3.096***	−0.472
	(0.416)	(0.000)	(0.126)	(0.000)	(0.607)
(z) l.3 equity ratio (p)	0.066	0.802***	−0.729	0.952	0.008
	(0.888)	(0.000)	(0.171)	(0.178)	(0.986)
Adjusted R^2	0.531	0.536	0.529	0.646	0.502
Observations	591618	57412	491725	224570	263861
BranchFE	yes	yes	yes	yes	yes
TimeMunFE	yes	yes	yes	yes	yes

Notes: This table reports results from conducting sample splits of our baseline estimation (reported in Column(1)). In Column (2) only branches with foreign parent banks are included, whereas in Column (3) only branches owned by domestic parent banks are included. Columns (4) and (5) report the results from splitting the sample into state-owned and private banks. The dependent variable is the quarterly growth rate of outstanding credit. Standard errors are clustered at the parent bank level, p-values are reported in parenthesis. Variables marked with a (c) are demeaned with their coefficients depicting the marginal effects of a deviation of one unit from the mean. Variables marked with a (z) are normalized with their coefficients depicting a deviation of one standard deviation from the mean. Variables marked with a (p)/(b) are measured at the parent bank/branch level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

TABLE D.IX: The effect of banks' size and capitalization.

	baseline (1)	large (2)	small (3)	high equity (4)	low equity (5)
(c) l.3 dep.share (p)	−0.003	0.231	−0.404**	0.008	0.385
	(0.990)	(0.674)	(0.017)	(0.951)	(0.196)
(c) l.3 dep.share (p) × (c) l.3 RR	−0.045**	−0.078***	−0.026**	−0.043**	−0.063***
	(0.046)	(0.000)	(0.028)	(0.022)	(0.001)
(z) l.3 ROA (b)	−0.280	−0.993**	0.164	−0.359**	−0.272**
	(0.333)	(0.035)	(0.369)	(0.016)	(0.014)
(z) l.3 log assets (b)	−0.753	−4.606***	−1.503**	−0.269	−3.008***
	(0.416)	(0.001)	(0.035)	(0.749)	(0.000)
(z) l.3 equity ratio (p)	0.066	1.786**	−0.131	0.127	2.203***
	(0.888)	(0.012)	(0.760)	(0.755)	(0.002)
Adjusted R^2	0.531	0.543	0.494	0.481	0.617
Observations	591618	351355	163298	197736	281793
BranchFE	yes	yes	yes	yes	yes
TimeMunFE	yes	yes	yes	yes	yes

Notes: This table reports results from conducting sample splits of our baseline estimation (shown in Column (1)). In Column (2) only branches with larger (assets above median) parent banks are included. In Column (3), branches owned by smaller (below or equal to the median) parent banks are included. In Column (4) branches with parent banks that have an equity ratio above the sample median are included. In Column (5) branches owned by parent banks with a below or equal to the median equity ratio are included. The dependent variable is the quarterly growth rate of outstanding credit. Standard errors are clustered at the parent bank level, p-values are reported in parenthesis. Variables marked with a (c) are demeaned with their coefficients depicting the marginal effects of a deviation of one unit from the mean. Variables marked with a (z) are normalized with their coefficients depicting a deviation of one standard deviation from the mean. Variables marked with a (p)/(b) are measured at the parent bank/branch level. *** indicates significance at the 1% level; ** at the 5%; * at the 10%.

Table D.X: Variables definitions.

Variable	Description	Construction
credit growth (b)	Quarterly growth rate of total outstanding credit (in percent).	$\frac{\text{credit}_{b,t} - \text{credit}_{b,t-3}}{\text{credit}_{b,t-3}}$
ROA (b)	Quarterly return on assets on parent bank level (in percent).	$\frac{\sum_{t=-3}^{t} \text{profit}_t}{\text{total assets}_{t-3}}$
dep.share (p)	Share of deposits over total assets at parent bank level (in percent).	$\frac{\text{deposits}_{p,t}}{\text{total assets}_{p,t}}$
log assets (b)	Natural logarithm of the total assets (in million USD) at branch level.	$\ln(\text{total assets}_t)$
equity ratio (p)	Share of parent bank's equity over parent's total assets (in percent).	$\frac{\text{equity}_{p,t}}{\text{total assets}_{p,t}}$
dep.share (b)	Share of deposits over total assets at branch level (in percent).	$\frac{\text{deposits}_{b,t}}{\text{total assets}_{b,t}}$
assets (p)	Deflated total assets of the parent bank in million USD.	
log M0	Natural logarithm of deflated monetary base in million USD.	$\ln(M0_t)$
RR	Reserve requirements on demand deposits (in percent).	
SELIC	Quarterly change in the policy interest rate set by the Central Bank of Brazil (in percentage points).	$Selic_t - Selic_{t-3}$

