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Chapter 3

The effect of bank credit supply on house prices: Evidence from Brazil*

3.1 Introduction

National house prices in many OECD countries experienced strong and almost synchronized increases starting in the mid-1990s. The size and duration of the house price increases and the extent to which they have disconnected from the business cycle were unprecedented (Bracke, 2013). In the U.S. and other developed countries this increase took place in an environment of strong financial innovations, insufficient risk management, lack of transparency, poor incentives and increasing leverage (Agnello and Schuknecht, 2011). In the end, the reversal of the uptrend, which in some countries started in 2006-07 and for others is still in course, affected the economic activity and the stability of the financial system.

Despite the impact of changes in house prices on the real economy and the financial system, it is difficult to assess whether increases in house prices are driven by economic fundamentals[1]. The rapid expansion in credit supply is often associated with house price appreciation and subsequent mortgage defaults (e.g. Mian and Sufi, 2009; Mian and Sufi, 2011). However, the causal effect of credit supply on house prices is not easy to establish because credit is not exogenous to the price of houses that are

*This chapter is co-authored with Cees Diks and Marco van der Leij from the University of Amsterdam.

[1]In the absence of frictions, property, like other assets, is priced by discounting expected future cash flows. However, deviations from long-run equilibria are more likely in housing markets than in financial markets because real estate involves non-standardized assets, absence of central trading which implies imperfect information, lack of transparency and high transaction costs in negotiations, and sluggish supply response due to constructions lags and limited land availability (Koetter and Poghosyan, 2010).

used as collateral. Credit also depends on current asset prices and expected economic conditions.

In this chapter, we estimate the effect of changes in credit supply on house prices at different municipalities in Brazil. To deal with the identification problem, we use the regulatory framework that governs the funding for home loans in Brazil as an instrument to identify exogenous increases in the availability of credit. This framework dates back to the 1960s and aims at providing affordable housing for low and middle income households (Araujo et al., 2017). The main source of funding for home loans are savings accounts which earn the same fixed interest rate at all deposit-taking institutions. Banks are required to lend 65% of the amount deposited on savings accounts to home purchase, construction or renovation and to hold 24.5% of the amount as reserve requirements at the central bank[2]. So, the amount deposited in savings accounts and, consequently, funding for home loans are to some extent exogenous to banks. Importantly, although savings deposits are collected in each municipality in which a bank has a branch, there is no requirement to allocate loans to municipalities in proportion to the amount of savings from the locality and banks are free to decide where to lend. So, a positive deposit shock in one locality may propagate to other places through the bank branch network.

We use the differences in the availability of credit to explain the heterogeneous trends of house prices in Brazilian municipalities. To deal with the identification problem, changes in savings deposits of the parent banks at the national level are used as an instrument for credit supply at the municipality level. The key idea of our identification strategy is that changes in savings deposits at the parent banks are based on the average of countrywide economic conditions since we are considering banks with large branch networks. Therefore, changes in savings deposits are exogenous to individual loans and to the conditions of the local economy or local housing markets. We then analyze the impact of credit supply on house prices and loan terms at different municipalities using data on bank branches.

First, we exploit the distribution of branches of distinct banks across municipalities to estimate the impact of changes in savings deposits on local credit supply. The results of the first stage regressions show that changes in savings deposits at the parent bank level have a positive and significant effect on credit supply at municipalities where banks have branches. We base our results on a sample of 409 municipalities that account for more than 80% of bank branches' total assets. These results hold even if we control for several municipality characteristics and locality and quarter fixed effects.

[2]If banks do not lend they must keep the amount deposited at the central bank receiving 80% of the interest rate paid on savings accounts.

In a second step of the analysis, we investigate the effect of the increase in credit supply on house prices in our IV setting. We show that the increase in supply of credit has a significant impact on house price growth. A one percent increase in loan origination leads to a 0.17 percent increase in the growth rate of house prices. The estimates are robust to the inclusion of panel fixed effects and controls for municipality characteristics such as population and income. This result is economically significant and comparable to elasticity estimates found for the U.S. housing market. For instance, Di Maggio and Kermani (2017) estimate that a one percent increase in the credit supply results in 0.33 percent increase in house price growth between 2003 and 2006 while Favara and Imbs (2015) show that a one percent increase in the growth rate of credit results in a 0.12 percent increase in the growth rate of house prices in the U.S..

In addition, we estimate the effect of credit supply on loan terms such as interest rate and loan maturity. We find that a one percent increase in the growth rate of credit supply results in a 0.28 percentage point (p.p.) decrease in the mean spread between loan interest rates and the benchmark rate. We do not find a significant result for the impact of credit supply on loan maturities which may be explained by a prudential limit on the maximum amortization period for loans that are underwritten.

