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Internal Liquidity Management and Local Credit Provision*

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Abstract

This paper studies the patterns of internal liquidity management and their effect on bank lending, using a novel branch-level dataset of Brazilian banks. Our results suggest that internal liquidity management increases during times of financial stress. Privately owned banks are most affected by a liquidity shock, and increase the level of internal funding to maintain their branch lending, while their government-owned competitors react strategically. Private and government banks increase the funding of branches in concentrated and riskier areas. This funding translates into more lending, as the sensitivity of lending to internal funding remains high after the liquidity shock. Altogether, this paper provides branch-level evidence of the way that banks ration internal liquidity, both in normal times and in times of stress, and the effect this has on bank lending.

JEL Classification: F32, G21, L21, O16
Keywords: Internal liquidity management, Brazil, bank lending.

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1. Introduction

The wave of financial globalization that started in the 1980s transformed financial markets and institutions around the world. As a result of this trend of financial integration, global banks increased their footprint within their domestic markets and across both emerging and advanced economies. In this process, banks developed different business models to manage the funds raised from external sources (CGFS, 2010). One of those business models operates by centrally managing liquidity within the banking organization. The central office in this type of banking organization allocates resources across its branches depending on the objectives of the officers of the bank. Thus, external liquidity raised throughout the bank is moved internally across offices in different countries or regions within a country (Campello, 2002).

This paper studies the patterns of internal liquidity management for large banks in Brazil and how these business practices affect bank lending to non-related borrowers. In particular, we attempt to answer two questions: How do banks manage liquidity within their organizations after suffering a liquidity shock? And what is the effect of liquidity management on bank lending?

To answer these questions, we use a novel data set that contains information on the Brazilian banking sector. The main advantage of these data is that they capture the balance sheets of branches that belong to the same banking organization aggregated by municipality. This information is recorded at a monthly frequency, which helps us investigate the effect of liquidity shocks on the aggregate balance sheet of the banking organization and of its local branches. More important, these data include the net lending of branches to other parts of the organization, which allows us to map, at the micro level, the degree of liquidity management that takes place within the organization as external factors change.

We need a second factor to answer our questions. More precisely, we have to find an external shock that affects Brazilian banks' liquidity conditions without this shock being

correlated with the solvency of those banks or the economic activity of the municipalities in which these banks operate. In our particular sample period, the closest shock with these characteristics is the so called taper tantrum (Fischer, 2014). In the spring of 2013, the Chairman of the U.S. Federal Reserve announced that the pace of asset purchases that the central bank was conducting at the time would decelerate in the near future. Financial markets reacted strongly and flows moved quickly out of some emerging markets (International Monetary Fund, 2013). Brazilian banks were not immune to this shock, and they lost roughly $20 billion in external funding in two quarters. This shock allows us to identify the reaction of banks within Brazil to the change in liquidity conditions and, in particular, their adjustment in net lending within their banking organization as a result of the reduction in external financing.

Figure 1 is a flow chart that shows how internal liquidity management works. In Municipality 1, the headquarters will raise external funds, potentially from foreign sources. It will then lend internally to branches in Municipality 2 and Municipality 3, depending on the liquidity needs of the branches in those locations. It is also possible that Municipality 2 and Municipality 3 will borrow from (lend to) each other. Our data only allow us to see the total intrabank assets and liabilities for each bank in each municipality. Thus, we cannot observe whether Municipality 2 is a net lender to Municipality 3 and a net borrower from Municipality 1. We can observe that the bank in Municipality 2 is a net borrower from the overall banking group (consisting of Municipality 1 and Municipality 3 in this example). From this information, we calculate a net due to position for each bank in each location. This position is simply the size of intrabank liabilities net of intrabank assets scaled by total assets in that location. A positive net due to position implies that the bank operating in a specific location has more intrabank liabilities than assets, which means that it is a net borrower from the banking group. Conversely, a negative net due to position implies that the bank operating in a specific location is a net lender to the banking group.

In our first set of tests, we assess whether banks react to a liquidity shock by reallocating

funds within the banking organization. We take advantage of the effect of the taper tantrum on Brazilian banks' access to foreign funding to determine whether these financial institutions changed their pattern of internal funding. Our results suggest that the banks most affected by this shock, foreign-funded banks and private banks (domestic and foreign-owned), increased the level of intrabank funding throughout their branching network after the taper tantrum. However, the direction of funding, as captured by the net due to position, differs significantly between the groups of banks analyzed. Government-owned banks, less affected by this shock, increased the funding of its branches on average. In contrast, privately owned banks (private banks) and foreign-funded banks slightly decreased the flows sent to their branches.

These results motivate the second set of tests. We analyze whether banks allocate resources differentially across their branches after the shock. As noted in Stein (1997), firms' corporate headquarters may engage in "winner picking," especially when faced with financing constraints. In our particular scenario, the liquidity shock may have forced the executive officers of banks to allocate resources across their branching network depending on the projects available for financing in those locations and their profitability. We test whether the characteristics of the municipality of the branch, such as its income or level of urbanization, determine the flow of funds to that location. We also explore whether the characteristics of the banking market of the receiving branch (i.e., bank concentration or profitability) have any effect on its funding. We find that government and private banks do not allocate more funding to their headquarters or to municipalities according to their income, population, or with a smaller industrial sector after the shock. We also do not find any connection between the internal flow of bank resources and links between the political party controlling the states where municipalities are located and the central government. In contrast, our results show that funds are distributed based on the characteristics of the local banking markets. Government banks appear to have focused on locations where they have a higher share of a locality's banking assets and that appear to be risker, as measured by the share of loan loss provisions to loans. Private banks allocated resources across localities with similar

characteristics, but the overall increase of intrabank flows after the shock is not significant for the average bank. This finding suggests that the less affected banks may have attempted to expand in municipalities where they could potentially receive higher benefits, although at a higher risk, by directing more funds to those locations.

To explore this hypothesis, we test whether liquidity management had any effects on Brazilian banks' lending to non-related customers. We find that banks' lending sensitivity to internal funding increased after the shock. This result is driven by private banks, which appear to have allocated resources internally to minimize the effect of the shock on their lending. Government banks' lending, although sensitive to the change in internal funds, did not experience any change in this sensitivity after the shock. However, we find that government banks increased their lending in those areas that received more internal funding, namely, areas where the banks had a higher market share. These banks may have reacted to private banks' retrenchment from these areas by trying to increase their market share or to satisfy the increasing demand for credit in these locations.

The study of liquidity management within banking organizations and its effect on lending activities has been an active field of research in recent years. Based on the work of Williamson (1985) and Stein (1997), Campello (2002) explored the role of internal liquidity markets and risk sharing within banking organizations to mitigate external funding shocks. This behavior is found particularly in banks that have a large global footprint that allows them to move funds between countries that face different sets of uncorrelated shocks (Cetorelli and Goldberg, 2012). A more recent paper by Cycon and Koetter (2015) analyzes the transmission of unconventional monetary policy within banking organizations.

Another strand of the literature related to our paper focuses on the real economic effect of having banking sectors with more geographically diversified banks (Morgan et al., 2004). This literature finds that as bank linkages across regions increase, the fluctuations in the business cycles of those states decrease, but at the same time, the fluctuations of these regions tend to converge.

The paper is also related to a long literature that explores the effects of capital and funding shocks on lending. This literature starts with the work of Peek and Rosengren (1997), which explores how a shock to the capital of Japanese financial institutions affects their lending to the United States. Similarly, a more recent study by Schnabl (2012) analyzes the reaction of Peruvian banks to a loss of access to international funding. The focus of the paper is on analyzing the effect of the liquidity shock on lending to firms without exploring the change in liquidity management by these banks.