Notes: This table lists all variables used in the regressions and describes their construction.

Chapter 6

General conclusion

The global financial crisis represented, from the perspective of emerging countries, a turning point in the way how to confront global-wide disruptions in capital flows. On the one hand, sound fiscal balances and inflation-targeting monetary policy regimes lead these countries to weather the storm of the crisis with effective countercyclical policy actions implemented for the first time in such a large scale. In opposite to previous historical events, when simultaneous banking and currency crisis restricted the scope of monetary and fiscal interventions, emerging countries were this time able to restore credit flows and economic growth within a few years after the collapse of Lehman Brothers. On the other hand, the crisis highlighted new fragilities that became evident by the transmission of financial disturbances via banks foreign exposures. While throughout the 1990s and until 2007 the burgeoning global financial system allowed many emerging countries to sustain high economic growth, this came along with a lack of cross-border supervisory capacity to steer the transmission of global credit cycles into local economies.

This dissertation provides novel insights about the mechanisms underlying the cross-border transmission of banking shocks by focusing on the experience of how the global financial crisis affected banking systems in Latin America. The papers included in the dissertation address the link between banking globalization and local financial stability from different perspectives, bringing in valuable policy lessons with applicability beyond emerging countries. In view of the technological changes that continue reducing the costs of cross-border banking operations and drawing in new types of financial instruments and institutions, assessing the benefits and costs of banking globalization is likely to remain a topical issue. In this context, the results drawn from this work provide researchers and policymakers with first-hand evidence of how banks in Latin America reacted to both different transmission channels of the crisis and to policy actions implemented locally and abroad.

The general contribution of the dissertation can be summarized as follows. First, the results stress that funding shocks during a financial crisis can take multiple forms, ranging from direct foreign funding shocks to indirect dry-ups in local interbank markets. The results highlight, in opposite to previous studies, the nonlinearities and complexities involved in the transmission of these shocks. Second, the dissertation shows that even in a context with multiple demand- and supply-side shocks, foreign funding shocks can have a specific effect on real economic outcomes. While several factors incrementing this effect are identified, one especially important for emerging countries are the local characteristics of regional banking sectors. Reducing the procyclicality of credit at the local level and providing borrowers with emergency credit lines can reduce the extent of the shocks' real effects. Finally, the analysis throughout the four main Chapters of the dissertation highlights that, even though effective, countercyclical macroprudential and monetary interventions face important obstacles. In particular, the heterogeneity of banks' funding structures, the high demand for liquid assets during crisis and, from industrial countries' perspective, banks' incentives to reallocate emergency liquidity across borders, hinder the effectiveness of policy actions. These are important lessons learned from the global financial crisis.

Despite of these contributions, a number of shortcomings limit the analysis of the papers in this dissertation and need to be taken into account when generalizing its main conclusions. It should be noted that the specificity of the institutional setting in emerging countries, and in particular in Latin America, can affect the results. For example, the relatively low degree of development of interbank wholesale markets and the minor role played by securitization in comparison to the industrial world are very likely to condition the results. Another aspect relates to the structure of the data sets used for the analysis. While the papers presented here are based on bank and bank-branch level data, a number of other studies rely on credit registers with information at the loan-level to assess questions about the transmission of banking shocks. This limitation in the data implies that we can only observe virtual borrowers represented by countries or country regions, in opposite to the actual firms and households demanding credit. In practice, this hinders analyzing the interactions between the lending channel of funding shocks and the characteristics of both loans and borrowers. Finally, the papers in the dissertation focus on external financial shocks that lead banks to adjust their credit supply. An alternative, though not exclusive, narrative might consider the role of real shocks to banks' individual borrowers within a specific geographic region. Taking the Brazilian data setting as an example, one might think of certain branches being exposed to firms relatively large affected by the crisis (i.e. export firms, commodity producers) and triggering negative liquidity shocks within their banking conglomerates. Even though the methodological approach in the dissertation effectively control for this scenario, this alternative explanation with potentially important policy implications was not explicitly addressed in the papers. These shortcomings leave open a large scope of possible extensions of the research questions investigated the dissertation.