Finally, the regulation in Brazil obliges banks to classify borrowers in accordance to a risk score and to make loan loss provisions based on borrower's level of risk. Using the minimum loan loss provisions that banks make at the moment of loan origination, we investigate whether the expansion of credit supply has led to a relaxation of lending standards. We show that an increase in credit supply is associated with an increase in provisions for loan losses due to an expansion of lending to riskier borrowers. We find that a one percent increase in credit supply growth raises the ratio of loan loss provisions to loans by 0.01 p.p., which is a 0.6% increase compared to the average cross-sectional minimum provisions of 2.05%, over the 2012–2015 period.

This work is related to other studies that examine the consequences of the expansion in credit supply. Adelino et al. (2012) and Favara and Imbs (2015) show that an exogenous expansion in mortgage credit has significant effects on house prices. Rajan and Ramcharan (2015) find that the availability of credit had a direct effect on inflating land prices in the 1920s and contributed to the subsequent surge of bank failures. Di Maggio and Kermani (2017) show that the supply of credit has an effect on the real economy. It is associated with a rise in the house price growth and an expansion of employment in nontradable sectors. On the other hand, Glaeser et al. (2010) find no evidence that changes in mortgage approval rates and down payment requirements can explain the movement in U.S. house prices. The results presented in this work contribute to this debate. We show that changes in credit supply have a significant effect on house price growth in a housing market other than the U.S.. It is worth mentioning that the ratio of housing credit to Brazil's GDP is relatively low by international standards. In this context, easier credit conditions may have a bigger influence on housing prices in a country where households are potentially more credit constrained, as predicted by the model of prime and subprime borrowers of Justiniano et al. (2016), for example.

As a solution to the endogeneity problem, the studies cited above have established the causal effect of credit supply on house prices using instrumental variables to measure changes in credit supply. The usual source of instruments are regulatory changes such as annual changes in the conforming loan limit[3] (Adelino et al., 2012), U.S. preemption rule in 2004 that excluded the application of state anti-predatory lending laws to national banks (Di Maggio and Kermani, 2017), and U.S. bank branching deregulations between 1994 and 2005 (Favara and Imbs, 2015). We present a novel identification strategy based on the regulatory framework that governs housing credit in Brazil. Although this framework is specific to the country, directed lending is a common policy in developing countries that could be exploited to generate exogenous changes in credit supply. See e.g. Paravisini (2008) for the case of Argentina.

This work also contributes to the large literature on credit booms and financial crises. Some papers emphasize the role of reduced credit constraints and easier access to credit to explain the U.S. mortgage default crisis (Mian and Sufi, 2009; Keys et al., 2010) while others focus on the role of expectation formation in the housing markets and its effect on demand and house prices (Bolt et al., 2014; Burnside et al., 2016; Landvoigt, 2016). We show that the increase in credit supply was accompanied by a reduction in the cost of credit and induced an expansion of housing credit to less creditworthy borrowers measured by the increase in the minimum loan loss provisions of banks. However, the data set does not allow us to investigate whether loan defaults in the subsequent months were higher than banks' expected losses.

Finally, market failures provide a rationale for policy intervention. For this reason, subsidized credit to households are a common policy adopted in various countries as a countermeasure for credit constraints in housing markets. In this work, we study the effect of the supply of banking credit on house prices exploiting regulations on lending in an IV setting. We do not make an analysis of the potential welfare gains associated with changes in the policy. Considering the importance of the housing market and its socioeconomic impacts, there may be benefits associated with this policy intended to provide credit to low income and potentially credit constrained borrowers. Nonetheless,

[3]The conforming loan limit (CLL) is a nominal cap set by regulators each year on the size of mortgages that Fannie Mae and Freddie Mac are allowed to purchase or securitize.

we contribute to the debate of the policy design by showing the dependence of the supply of housing credit on savings deposits and its influence on house prices and loan terms at the local level.

The rest of the chapter is structured as follows. In Section 3.2, we provide background information of the regulation related to savings deposits and housing loans. Section 3.3 describes the data employed in the study. In Section 3.4 we discuss the identification strategy and describe the empirical methodology. In Section 3.5 we present the main results and Section 3.6 concludes.

3.2 Institutional Background: Savings Deposits and Home Loans

Savings accounts are the most common investment in Brazil. They are a non taxable, liquid and safe[4] investment, but yield a modest return compared to other interest-bearing deposits. In all depositary institutions savings accounts earn a fixed monthly interest rate of 0.5%[5] if the central bank policy interest rate, known as *Taxa Selic*, is higher than 8.5% per year, and 70% of *Taxa Selic* if the policy rate is equal or lower than this threshold.

In Figure (3.1), we present the real balance of savings deposits and the amounts deposited/withdrawn[6] from January 2007 to December 2016. During this period, the real growth of savings deposits was 89.5%. It is possible to see that after a period of strong growth from 2007 to 2014, the amount deposited in savings accounts have reduced due to the strong economic recession of the years 2015 and 2016. Annibal (2012) investigates the main factors that affect the growth of savings deposits and concludes that the difference between the central bank policy rate and the yield of savings deposit has a negative and significant impact on the growth of deposits. In Appendix 3.A.1, we estimate the effect of macroeconomic variables on the growth of savings deposits using a panel of banks. As expected, we show that the policy rate has a negative while GDP growth has a positive effect on savings deposits.