In a closely related paper, Coleman and Feler (2015) analyze the divergent reaction of government and private banks after the Global Financial Crisis. As noted in the study, government banks increased lending to offset the decline in private lending during this episode, which helped mitigate the effect of the increase in financial stress on employment. However, government banks did not curtail credit after the recovery, and some lending was misallocated, potentially affecting productivity.

Finally, several recent papers have exploited the richness of Brazilian banking data to study related questions. Although our paper is only tangentially related to the role of networks in financial markets, Silva et al. (2016) use Brazilian bank data to analyze whether the structure of interbank networks in the country are cost efficient for banks and whether these structures affect systemic risk. In another related paper, Noth and Ossandon Busch (2017) use the same data as in our paper to test whether the shock initiated by the collapse of Lehman Brothers had an effect on the labor markets of Brazilian localities through the role of the banking sector.

Our paper contributes to these strands of the literature, as we use detailed bank branch-level information to study the effect of a liquidity shock on the internal management of liquidity within banks and on lending to third parties. We further examine the channels by which any smoothing in lending occurs. Namely, we can observe the inter-branch transfers within a bank to determine which branches are obtaining resources from or lending resources to their branch network. More importantly, we test which locations are preferred by bank

executives in periods of funding constraints, which provides insight on the decision-making process of large organizations with a geographically diversified footprint.

The rest of the paper is organized as follows. Section 2 describes the sample and data used in the analysis. Section 3 discusses the empirical framework and results. Finally, section 4 concludes.

2. Sample Selection and Data

This section discusses the sample selection, data, and summary statistics.

2.1. Sample

For our analysis, we focus on the period between 2012Q1 and 2014Q4 and divide the sample into pre- and post-taper periods. Our taper variable takes a value of 1 starting in 2013Q2 when the Federal Reserve's Federal Open Market Committee (FOMC) began publicly discussing plans to scale down its quantitative easing program.

Brazil has 5,565 municipalities, which subdivide the states into smaller administrative entities. Because municipalities split and recombine over time, we collapse municipalities into spatially constant units, which we term "localities." More specifically, we use municipal borders from 1970 and then further combine municipalities that are part of the same urban agglomeration (metropolitan area). Our final sample includes the 2,375 localities that have at least one bank branch, roughly corresponding to individual labor and credit markets.

Currently, approximately one-third of Brazil's nearly 20,000 bank branches belong to federal government banks, approximately one-half to private sector banks, and the remainder to state-government banks. Collectively, state and federal government banks account for approximately 45 percent of total bank assets in Brazil (Barth et al., 2013). Our sample of 28 banks consists of government banks and privately owned domestic and foreign banks. To exclude some smaller and economically unimportant banks that could drive the results, we first trim the sample to include only those banks that make up the top 99 percent of assets

in the banking sector. Without any reporting errors, we would expect internal borrowing and lending between branches to equal one another when aggregating across all branches for a given bank. We exclude a small number of banks that are believed to be inaccurate reporters when the differences in these net positions are nontrivial (greater than 1 percent of consolidated bank assets).

2.2. Data

Due to data limitations, previous research has been unable to provide a robust analysis of intrabank funding and how it is used in times of funding stress. For example, the U.S. Summary of Deposits data include information on branch locations and deposits but do not provide broader balance sheet information at the branch or locality level. We overcome this shortcoming in the literature by using a rich database for Brazilian banks, which includes comprehensive financial statements at various levels of aggregation. We utilize both consolidated bank balance sheets and bank balance sheets disaggregated by municipality, which are published monthly by the Central Bank of Brazil. For our analysis, we collapse the data to quarterly averages. In the context of internal liquidity management, the granularity of the data allows us observe how different branches within a banking network shift deposits between each other in response to an external funding shock or changes in local economic conditions.

Figures 2 and 3 show the relationship between the average net due to position in a given locality for each bank plotted against log per capita income and log total lending. We observe that, for government banks, there does not appear to be a relationship between the income in a given locality and its average net due to position. There is a strong positive relationship, however, between these variables for private banks. This evidence is consistent with bank branches that are located in poorer areas lending money internally to bank branches within the same banking organization in richer areas. Figure 3 shows the strongly positive relationship between the net due to position and bank branch lending. This correlation implies that

internal transfers are related to the lending done by branches.

2.3. Summmary Statistics

Figure 4 shows the Brazilian banking sector credit default swap (CDS) spread. In the period after the Global Financial Crisis period, the U.S. Federal Reserve announced a series of unconventional monetary policies, which increased global liquidity in dollars. The figure reveals that the stress in the Brazilian banking sector increased significantly following the announcement of the decision to taper these unconventional monetary programs established by the Federal Reserve.

Table 1 provides initial statistics summarizing the sample of banks, the associated net due to positions, and the banking structure. The average locality in our sample has nearly three bank branches, of which one-half are owned by government banks and one-half by private banks. Among the private banks, about three-fourths of the branches are owned by domestic banks rather than foreign banks. Banks in Brazil are heavily deposit funded, accounting for over 81 percent of bank branch liabilities, and the average return on assets of each branch is about 5 percent. The average bank branch has intrabank assets that are greater than intrabank liabilities by about 14 percent of total assets. Finally, we note that there is a significant heterogeneity in the level of bank competition across localities.

Tables 2 and 3 show how the average net due to position varies by bank ownership and income level and by bank ownership for the periods before and after the taper tantrum, respectively. On average, government bank branches have intrabank assets that are less than intrabank liabilities by about 11 percent of total bank branch assets in low-income areas and about 14 percent of total bank branch assets in high-income areas. This finding is in stark contrast with private banks, which have significantly negative net due to positions. This observation is consistent with government banks' development story that justifies their existence by giving credit and assisting growth in underserved areas. We also observe changes in the net due to positions in the pre- and post- taper-tantrum period. The average position

for government banks doubled from about 8 percent in the pre-tantrum period to about 15 percent in the post-tantrum period. Foreign banks additionally saw a substantial change in their net due to positions, which went from negative 16 percent to negative 23 percent. Domestic banks declined from negative 37 percent to negative 44 percent.

3. Empirical Framework

This paper aims to understand the effect that bank funding stress has on the intrabank market and how this, in turn, affects local lending and real economic outcomes. To attribute a causal effect, we use the so-called taper tantrum event when markets began to anticipate the Federal Reserve's shift away from accommodative monetary policies. This event can be characterized as an exogenous shock to bank funding conditions in Brazil, as it was mostly related to the economic conditions of the United States. In this section we describe our econometric methodology.

3.1. Internal Liquidity Management

First, we are interested in understanding the effect of this shock on the provision of liquidity within banks' interbranch network. In our analysis, we treat the taper tantrum as an exogenous shock on the ability of banks to access funding in international markets, which may require banks to rely more heavily on their branch networks. To test this relationship, we run the following specification:

$$y_{ijt} = \alpha + \beta_1 Post_t + \beta_2 PostXForeignFunded_{jt} + \beta_3 X_{ijt-1} + \delta_i + \theta_j + \epsilon_{ijt} \qquad (1)$$

where y_{ijt} is the total intrabank activity calculated as
$[intrabank\ liabilities_{ijt} + intrabank\ assets_{ijt}]/[total\ assets_{ijt}]$
or the net due to position calculated as
$[intrabank\ liabilities_{ijt} - intrabank\ assets_{ijt}]/[total\ assets_{ijt}]$.