Understanding the risks of banking globalization is a crucial task in order to improve global banking supervision and to contain pressures that might prevent countries from benefiting from an integrated global financial system. By taking the global financial crisis as an example and by looking at the problematic of banking globalization from emerging countries' perspective, this dissertation contributes to sort out some important lessons from the crisis. Despite of its limitations, I expect the papers discussed in this work to add to a renew interest in understanding the role of banks in emerging countries and the policy actions that can facilitate the contribution of banking globalization to standards of living worldwide.

Bibliography

Acharya, Viral V. and Ouarda Merrouche. “Precautionary hoarding of liquidity and interbank markets: Evidence from the subprime crisis”. In: Review of Finance 17 (2013), pp. 107–160.

Acharya, Viral V. and David Skeie. “A model of liquidity hoarding and term premia in inter-bank markets”. In: Journal of Monetary Economics 58 (2011), pp. 436–447.

Acharya, Viral V., Douglas Gale, and Tanju Yorulmazer. “Rollover risk and market freezes”. In: Journal of Finance 66(4) (2011), pp. 1177–1209.

Adrian, Tobias and Hyun Song Shin. “Financial intermediaries, financial stability and monetary policy”. In: Proceedings - Economic Policy Symposium - Jackson Hole Federal Reserve Bank of Kansas City (2008), pp. 287–334.

Afonso, Gara and Hyun Song Shin. “Precautionary demand and liquidity in payment systems”. In: Journal of Money, Credit and Banking 43(2) (2011), pp. 589–619.

Afonso, Gara, Anna Kovner, and Antoinette Schoar. “Stressed not frozen: The Fed funds market in the financial crisis”. In: Journal of Finance 66(4) (2011), pp. 1109–1139.

Agur, Itai and Maria Demertzis. “Will Macroprudential Policy Counteract Monetary Policy’s Effects on Financial Stability?” In: IMF Working Paper No. 15/283 (2015).

Aiyar, Shekhar. “From financial crisis to great recession: The role of globalized banks”. In: American Economic Review 102 (2012), pp. 225–230.

Aiyar, Shekhar, Charles W. Calomiris, and Tomasz Wieladek. “Does macroprudential regulation leak? Evidence from a UK policy experiment”. In: Journal of Money, Credit and Banking 46 (2014), pp. 181–214.

Aizenman, Joshua, Yothin Jinjarak, and Donghyun Park. “International reserves and swap lines: Substitutes or complements?” In: International Review of Economics and Finance 20(1) (2010), pp. 5–18.

Allen, Franklin and Douglas Gale. “Financial fragility, liquidity, and asset prices”. In: Journal of the European Economic Association 2 (2004), pp. 1015–1048.

Allen, Franklin and Douglas Gale. “Financial intermediaries and market”. In: Journal of Financial Economics 72 (2004), pp. 1023–1061.

Allen, Franklin, Aneta Hryckiewicz, Oskar Kowalewski, and Gunseli Turmer-Alkanm. “Transmission of bank liquidity shocks in loan and deposit markets: The role of interbank borrowing and market monitoring”. In: Journal of Financial Stability 15 (2014), pp. 112–126.

Ananda, Kartik, Prasanna Gaib, and Matteo Marsilid. “Rollover risk, network structure and systemic financial crises”. In: Journal of Economic Dynamics and Control 36(8) (2011), pp. 1088–1100.

Andrade, Philippe, Christophe Cahn, Henri Fraisse, and Jean-Stéphane Mésonnier. “Can the provision of long-term liquidity help to avoid a credit crunch? Evidence from the eurosystem’s LTROs”. In: Working papers 540 540 (2015).