These measures are reported for bank i in locality j in quarter t. A positive net due to position implies that a bank branch is a net borrower from other bank branches within the banking organization, and a negative position implies that the bank branch is a net lender from other bank branches.

Figure 5 shows the geographical distribution of net borrower and net lender branches across localities for the Bank of Brazil, overlaid on top of the level of income across localities. This network is an example of the heterogeneity that we are using to estimate equation 1 and the subsequent estimations described later. The blue dots represent net borrower branches, while the red dots are net lender branches. The blue background represents areas with low per capita income and the red areas are localities with high per capita income. This simple map shows the heterogenous role that branches play within organizations and how this role may be determined by the characteristics of the location of the branch.

The regressors of interest are $Post_t$, a dummy variable equal to 1 after 2013Q2, and its interaction with $ForeignFunded_{jt}$. These variables capture the effect of the liquidity shock on the internal liquidity positions of banks and the differential effect for those banks that are more reliant on foreign funding, which should experience a larger effect from the shock. A bank is defined as being foreign funded if the share of liabilities that have foreign origin, relative to the total liabilities of the bank, falls in the top third of the distribution for all banks in our sample as of 2011. In alternative specifications, we use an indicator variable for privately owned banks (domestic and foreign) and replace the $Post_t$ indicator variable with the CDS spreads for Brazilian banks.

The regression also includes a vector of branch and parent bank-level controls lagged by one period (X_{ijt-1}). The specification is estimated with bank fixed effects, δ_i and locality fixed effects, θ_j. In all of our estimations in this and the following sections, we cluster at the bank-time level.

The second set of tests is structured to analyze whether executives at banks' corporate headquarters protect or expand in specific locations when resources become scarce. This

behavior is typically labeled winner picking in the corporate finance literature. For example, executives may funnel liquidity to the headquarter location if they need to repay maturing external funding booked at this location or if they assess that projects are better evaluated in the main office. Figure 6 shows the geographic distribution of the headquarters of banks in Brazil. The sample headquarter locations are largely concentrated in Sao Paulo and Brasilia, which may attract more resources in periods of stress.

In general, we test whether banks allocate resources to branches based on the location characteristics and the structure and profitability of the local banking market. For the first set, we use indicators for the headquarters location of the bank, the per capita income of the location, as well as its level of urbanization and its industrial production. We also include an indicator variable equaling 1 if the state has a governor that belongs to the ruling party of the country, in this case the Workers Party, or PT. This indicator would capture whether political connections are a factor in determining the allocation of funds across branches.

For the second set of indicators, we calculate two measures that reflect the structure of the banking market. The first one is an index of bank asset concentration, as measured by the Herfindahl-Hirschman index for branch assets in each location, while the second one is the share of assets of the bank's branches in each location. We also include an indicator of the profitability of the bank's assets in each location, as summarized by the return on assets. Lastly, we include the ratio of provisions to loans, which captures the riskiness of the each branch's loan portfolio. All of these indicators are measured as of 2011, which predates the date of the liquidity shock.

To formally test how banks changed their liquidity management with respect to specific branching locations depending on their characteristics, we estimate the following specification:

$$\begin{aligned} y_{ijt} = \alpha + \beta_1 Post_t + \beta_2 Characteristic_{ij} + \beta_3 PostXCharacteristic_{tij} \\ + \beta_4 X_{ijt-1} + \delta_i + \theta_j + \epsilon_{ijt}, \end{aligned} \tag{2}$$

where y_{ijt} is the net due to position, as calculated above. In these regressions we include bank and locality fixed effects. The coefficients of interest are those associated with $Post_t$, which should capture the change in the net due to position after the taper tantrum. In particular, the interaction term with $Characteristic_{ij}$ provides information on whether banks prefer certain locations to others after the liquidity shock. We estimate this equation separately for private and government-owned banks to assess whether their liquidity management strategies are different. The other controls are as in equation 1.

3.2. Lending

We ultimately aim to test the effect of the liquidity shock on bank lending at the locality level and the role played by internal liquidity management. For this purpose, we proceed in two steps. First, we estimate the sensitivity of branch lending to its net due to position and whether it changed after the shock. Second, we test whether branch lending changed in the areas with larger internal funding movements.

We assess the sensitivity of lending to internal funding by estimating the following equation:

$$\begin{aligned}\Delta y_{ijt} = \alpha + \beta_1 Post_t + \beta_2 \Delta NetDueTo_{ijt} + +\beta_3 PostX\Delta NetDueTo_{ijt} \\ + \beta_4 PrivateX\Delta NetDueTo_{ijt} + \beta_5 PostXPrivateX\Delta NetDueTo_{ijt} \\ + \beta_6 X_{ijt-1} + \delta_i + \theta_j + \epsilon_{ijt},\end{aligned} \tag{3}$$

where y_{ijt} is the natural logarithm of total or retail credit operations for bank i in locality j in time t. The coefficients of interest are related to the change in the net due to position of each branch over time. These terms allow us to assess whether the sensitivity of lending to internal funding changed post-shock and whether it did differentially for private and government-owned banks. Our hypothesis is that bank branches will lend more if their intrabank liabilities are higher ($\beta_2 > 0$), because it is precisely these liabilities that will allow them to continue their credit expansion if they run out of deposits to lend. This effect

could change over time and across banks.

As in the previous equations, we include controls at the bank-by-locality level, at the banking group level, and at the locality level. These controls include the share of deposit funding and the capitalization of the parent bank. Fixed effects at the locality and bank level are also estimated.

In the last test, we explore whether branches most affected by the liquidity shock also adjusted their lending. For this analysis, we estimate a variant of equation 2, where we substitute the dependent variable for the change in lending. We focus on the market structure characteristics as our variables of interest.

4. Results

We first present results that test for banks' changes in internal liquidity management following the taper tantrum. We allow for a differential effect on foreign-funded and domestically funded banks, as foreign-funded banks are more exposed to the United States' financial sector. We also allow for differential effects between private and government-owned banks, as the latter may be able to receive government support in a period of acute financial stress. Besides using a dummy that captures the period at the tantrum, we additionally use the Brazilian bank CDS spread index, which measures the level of financial stress of the Brazilian banking sector at any given moment. We then test whether banks allocated funds to different branches depending on the locations' characteristics. The last set of results looks at the effect of internal liquidity management on lending by bank branches in Brazil.

4.1. Internal Liquidity Management

Table 4 shows the results from estimating equation 1. The dependent variable is the total intrabank position at the branch level, which is regressed on a post- taper-tantrum period dummy ($Post$) and the interaction between $Post$ and a dummy variable for whether the bank is foreign funded, included in the even-numbered columns. The odd numbered columns

alternatively report results using a dummy for a bank being privately owned (instead of government owned), which in subsequent tables we use as our proxy for foreign exposure (most government-owned banks fall in the category of domestically funded).

Column (1) includes bank and locality fixed effects and the following set of bank and bank-location-specific controls lagged by one period: the ratio of deposits to assets for the branch and the group, the log of assets for the branch and the group, the return on assets for the branch and the group, the ratio of liquid assets to total assets for the group, and an indicator variable equal to 1 if the branch is the headquarters location. Standard errors are clustered by bank time.

The results presented in the column show that total intrabank funding increased significantly during the taper tantrum. However, we observe a differential effect when we differentiate foreign-funded or privately owned banks from the rest. Column (2) shows the that foreign funded banks increased the share of total intrabank funding relative to assets in their branches, which is also true for private banks, as shown in column (3). These results are consistent with the hypothesis that internationally exposed banks are more active in managing internal liquidity as foreign funds become scarce.

Instead of using a dummy variable for the taper tantrum to proxy for stress in the Brazilian banking sector, one could instead use a banking sector CDS spread to provide a more contemporaneous measure of stress. The aggregate CDS index is shown in Figure 4 with a vertical line indicating the beginning of the taper tantrum. We see that, following the start of the tantrum, bank CDS spreads increase significantly, suggesting an increase in banking system stress in Brazil.

Columns (4) through (6) present results for the same specification, but using the Brazilian banking sector CDS spread instead of the Post dummy. Again, we find positive and marginally statistically significant coefficients on the CDS spread, implying that as banking system stress increases, banks fund themselves more prominently through internal liquidity management. This effect, however, is again driven by the foreign-funded banks (column (5))

and somewhat weakly through private banks (column (6)).

We repeat the same set of tests using the net due to position of each branch relative to assets as the dependent variable. The results are presented in Table 5. The net due to position allows us to assess the direction of funding, that is, whether each branch is receiving more funding or sending more funds to related offices. As shown in the first three columns, domestically funded and government-owned banks appear to have increased their funding of branches after the liquidity shock. In contrast, foreign-funded and private banks either maintained their net position constants or slightly decreased them. This outcome is still consistent with the previous results, as this group of banks may have actively used their internal market to maintain their net position at the same level as before the shock. The last three columns show similar, although noisier, results as we replace the tantrum dummy with our measure of banks' CDS spreads.

One innovation of this paper is that we are able to observe the net due to position of bank branches at the locality level. This ability allows us to determine the locations where banks are moving funds to and from in times of stress. Are banks moving internal funds from the headquarter location, where they may have been able to obtain funds through capital markets? Are banks moving internal funds from poorer areas with few viable investment opportunities to richer areas with more investment potential?

Table 6 reports results estimated using equation 2, which captures the net due to positions of banks and how they vary by location after the shock. For the remainder of the analysis, we compare private banks with government-owned banks, as the breakdown of these groups represents a cleaner proxy for foreign funding exposures than our constructed measure of foreign funding. However, in an unreported test, we find that the two measures yield the same qualitative results. Panel A shows the results for government-owned banks, while Panel B presents the findings for private banks.

In the set of estimations presented in Table 6, we focus on locality characteristics such as the location of the bank's headquarters and the locality's income, urbanization, and

industrial share. We also analyze whether political connectedness may have played a role in the allocation of resources. A locality is defined as being politically connected if the governor of the state belongs to the same party as that of the national ruling party (the Workers' Party or PT). We do not find any statistically significant evidence that government- or privately owned banks allocated resources differentially based on these measures after the shock. However, the government-owned banks still increased their funding after the shock to locations with higher income and locations that are more urban and politically connected. This finding is more clearly observed using the coefficient on "Post total change" at the bottom of the table and the respective p-values. This calculation is the sum of the coefficient on $Post$ and $PostXInteraction$.

In Table 7, we present results for a similar set of estimations using banking market conditions as our characteristic of interest. As in the previous table, Panel A reports the findings for government-owned banks and Panel B for private banks. Column (1) shows the result of estimating the net due to position as a function of the $Post$ dummy and its interaction with the market characteristic. At the bottom of the table, we show the sum of coefficients for the overall effect of the change in net due to position after the shock for areas that are more concentrated (Post total change). Given that bank concentration is a continuous variable, we evaluate the sum of these coefficients at the mean for the concentration proxy. As the coefficient on the interaction term shows, private banks appear to have directed resources toward more concentrated locations, whereas this variable is not significantly relevant for government banks. However, government-owned banks still significantly increase their funding of branches in areas with average concentration levels, as shown by the sum of coefficients at the bottom of the table.

Columns (2), (3), and (4) reproduce the same exercise using the market share of each branch as measured by assets, the branch-specific return on asset (ROA), and the level of provisions to loans of the branch. The first measure is another indicator of market competition, the ROA captures the branches' profitability, and the provisions measure the riskiness

of the loan portfolio. As noted before, to avoid any endogenous effects, we use the values of these variables as of 2011, before the liquidity shock.

As with concentration, private banks directed more internal funds to locations where they had a larger market share but also were riskier. A similar pattern is observed for the government-owned banks. In addition, these government banks also increased their overall funding to the average performing branches, as captured by the "Post total change" row in the ROA column.

The results on the effect of market structure on liquidity management appear to be consistent between foreign-funded, private banks, and locally funded banks. As liquidity in the system declines, banks appear to direct their resources where there is less competition or where they have a stronger footprint. These actions are likely to guarantee stronger returns, but at the price of an increase in risk, as captured by the findings on provisions.

Our internal liquidity management results suggest the following: first, total intrabank and net due to positions change during times of financial stress, but this increase is driven by specific types of banks, such as those that are foreign funded or government owned. Second, banks tend to allocate internal resources to different locations, depending on the characteristics of the locality, as a result of liquidity shocks. These allocations also depend on the type of bank. Third, the structure and profitability of the banking market is also important for the internal distribution of funds for both private and government-owned banks. These results hold whether we use a dummy for the taper tantrum or the CDS spreads, control for various specifications of fixed effects, or bootstrap standard errors (not shown).

4.2. Lending

The previous section showed how the net due to positions of bank branches changed when bank funding became scarce. This section presents results on the relation between lending and the internal liquidity management of banks and on the effect of the taper tantrum

episode on branch lending. We test whether the winner picking strategy by bank executives actually leads to a change in lending to non-affiliated borrowers.

Table 8 presents the estimates for equation 3, which relates changes in lending to changes in the net due to positions of bank branches. We want to capture the change in the sensitivity of lending to internal funding after the shock for our groups of banks. All specifications include bank and locality fixed effects as well as the control variables described in the previous section. In addition, we include a measure of the capitalization of the bank, namely, the capital-to-asset ratio for the banking group. Standard errors are clustered by bank time.

The first four columns use the change in log total lending as the dependent variable, while the last four use the change in log retail lending. In columns (1) and (5), we show that changes in the net due to position are positively correlated with locality-level lending, which implies that bank branches that are net borrowers are using that money to increase lending beyond what would be possible using only local deposits. Moreover, we find that this dependence on internal liquidity becomes more important during the stress period, as shown by the interaction term between *Post* and the change in the net due to position.

We also find that most of the change in the sensitivity of lending to internal funds is driven by private banks, which are more exposed to international funding markets. This finding is shown in the results presented in columns (2) through (4) and (6) through (8). Although government bank lending does not become more sensitive after the shock (columns (2) and (6)), the sum of the coefficient on $Ch.Netdueto$ and its interaction with *Post* is still positive and significant in both specifications. The results in columns (4) and (8) show that the sensitivity of lending to internal funds is significantly different between private and government banks after the shock.

In sum, we find that banks use internal liquidity management to allocate resources to specific locations where they want to change their lending presence. For private banks, liquidity management allowed them to move funds across branches to distribute their liquidity across the organization, perhaps in an effort to maintain their lending presence. In contrast,

government banks that did not suffer the external funding shock maintained the relationship between internal funds and lending that they had prior to the taper tantrum.

In the last set of tests, we assess whether banks changed their lending in those locations that we determined to have movements in internal funding after the shock. We focus primarily on the effect of banking market characteristics on lending, as was covered in Table 7. We estimate a variant of equation 2 using the change in total lending as the dependent variable. The results are presented in Table 9. We include the same controls as in Table 8, as well as the same estimation technique.