Andries, Natalia and Steve Billon. “The effect of bank ownership and deposit insurance on monetary policy transmission”. In: Journal of Banking & Finance 34(12) (2010), pp. 3050–3054.

Angrist, Joshua, Victor Lavy, and Analia Schlosser. “Multiple experiments for the causal link between the quantity and quality of children”. In: Journal of Labor Economics 28 (2010), pp. 773–824.

Ashcraft, Adam B. “Are bank holding companies a source of strength to their banking subsidiaries?” In: Journal of Money, Credit and Banking 4 (2) (2008), pp. 273–294.

Avery, Robert B. “Loan commitments and bank risk exposure”. In: Journal of Banking & Finance 15 (1991), pp. 173–192.

BCB. “Relatorio de estabilidade financeira (financial stability report)”. In: Banco Central do Brasi 9(1) (2010), April.

Bernanke, Ben S. “The policy response to the crisis in Korea and other emerging market economies”. In: Remarks by the chairman Board of Governors of the Federal Reserve System at the Bank of Korea’s International Conference Seoul, Korea (2010), May.

Berrospide, Jose. “Bank liquidity hoarding and the financial crisis: An empirical evaluation”. In: Finance and Economics Discussion Series, Federal Reserve Board, Washington, D.C. 03 (2013).

Bertrand, Marianne, Ester Duflo, and Sendhil Mullainathan. “How much should we trust difference-in-difference estimates?” In: The Quarterly Journal of Economics 119 (2004), pp. 249–275.

Bhaumik, Sumon K., Vinh Dank, and Ali M. Kutan. “Implications of bank ownership for the credit channel of monetary policy transmission: Evidence from India”. In: Journal of Banking & Finance 35(9) (2011), pp. 2418–2428.

Borio, Claudio and Haibin Zhu. “Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism?” In: Journal of Financial Stability 8(4) (2012), pp. 236–251.

Borio, Claudio, Craig Furfine, Philip Lowe, et al. “Procyclicality of the financial system and financial stability: Issues and policy options”. In: BIS papers 1 (2001), pp. 1–57.

Boutina, Xavier, Giacinta Cestoneb, Chiara Fumagallie, Giovanni Picag, and Nicolas Serrano-Velarde. “The deep-pocket effect of internal capital markets”. In: Journal of Financial Economics 109(1) (2013), pp. 122–145.

Brissimis, Sophocles N., Manthos D. Delis, and Maria Iosifidi. “Bank market power and monetary policy transmission”. In: International Journal of Central Banking 10(4) (2014), pp. 173–214.

Brunnermeier, Markus. K. “Deciphering the liquidity and credit crunch 2007-08”. In: Journal of Economic Perspectives 23(1) (2009), pp. 77–100.

Buch, Claudia M. and C. Goldberg. “Cross-border prudential policy spillovers: How much? How important? Evidence from the International Banking Research Network”. In: International Journal of Central Banking March (2017), pp. 505–558.

Buch, Claudia M. and Linda S. Goldberg. “International banking and liquidity risk transmission: Lessons from across countries”. In: IMF Economic Review 63 (2015), pp. 377–410.

Buch, Claudia M., Joerg Doepke, and Kerstin Stahn. “Great moderation at the firm level? Unconditional vs. conditional output volatility”. In: The B.E. Journal of Economic Analysis & Policy 9(1) (2009), pp. 1–27.

Caballero, Ricardo J. and Arvind Krishnamurthy. “Collective risk management in a flight-to-quality episode”. In: Journal of Finance 63 (2008), pp. 2195–2230.

Campello, Murillo. “Internal capital markets in financial conglomerates: Evidence from small bank responses to monetary policy”. In: Journal of Finance 57 (6) (2002), pp. 2773–2805. ISSN: 1540-6261.

Carpinelli, Luisa and Matteo Crosignani. “The effect of central bank liquidity injections on bank credit supply”. In: Working Paper (2015).

Carvalho, Daniel. “The real effects of government-owned banks: Evidence from an emerging market”. In: Journal of Finance 69(2) (2014), pp. 577–609.

Casiraghi, Marco, Eugenio Gaiotti, Lisa Rodano, and Alesandro Secchi. “The impact of unconventional monetary policy on the Italian economy during the sovereign debt crisis”. In: Questioni di Economia e Finanza 203 (2013).