The results show that government-owned banks increased lending differentially after the shock in areas where they had a greater market share. This finding has two interpretations. First, government banks may be optimally searching for profit opportunities in these more concentrated areas and perhaps lending to potentially riskier borrowers. Some of this behavior is partially confirmed by the results in column (4). Government banks appear to have lent more in areas where their branches had higher provisioning, although the coefficients are not statistically significant. Second, although we do not observe a decrease in lending for private banks, government banks could be taking on new borrowers that were not able to access credit from the private banks. In contrast, private banks appear to have increased their lending in less concentrated areas, although they may have used external resources to do so, as the internal funding to these areas did not change.

These findings confirm that management indeed emphasizes certain locations to focus potentially scarce resources. These locations appear to be chosen following a profit motive rather than a different development-focused objective. This observation is particularly relevant for government-owned banks.

5. Conclusion

Using a unique data set that allows us to see the operations of internal bank networks, we analyze how banks utilize their intrabank market to raise funding, e.g., take deposits from

certain locations and transfer them to other branches within their banking group. As far as we know, this study is one of the first that has been able to use bank balance sheets at the city level, which allows us to clearly identify the dynamics of internal bank liquidity provision.

Our internal liquidity management results suggest, first, that internal funding at banks increases during times of financial stress (liquidity shock). This change is driven by those banks most exposed to the liquidity shock. Second, the direction of funds, as captured by the net internal borrowing of branches, differs significantly between domestically funded and government-owned banks, and foreign-funded and private banks. The former group directs more internal funding to their branches, while the latter maintain their funding or slightly decrease it. Third, we find evidence that banks select specific branches to fund in periods of stress. This method is labeled winner picking in the corporate finance literature. Government-owned and private banks allocate resources to areas with more concentrated banking markets, although with riskier borrowers. We do not find any evidence that banks, especially government-owned banks, allocate resources with development objectives or as a result of political connections.

This allocation of resources across the internal branch network has implications for lending. We find that the sensitivity of lending to internal funds is high for private and government-owned banks. However, this sensitivity increases even further for the private banks in the period after the liquidity shock. We also find that, consistent with the liquidity management results, government-owned banks expand their lending in concentrated areas.

Taken together, this paper provides the first branch-level evidence of the way that banks ration liquidity both in normal and in stressful times and the importance of these factors in banks' lending decisions.

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Table 1: Summary Statistics

This table reports summary statistics of the main variables of the analysis, including the composition of banks, bank characteristics, and the banking structure of localities.

	Mean	**Median**	**Stand. Dev.**	**Min.**	**Max.**	**Localities**
By Locality:						
Bank Composition:						
Number of Banks	2.80	2	1.90	1	15	2,375
Government Banks	1.43	1	.88	0	7	2,375
Domestic Banks	1.03	1	.88	0	6	2,375
Foreign Banks	.35	0	.63	0	2	2,375
Total Branches	9.15	2	82.15	1	3,299	2,375
Government Branches	3.99	1	25.73	0	890	2,375
Domestic Branches	3.71	1	40.13	0	1,662	2,375
Foreign Branches	1.46	0	17.83	0	747	2,375
Bank Characteristics:						
Net Due To/Total Assets	-.142	-.144	.34	-.90	.80	2,375
Total Credit/Total Assets	.93	.96	.09	.27	.99	2,375
Net Income/Total Assets	.05	.04	.04	-.15	.28	2,375
Deposits/Total Liabilities	.81	.89	.20	.08	.99	2,375
Banking Structure:						
Herfindahl Index: Deposits	.63	.5	.33	.14	1	2,375
Herfindahl Index: Total Assets	.73	.83	.29	.13	1	2,375

Source: Central Bank of Brazil

Table 2: Statistics by the Localities' Per Capita Income

This table reports summary statistics of the main variables of the analysis, including the composition of banks, bank characteristics, and the banking structure of localities split between localities that are below and above the median per capita income.

Net Due To/Total Assets	**Mean**	**Median**	**Stand. Dev.**	**Bank Locations**
Below Median Per Capita Income:				
All Banks	-.135	-.050	.457	2,802
Government Banks	.107	-.000	.345	1,681
Domestic Banks	-.544	-.629	.314	994
Foreign Banks	-.139	-.176	.418	127
Above Median Per Capita Income:				
All Banks	-.087	-.021	.462	4,018
Government Banks	.137	-.000	.335	1,853
Domestic Banks	-.314	-.478	.506	1,464
Foreign Banks	-.206	-.265	.373	701

Source: Central Bank of Brazil

Table 3: Statistics for the Pre- and Post- Taper-Tantrum Period

This table reports the mean, median, and standard deviation of the net due to position of banks both before the taper tantrum and after. The sample is additionally split between government banks, domestic private banks, and foreign private banks.

Net Due To/Total Assets	**Mean**	**Median**	**Stand. Dev.**	**Bank Locations**
Pre-period:				
All Banks	-.114	-.057	.448	6,656
Government Banks	.078	-.000	.340	3,379
Domestic Banks	-.365	-.509	.467	2,449
Foreign Banks	-.155	-.207	.393	827
Post-period:				
All Banks	-.110	-.018	.478	6,813
Government Banks	.147	-.000	.344	3,533
Domestic Banks	-.441	-.594	.451	2,453
Foreign Banks	-.225	-.309	.387	827

Source: Central Bank of Brazil

Table 4: Total Intrabank Activity

This table estimates equation 1 for the total intrabank activity of a bank (multiplied by 1,000) in a given locality. The regressors are a dummy, *Post*, equal to 1 during the taper tantrum period and interactions of *Post* with a dummy for being foreign funded (column (2)) and with a dummy for being a privately owned bank (column (3)). In columns (4) through (6), we substitute the 5-year CDS spread (expressed as a percent instead of basis points) of the Brazilian banking sector for *Post*. Total intrabank activity at the bank-by-locality level is calculated as 1,000 times intrabank assets plus intrabank liabilities scaled by total assets of that bank in that particular locality. All regressions include lagged controls at both the banking group level and the bank-by-locality level (including total assets, deposit-to-assets ratio, return on assets, and a liquidity ratio) and locality-level controls. All regressions include bank and locality fixed effects and are clustered at the bankXtime level. * denotes statistically significant results at the 10 percent level, ** at the 5 percent level, and *** at the 1 percent level.

	Total Intrabank Activity					
	(1)	(2)	(3)	(4)	(5)	(6)
Post	11.259**	-2.386	-0.619			
	(4.440)	(5.503)	(6.342)			
PostXForeign Funded		25.763***				
		(6.702)				
PostXPrivate Bank			16.581**			
			(7.107)			
CDS Spread				8.820*	-1.749	2.607
				(4.989)	(5.942)	(5.775)
CDSXForeign Funded					25.116**	
					(10.799)	
CDSXPrivate Bank						10.768
						(8.978)
N	75950	75950	75950	75950	75950	75950
Adj. within-R2	0.24	0.24	0.24	0.24	0.24	0.24

Table 5: Net Due to Position of the Branches

This table estimates equation 1 for the net due to position of a bank (multiplied by 1,000) in a given locality. The regressors are a dummy, *Post*, equal to 1 during the taper tantrum period and interactions of *Post* with a dummy for being foreign funded (column (2)) and with a dummy for being a privately-owned bank (column(3)). In columns (4) through (6), we substitute the 5-year CDS spread (expressed as a percent instead of basis points) of the Brazilian banking sector for *Post*. The net due to positions at the bank-by-locality level are calculated as intrabank assets minus intrabank liabilities scaled by total assets of that bank in that particular locality. All regressions include lagged controls at both the banking group level and the bank-by-locality level (including total assets, deposit-to-assets ratio, return on assets, and a liquidity ratio) and locality-level controls. All regressions include bank and locality fixed effects and are clustered at the bankXtime level. *** denotes statistically significant results at the 1 percent level.