Cavallo, Eduardo, Andre Powell, Mathieu Pedemonte, and Pilar Tavella. “A new taxonomy of sudden stops: Which sudden stops should countries be most concerned about?” In: Journal of International Money and Finance 51 (C) (2015), pp. 47–70.

Cecchetti, Stephen G. “On the separation of monetary and prudential policy: How much of the pre-crisis consensus remains?” In: Journal of International Money and Finance 66 (2016), pp. 157–169.

Cetorelli, Nicola and Linda S. Goldberg. “Banking globalization and monetary transmission”. In: Journal of Finance 67 (5) (2012), pp. 1811–1843.

Cetorelli, Nicola and Linda S. Goldberg. “Global banks and international shock transmission: Evidence from the crisis”. In: IMF Economic Review 59 (2011), pp. 41–46.

Cetorelli, Nicola and Linda S. Goldberg. “Liquidity management of U.S. global banks: Internal capital markets in the great recession”. In: Journal of International Economics 88 (2) (2012), pp. 299–311.

Chodorow-Reich, Gabriel. “Effects of unconventional monetary policy on financial institutions”. In: Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution 48 (2014), pp. 155–227.

Chodorow-Reich, Gabriel. “The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis”. In: The Quarterly Journal of Economics 129 (2014), pp. 1–59.

Claessens, Stijn and Neeltje Van Horen. “The impact of the global financial crisis on banking globalization”. In: IMF Economic Review 63(4) (2014), pp. 868–918.

Claessens, Stijn, Swati R Ghosh, and Roxana Mihet. “Macro-prudential policies to mitigate financial system vulnerabilities”. In: Journal of International Money and Finance 39 (2013), pp. 153–185.

Coleman, Nicholas and Leo Feler. “Bank ownership, lending, and local economic performance during the 2008–2009 financial crisis”. In: Journal of Monetary Economics 17 (2015), pp. 50–66.

Cornett, Marcia Millon, Jamie John McNutt, Philip E. Strahan, and Tehranian Hasan. "Liquidity risk management and credit supply in the financial crisis". In: Journal of Financial Economics 101 (2011), pp. 297–312.

Crosginani, Matteo, Miguel Faria-e Castro, and Luis Fonseca. "The (unintended?) consequences of the largest liquidity injection ever". In: Bank of Portugal Working Paper 2015/9 2015/9 (2015).

Da Silva, Luiz Awazu Pereira and Ricardo Eyer Harris. "Sailing through the global financial storm: Brazil's recent experience with monetary and macroprudential policies to lean against the financial cycle and deal with systemic risks". In: Banco Central do Brasil Working Paper Series 290 (2012), pp. 1–59.

Dahl, Drew, Ronald E. Shrieves, and Michael F. Spivey. "Financing loan growth at banks". In: Journal of Financial Services Research 22(3) (2002), pp. 189–202.

Danisewicz, Piotr, Dennis Reinhardt, and Rhiannon Sowerbutts. "On a tight leash: does bank organisational structure matter for macroprudential spillovers?" In: Bank of England Working Paper 524 (2015).

De Haas, Ralph and Neeltje van Horen. "International shock transmission after the Lehman Brothers collapse: Evidence from syndicated lending". In: American Economic Review 102 (2012), pp. 231–237.

De Haas, Ralph and Iman van Lelyveld. "Foreign banks and credit stability in Central and Eastern Europe. A panel data analysis". In: Journal of Banking & Finance 30 (2006), pp. 1927–1952.

De Haas, Ralph and Iman van Lelyveld. "Internal capital markets and lending by multinational bank subsidiaries". In: Journal of Financial Intermediation 19 (2010), pp. 1–25.

De Haas, Ralph and Iman van Lelyveld. "Multinational banks and the global financial crisis: Weathering the perfect storm?" In: Journal of Money, Credit and Banking 46 (2014), pp. 333–364.

Degryse, Hans, Olivier De Jonghe, Sanja Jakovljević, Klaas Mulier, and Glenn Schepens. "The impact of bank shocks on firm-level outcomes and bank risk-taking". In: Available at SSRN 2788512 (2016).