	Net Due To Position					
	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.002	0.038***	0.046***			
	(0.012)	(0.013)	(0.017)			
PostXForeign Funded		-0.068***				
		(0.016)				
PostXPrivate Bank			-0.062***			
			(0.017)			
CDS Spread				-0.003	0.026	0.030
				(0.016)	(0.017)	(0.021)
CDSXForeign Funded					-0.069***	
					(0.021)	
CDSXPrivate Bank						-0.058***
						(0.021)
N	75950	75950	75950	75950	75950	75950
Adj. within-R2	0.581	0.584	0.583	0.581	0.583	0.582

Table 6: Net Due to Position of the Branches: Location Characteristics

This table estimates equation 2 for the net due to position of a bank (multiplied by 1,000) in a given locality. The regressors are a dummy, *Post*, equal to 1 during the taper tantrum period and interactions of *Post* with different variables that capture a specific feature of the locality. These locality features include whether a given locality is the bank's headquarters location (column (1)), income per capita (column (2)), urbanization (column (3)), industrial output as a fraction of total output in that locality (column (4)), and whether the locality is politically connected (column (5)). Panel A includes only government banks and Panel B includes only private banks. The net due to positions at the bank-by-locality level are calculated as intrabank assets minus intrabank liabilities scaled by total assets of that bank in that particular locality. All regressions include lagged controls at both the banking group level and the bank-by-locality level (including total assets, deposit-to-assets ratio, return on assets, and a liquidity ratio) and locality-level controls. All regressions include bank and locality fixed effects and are clustered at the bankX-time level. * denotes statistically significant results at the 10 percent level and ** at the 5 percent level.

Panel A: Government Banks

	(1) Headquarters	(2) Income	(3) Urbanization	(4) Industrial	(5) Pol. conn.
Post	0.037**	0.041**	0.038	0.037**	0.038**
	(0.016)	(0.016)	(0.029)	(0.018)	(0.016)
PostXInteraction	-0.023	-0.008	-0.001	0.002	-0.003
	(0.042)	(0.006)	(0.035)	(0.042)	(0.006)
N	38505	38505	38505	38505	38505
Adj. within-R2	0.673	0.673	0.673	0.673	0.673
Post total change	0.015	0.033	0.037	0.039	0.035
p-value	0.744	0.056	0.059	0.313	0.029

Panel B: Private Banks

	(1) Headquarters	(2) Income	(3) Urbanization	(4) Industrial	(5) Pol. conn.
Post	0.015	0.022	0.057*	0.019	0.015
	(0.012)	(0.016)	(0.034)	(0.014)	(0.012)
PostXInteraction	-0.053	-0.010	-0.053	-0.017	0.007
	(0.058)	(0.010)	(0.040)	(0.046)	(0.009)
N	37443	37443	37443	37443	37443
Adj. within-R2	0.548	0.548	0.548	0.548	0.548
Post total change	-0.038	0.012	0.004	0.002	0.022
p-value	0.519	0.290	0.792	0.958	0.165

Table 7: Net Due to Position of the Branches: Market Characteristics

This table estimates equation 2 for the net due to position of a bank (multiplied by 1,000) in a given locality. The regressors are a dummy, *Post*, equal to 1 during the taper tantrum period and interactions of *Post* with different variables that capture market characteristics of the locality. These market characteristics include the concentration of banks in that locality (column (1)), a bank's market share in that locality (column (2)), a bank's profitability in that location (column (3)), and a bank's loan loss provisions in that locality (column (4)). Panel A includes only government banks and Panel B includes only private banks. The net due to positions at the bank-by-locality level are calculated as intrabank assets minus intrabank liabilities scaled by total assets of that bank in that particular locality. All regressions include lagged controls at both the banking group level and the bank-by-locality level (including total assets, deposit-to-assets ratio, return on assets, and a liquidity ratio) and locality-level controls. All regressions include bank and locality fixed effects and are clustered at the bankXtime level. ** denotes statistically significant results at the 5 percent level and *** at the 1 percent level.

Panel A: Government Banks

	(1) Bank Conc.	(2) Mkt. share (assets)	(3) Return on Assets	(4) Provisions/Loans
Post	0.015	-0.005	0.029**	0.032**
	(0.024)	(0.013)	(0.015)	(0.014)
PostXInteraction	0.036	0.006***	0.024	0.137***
	(0.027)	(0.001)	(0.032)	(0.029)
N	38505	36879	36710	36879
Adj. within-R2	0.673	0.704	0.698	0.699
Post total change	0.036	-0.005	0.031	0.036
p-value	0.022	0.701	0.030	0.010

Panel B: Private Banks

	(1) Bank Conc.	(2) Mkt. share (assets)	(3) Return on Assets	(4) Provisions/Loans
Post	-0.012	0.010	0.010	0.016
	(0.018)	(0.014)	(0.011)	(0.012)
PostXInteraction	0.051**	0.003**	0.002	0.038***
	(0.025)	(0.001)	(0.002)	(0.012)
N	37443	37092	32309	37092
Adj. within-R2	0.549	0.558	0.525	0.558
Post total change	0.015	0.010	0.010	0.015
p-value	0.211	0.479	0.367	0.244

Table 8: Sensitivity of Lending to Internal Liquidity Management

This table estimates equation 3 for the change in total and retail lending for branches in different localities. The regressors are the change in the net due to position in each locality; a dummy, *Post*, equal to 1 during the taper tantrum period; and the interaction of *Post* and the change in the net due to position in each locality. The net due to positions at the bank-by-locality level are calculated as intrabank assets minus intrabank liabilities scaled by total assets of that bank in that particular locality. All regressions include lagged controls at both the banking group level and the bank-by-locality level (including total assets, deposit-to-assets ratio, return on assets, a liquidity ratio, and the leverage ratio of the parent) and locality-level controls. All regressions include bank and locality fixed effects and are clustered at the bankXtime level. Columns (1), (4), (5), and (8) include all banks in the sample; columns (2) and (6) include only government banks; and columns (3) and (7) include only private banks. ** denotes statistically significant results at the 5 percent level and *** at the 1 percent level.

	Ch. Lending				Ch. Retail Lending			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ch. Net due to	0.372***	0.414***	0.352***	0.439***	0.238***	0.319***	0.218***	0.320***
	(0.096)	(0.044)	(0.110)	(0.051)	(0.077)	(0.051)	(0.081)	(0.048)
Post	-0.002	0.012	-0.001	0.011	-0.005	-0.000	-0.006	0.004
	(0.007)	(0.008)	(0.006)	(0.008)	(0.009)	(0.013)	(0.008)	(0.011)
PostXCh. Net due to	0.318***	-0.029	0.443***	-0.049	0.193**	-0.012	0.252**	-0.019
	(0.110)	(0.065)	(0.124)	(0.068)	(0.089)	(0.068)	(0.099)	(0.066)
Ch. Net due toXPrivate				-0.086				-0.104
				(0.127)				(0.104)
PostXPrivateXCh. Net due to				0.503***				0.285**
				(0.143)				(0.123)
N	75872	38505	37365	75872	75816	38505	37309	75816
Adj. within-R2	0.187	0.213	0.185	0.195	0.125	0.222	0.103	0.128
Bank sample	All	Government	Private	All	All	Government	Private	All

Table 9: Effect of Market Characteristics on Lending

This table estimates an equation similar to 2, but using the change in total lending for branches in different localities as the dependent variable. The regressors are a dummy, *Post*, equal to 1 during the taper tantrum period and interactions of *Post* with different variables that capture market characteristics of the locality. These market characteristics include the concentration of banks in that locality (column (1)), a bank's market share in that locality (column (2)), a bank's profitability in that location (column (3)), and a bank's loan loss provisions in that locality (column (4)). Panel A includes only government banks and Panel B includes only private banks. All regressions include lagged controls at both the banking group level and the bank-by-locality level (including total assets, deposit-to-assets ratio, return on assets, a liquidity ratio, and the leverage ratio of the parent) and locality-level controls. All regressions include bank and locality fixed effects and are clustered at the bankXtime level. ** denotes statistically significant results at the 5 percent level and *** at the 1 percent level.

Panel A: Government Banks

	(1) Bank Conc.	(2) Mkt. share (assets)	(3) Return on Assets	(4) Provisions/Loans
Post	0.013	-0.001	0.005	0.006
	(0.008)	(0.006)	(0.006)	(0.006)
PostXInteraction	0.001	0.001**	0.011	0.006
	(0.009)	(0.001)	(0.010)	(0.011)
N	38505	36879	36710	36879
Adj. within-R2	0.127	0.058	0.051	0.055
Post total change	0.013	-0.001	0.006	0.006
p-value	0.099	0.847	0.309	0.299

Panel B: Private Banks

	(1) Bank Conc.	(2) Mkt. share (assets)	(3) Return on Assets	(4) Provisions/Loans
Post	0.038***	0.002	0.026***	0.007
	(0.009)	(0.010)	(0.006)	(0.007)
PostXInteraction	-0.058***	0.002	-0.012	0.001
	(0.019)	(0.002)	(0.011)	(0.008)
N	37365	37049	32266	37049
Adj. within-R2	0.040	0.031	0.017	0.030
Post total change	0.008	0.002	0.025	0.007
p-value	0.242	0.820	0.000	0.301

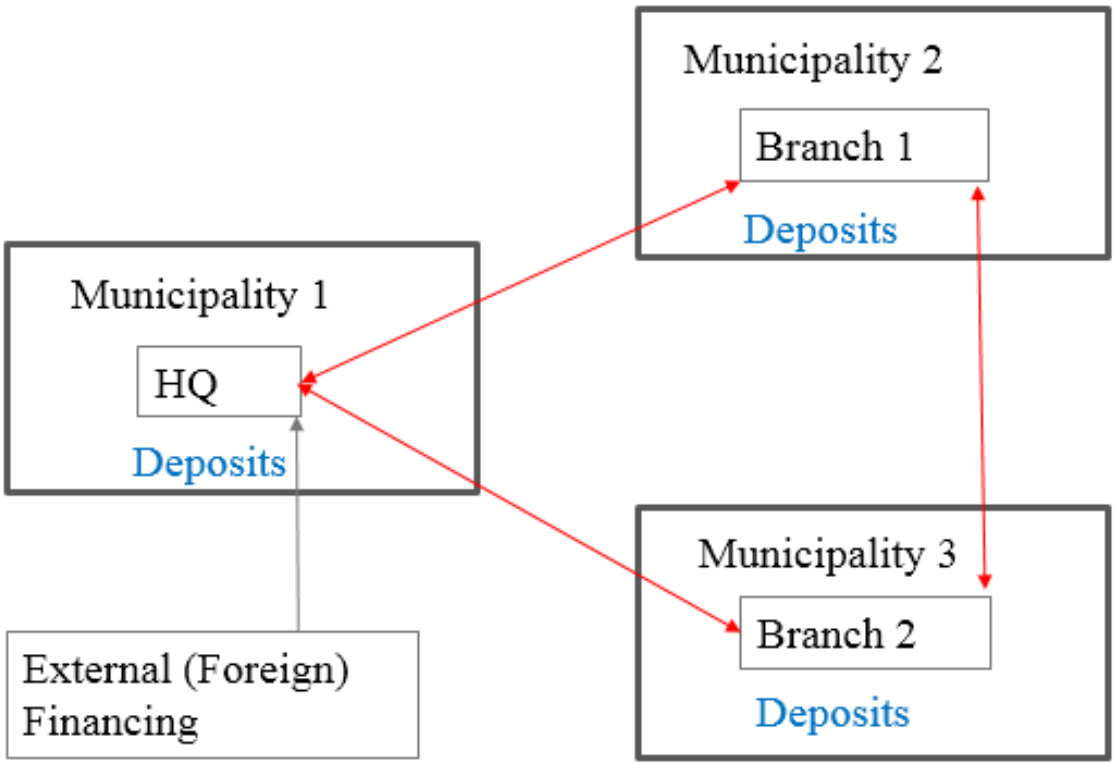