Demirgüç-Kunt, Asli and Harry Huizinga. "Bank activity and funding strategies: The impact on risk and returns". In: Journal of Financial Economics 98(3) (2010), pp. 626–650.

Di Maggio, Marco, Amir Kermani, and Rodney Ramcharan. "Monetary policy pass-through: Household consumption and voluntary deleveraging". In: Columbia Business School Research Paper 14–24 (2015).

Diamond, Douglas W. and Philip H. Dybving. "Bank runs, deposit insurance, and liquidity". In: Journal of Political Economy 91(5) (1983), pp. 401–419.

Diamond, Douglas W. and Raghuram Rajan. "The credit crisis: Conjectures about causes and remedies". In: American Economic Review, American Economic Association 99 (2009), pp. 606–610.

Ferri, Giovanni, Panu Kalmi, and Eeva Kerola. "Does bank ownership affect lending behavior? Evidence from the euro area". In: Journal of Banking & Finance 48 (2014), pp. 194–209.

Fostel, Ana and John Geanakoplos. "Collateral restrictions and liquidity under-supply: a simple model". In: Economic Theory 35(3) (2008), pp. 441–467.

Fourel, Valere, Jean-Cyprien Heam, Dilyara Salakhova, and Santiago Tavolaro. "Domino effects when banks hoard liquidity: The French network". In: Banque de France Working Paper No. 432 (2013), April.

Freixas, Xavier, Antoine Martin, and David Skeie. "Bank liquidity, interbank markets, and monetary policy". In: Review of Financial Studies, Society for Financial Studies 24(8) (2011), pp. 2656–2692.

Freixas, Xavier, Luc Laeven, and Jose-Luis Peydro. "Systemic risk, crises, and macroprudential regulation". In: MIT Press Books Edition 1, volume 1, No. 0262028697 (2015), September.

Frey, Rainer, Cornelia Kerl, and Alexander Lipponer. “Withdrawal from foreign lending in the financial crisis by parent banks and their branches and subsidiaries: Supply versus demand effects”. In: Journal of Financial Services Research (2016), pp. 1–48.

Gabrieli, Silvia and Co-Pierre Georg. “A network view on interbank market freezes”. In: Deutsche Bank Working Paper No. 44 (2014), December.

Gale, Douglas and Tanju Yorulmazer. “Liquidity hoarding”. In: Theoretical Economics, Econometric Society 8(2) (2013), May.

García-Posada, Miguel and Marcos Marchetti. “The bank lending channel of unconventional monetary policy: The Impact of the VLTROS on credit supply in Spain”. In: Documentos de Trabajo 1512 (2015).

Giannetti, Mariassunta and Luc Laeven. “The flight home effect: Evidence from the syndicated loan market during financial crises”. In: Journal of Financial Economics 104 (2012), pp. 23–43.

Giroud, Xavier and Holger M. Mueller. “Firm leverage, consumer demand, and unemployment during the great recession”. In: The Quarterly Journal of Economics 132 (1) (2017), pp. 271–316.

Glocker, Christian and Pascal Towbin. “Reserve requirements as a macroprudential instrument: Empirical evidence from Brazil”. In: Journal of Macroeconomics 44 (2015), pp. 158–176.

Heider, Florian, Carlos Garcia-de Andoain, Marie Hoerova, and Simone Manganelli. “Lending-of-last-resort is as lending-of-last-resort-does: Central bank liquidity provision and interbank market functioning in the euro area”. In: Journal of Financial Intermediation (forthcoming).

Heider, Florian, Farzad Saidi, and Glenn Schepens. “Life below Zero: Bank lending under negative policy rates”. In: Mimeo (2016).

Heider, Florian, Marie Hoerova, and Cornelia Holthausen. “Liquidity hoarding and interbank market spreads: The role of counterparty risk”. In: Journal of Financial Economics 118 (2015), pp. 336–354.

Holod, Dmytro and Joe Peek. "Capital constraints, asymmetric information, and internal capital markets in banking: New evidence". In: Journal of Money, Credit and Banking, Blackwell Publishing 42(5) (2010), pp. 879–906.

Houston, Joel F. and Christopher James. "Do bank internal capital markets promote lending?" In: Journal of Banking & Finance 22(6) (1998), pp. 899–918.

Houston, Joel F., Christopher James, and David Marcus. "Capital market frictions and the role of internal capital markets in banking". In: Journal of Financial Economics 46 (1997), pp. 135–164.

Huang, Rocco and Lev Ratnovski. "The dark side of bank wholesale funding". In: Journal of Financial Intermediation 20(2) (2011), pp. 248–263.

Imbens, Guido and Jeffrey Wooldridge. "Recent developments in the econometrics of program evaluation". In: Journal of Economic Literature 47 (2009), pp. 5–86.

IMF. "Macroprudential policy: An organizing framework". In: Document prepared by the Monetary and Capital Markets Department (2011).

IMF. "The interaction of monetary and macroprudential policies". In: Document prepared by a staff team coordinated by Stijn Claessens and Karl Habermeier and comprising Erlend Nier, Heedon Kang, Tommaso Mancini-Griffoli, and Fabian Valencia (2013).

IMF. "World economic outlook: Crisis and recovery". In: IMF World Economic and Financial Surveys ISBN 978-1-58906-806-3 (2009), April.

Jeon, Bang Nam and Ji Wu. "The role of foreign banks in monetary policy transmission: Evidence from Asia during the crisis of 2008–9". In: Pacific-Basin Finance Journal 29(C) (2014), pp. 96–120.

Jeon, Bang Nam, Maria P. Olivero, and Ji Wu. "Multinational banking and the international transmission of financial shocks: Evidence from foreign bank subsidiaries". In: Journal of Banking & Finance 37 (2013), pp. 952–972.

Kamil, Herman and Kulwant Rai. “The effect of the global credit crunch on foreign banks lending to emerging markets: Why did Latin America fare better?” In: IMF Working Papers 10/102, International Monetary Fund. (2010).

Kashyap, Anil and Heremy Stein. “The impact of monetary policy on bank balance sheet”. In: Carnegie-Rochester Series on Public Policy 42 (1995), pp. 151–195.

Kashyap, Anil and Heremy Stein. “What do a million observations on banks say about the transmission of monetary policy”. In: American Economic Review 90 (3) (2000), pp. 407–428.

Khwaja, Asim Ijaz and Atif Mian. “Tracing the impact of bank liquidity shocks: Evidence from an emerging market”. In: American Economic Review 98 (2008), pp. 1413–1442.

Kishan, Ruby and Timothy Opiela. “Bank size, bank capital, and the bank lending channel”. In: Journal of Money, Credit and Banking, Blackwell Publishing 32 (2000), pp. 121–141.

Klapper, Leora, Luc Laeven, and Raghuram Rajan. “Entry regulation as a barrier to entrepreneurship”. In: Journal of Financial Economics 82(3) (2006), pp. 591–629.

Koetter, Michael, Thomas Kick, and Manuela Storz. “Cross-border transmission of U.S. emergency liquidity provision?” In: Mimeo (2015).

Lambert, Claudia, Felix Noth, and Ulrich Schüwer. “How do insured deposits affect bank risk? Evidence from the 2008 emergency economic stabilization act”. In: Journal of Financial Intermediation 29 (2015), pp. 81–102.

Manganelli, Simone and Alexander Popov. “Financial development, sectoral reallocation, and volatility: International evidence”. In: Journal of International Economics 96(2) (2015), pp. 323–337.

Menkhoff, Lukas, Doris Neuberger, and Chodechai Suwanaporn. “Collateral-based lending in emerging markets: Evidence from Thailand”. In: Journal of Banking & Finance 30(1) (2006), pp. 1–21.

Montoro, Carlos and Ramon Moreno. "The use of reserve requirements as a policy instrument in Latin America". In: BIS Quarterly Review March (2011), pp. 53–65.

Noth, Felix and Matias Ossandon Busch. "Foreign funding shocks and the lending channel: Do foreign banks adjust differently?" In: Finance Research Letters 19 (2016), pp. 222–227.

Ohls, Jana, Marcus Pramor, and Lena Tonzer. "International banking and cross-border effects of regulation: Lessons from Germany". In: International Journal of Central Banking March (2017), pp. 129–162.