Figure 1: Internal Liquidity Management

Figure 2: Raw Data: Net Due To/Total Assets vs. Per Capita Income

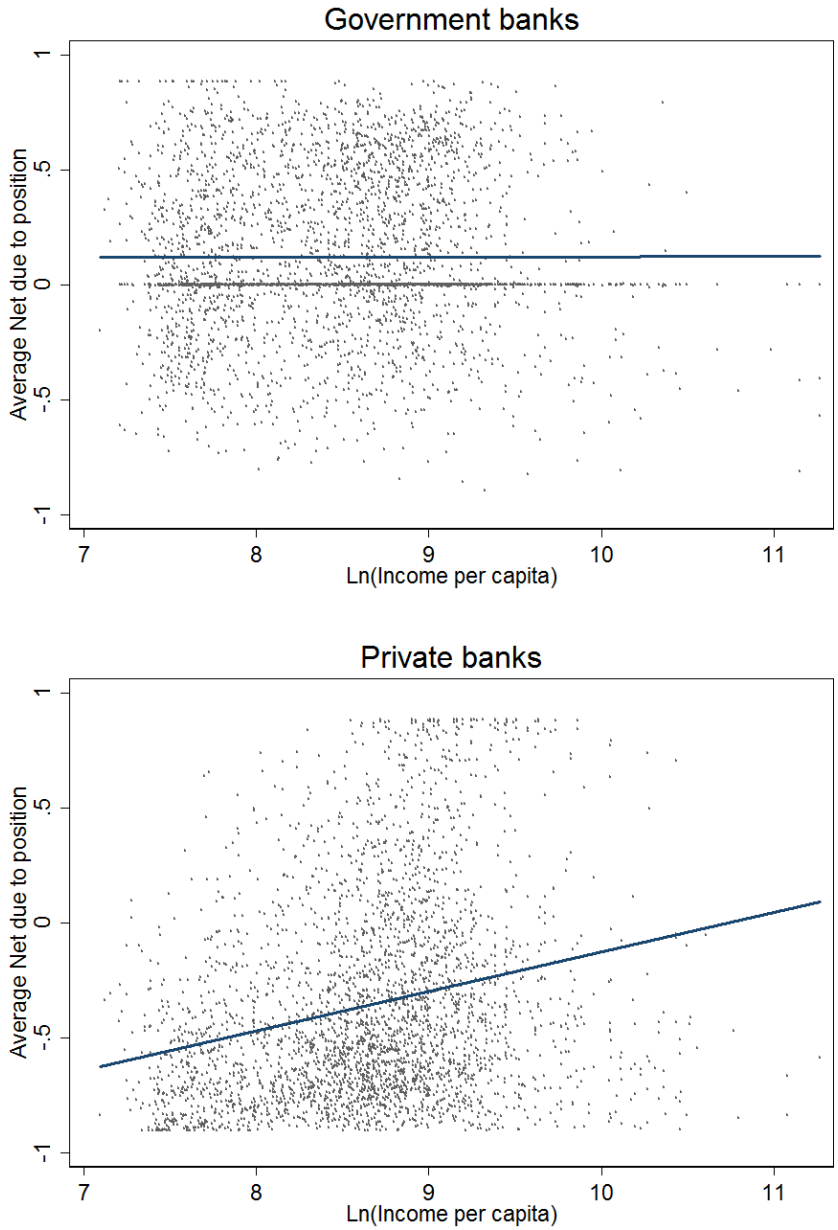


Figure 3: Raw Data: Net Due To/Total Assets vs. Lending

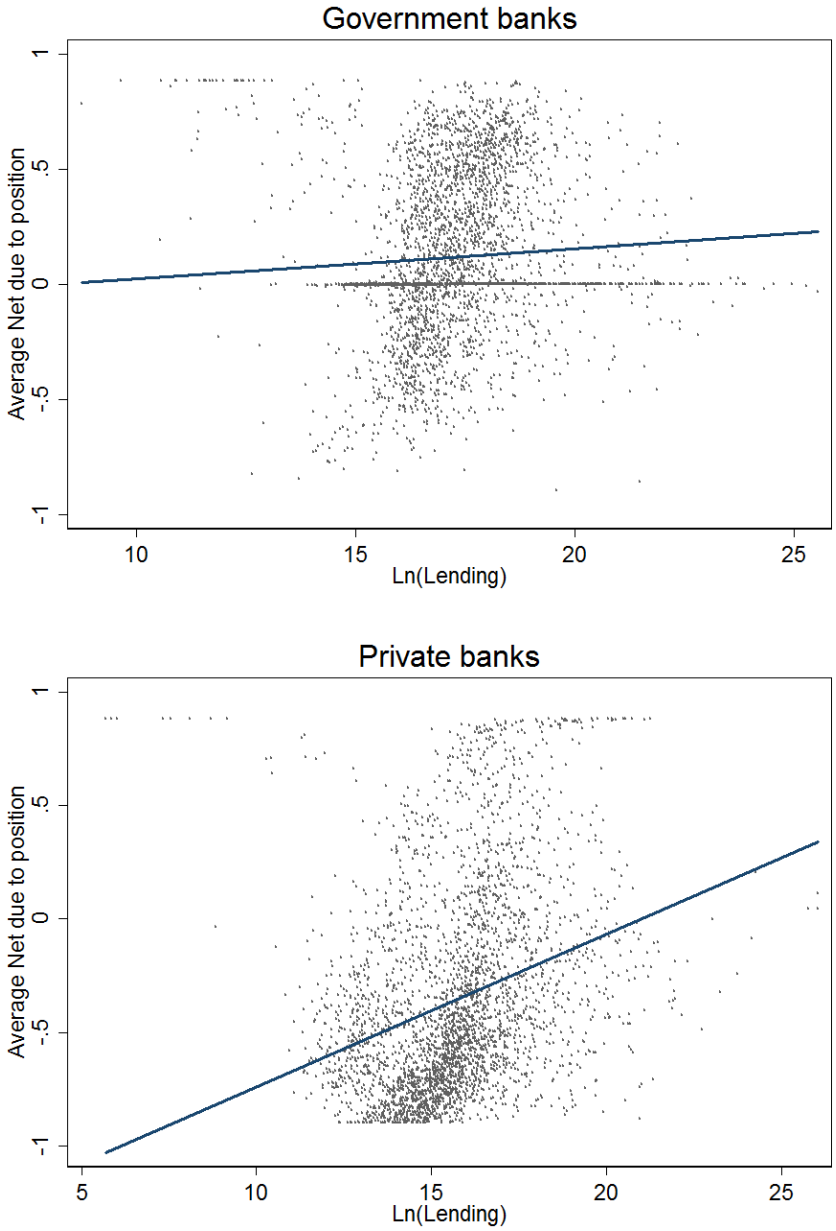
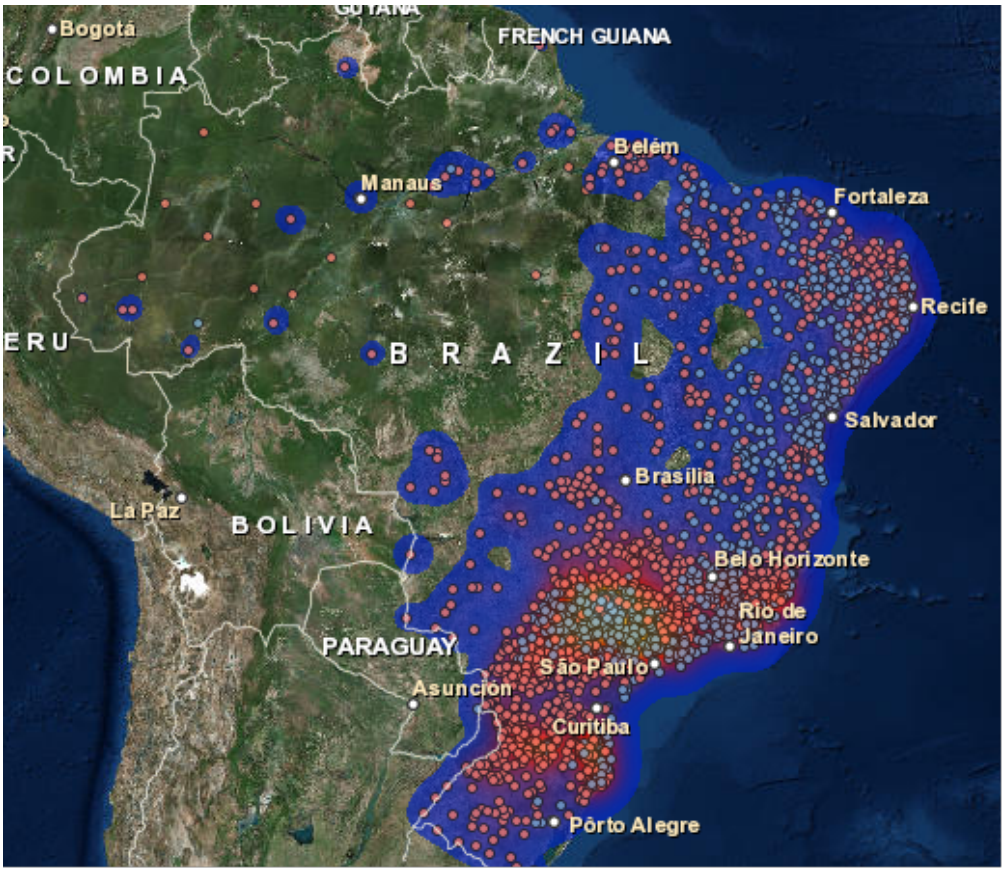


Figure 4: CDS Spreads of Brazilian Banks

Figure 5: Net Lender vs. Borrower Locations of Bank of Brazil Branches



Notes: This map shows which localities are net lenders and which are net borrowers for the Bank of Brazil. The blue dots represent bank branch locations of the Bank of Brazil which are net borrowers within the banking group and the red dots are net lenders within the banking group.

Figure 6: Bank Headquarters

Notes: This map shows the headquarters locations of the banks in our sample.