Ongena, Steven, Jose-Luis Peydro, and Neeltje van Horen. "Shocks abroad, pain at home? Bank-firm level evidence on the international transmission of financial shocks". In: IMF Economic Review 63(4) (2015), pp. 698–750.

Peek, Joe and Eric Rosengren. "The international transmission of financial shocks: The case of Japan". In: American Economic Review 87 (1997), pp. 495–505.

Pérignon, Cristoph, David Thesmar, and Guillaume Vuillemey. "Wholesale funding runs". In: Mimeo (2016).

Pesaran, M. Hashem. "Estimation and inference in large heterogeneous panels with a multifactor error structure". In: Econometrica 74(4) (2006), pp. 967–1012.

Petersen, Mitchell A. "Estimating standard errors in finance panel data sets: Comparing approaches". In: Review of Financial Studies 22 (2009), pp. 435–480.

Popov, Alexander and Jörg Rocholl. "Do credit shocks affect labor demand? Evidence for employment and wages during the financial crisis". In: Journal of Financial Intermediation (2016), forthcoming.

Popov, Alexander and Gregory Udell. "Cross-border banking, credit access, and the financial crisis". In: Journal of International Economics 81 (2012), pp. 147–161.

Puri, Manju, Jörg Rocholl, and Sascha Steffen. “Global retail lending in the aftermath of the US financial crisis: Distinguishing between supply and demand effects”. In: Journal of Financial Economics 100 (2011), pp. 556–578.

Rajan, Raghuram. “A step in the dark: Unconventional monetary policy after the crisis”. In: Andre Crocket Memorial Lecture, Bank for International Settlements (BIS) (2013), Lecture delivered at the BIS on 23 June 2013.

Rajan, Raghuram. “Competitive monetary easing: Is it yesterday once more?” In: Speech at the Brookings Institution (2014), April 10.

Rajan, Raghuram. “Has finance made the world riskier?” In: European Financial Management 12(4) (2006), pp. 499–533.

Rajan, Raghuram and Luigi Zingales. “Financial dependence and growth”. In: American Economic Review 88 (1998), pp. 559–586.

Rey, Helene. “International channels of transmission of monetary policy and the Mundellian trilemma”. In: IMF Economic Review 64(1) (2016), pp. 6–35.

Robitaille, Patrice. “Liquidity and reserve requirements in Brazil”. In: International Finance Discussion Papers No. 1021 (2011).

Schnabl, Philipp. “Financial globalization and the transmission of bank liquidity shocks: Evidence from an emerging market”. In: Journal of Finance 67 (2012), pp. 897–932.

Stiglitz, Joseph E. “The financial crisis of 2007-2008 and its macroeconomic consequences, in time for a visible hand: Lessons from the 2008 world financial crisis, S. Griffith-Jones, J.A. Ocampo, and J.E. Stiglitz, eds.” In: Initiative for Policy Dialogue Series, Oxford: Oxford University Press (2010), pp. 19–49.

Tovar Mora, Camilo Ernesto, Mercedes Garcia-Escribano, and Mercedes Vera Martin. “Credit growth and the effectiveness of reserve requirements and other macroprudential instruments in Latin America”. In: IMF Working Paper No. 12142 (2012).

Tressel, Thierry and Yuanyan Sophia Zhang. “Effectiveness and channels of macroprudential instruments: Lessons from the Euro Area”. In: IMF Working Paper No. 1604 (2016).

Van Rijckeghem, Carolina and Beatrice Weder di Mauro. “Sources of contagion: Finance or trade”. In: Journal of International Economics 54 (2001), pp. 293–308.

Vannoorenberghe, Gonzague. “"Firm-level volatility and exports”. In: Journal of International Economics 86(1) (2012), pp. 57–67.

Wu, Ji, Bang Nam Jeon, and Alina C. Luca. “Foreign bank penetration and the lending channel in emerging economies: Evidence from bank-level panel data”. In: Journal of International Money and Finance 30(6) (2011), pp. 1128–1156.

Zdzienicka, Aleksandra, Sally Chen, Federico Diaz Kalan, Stefan Laseen, and Katsiaryna Svirydzenka. “Effects of monetary and macroprudential policies on financial conditions: Evidence from the United States”. In: IMF Working Paper No. 15288 (2015).