Despite their modest rate of return, savings deposits are the most usual investment among bank account holders and an important low-cost and stable source of funding

[4]Savings deposits as other deposits are guaranteed by the deposit insurance fund up to the limit of R$250,000.

[5]In addition, savings deposits also earn a small monthly floating rate of roughly 0.05%, known as *Taxa Referencial*.

[6]All monetary values are deflated by the Brazilian consumer price index (*Índice Nacional de Preços ao Consumidor Amplo - IPCA*) and expressed in 2007 Brazilian Real (BRL).

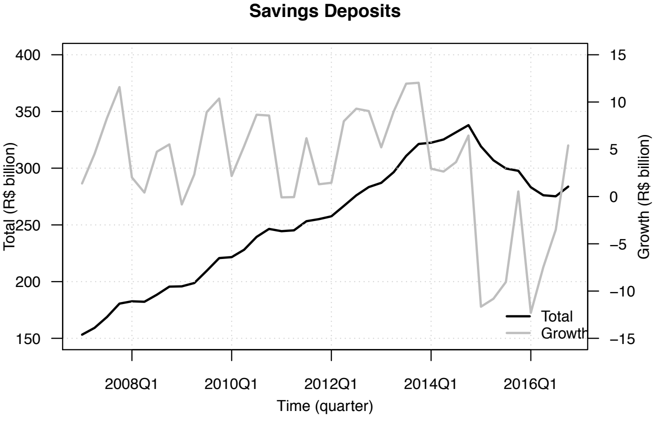

Figure 3.1: Real balance of savings deposits and amount deposited/withdrawn from January 2007 to December 2016.

for Brazilian banks. Their prominence as the main source of funding for home loans is explained by the complex set of rules that governs home loans in Brazil. The aim of the regulation is to support homeownership for low and middle income households. The regulation establishes that 65% of the amount deposited in savings accounts should be lent to home purchase and 24.5% should be kept at the central bank as reserve requirements. To comply with the 65% lending rule, banks can also lend for home renovation or construction or they can purchase or issue securities backed by home loans up to a certain limit[7]. Although banks have some discretionary power in the use of funds, 84.7% the resources earmarked for housing credit were lent for home purchases[8], as of December 2016.

The regulation also establishes that 80% of 65% (= 52%) of the savings deposits balances should be lent under the rules that governs the system called *SFH* (*Sistema Financeiro de Habitação*). *SFH* rules determine the maximum interest rates on loan contracts (approximately 12%) and the amount that can be borrowed based on nominal limits on the price of the property and also on loan to value (LTV) limits. Limits on the property price are set to restrain the use of earmarked credit by high income households. Changes in the property price limits are not frequent and until 2013 the same limit applied for home loans in all Brazilian municipalities. The remaining 20% of 65% (13%) of the savings deposits balances might be lent at interest rates set freely by banks.

[7]Since the securitization market is still evolving, banks retain most of the home loans on their balance sheets.

[8]Statistics of the *SFH*, available at http://www.bcb.gov.br/?SFHESTAT.

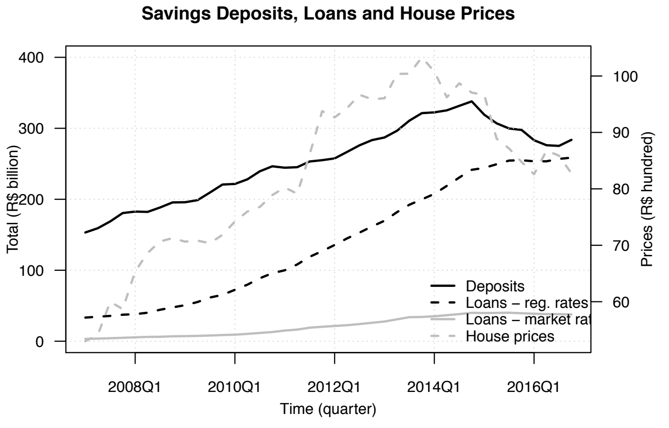

Figure 3.2: Real balance of savings deposits (Deposits), total housing credit at regulated interest rates (Loan - reg. rates) and market interest rates (Loan - market rates) and real median price of houses (House prices), from January 2007 to December 2016.

Due to the regulation, the largest share of resources earmarked for housing credit is lent at regulated interest rates whereas a small part of it is lent at market interest rates. Depending on the borrower's financial condition, regulated interest rates can be lower than the policy interest rate. In Figure (3.2), we show the real balance of savings accounts, the amount lent by commercial banks to households at regulated and market lending rates and the real median price of houses which are used as collateral in home loans. After a period of strong growth, it is possible to see that the economic crisis of 2015-2016 has affected the growth of credit and house prices.

In our regressions, we consider only loans where the funding source is from savings deposits. The other source of funding for housing credit is the unemployment benefit fund (*FGTS*). The *FGTS* fund invests a substantial part of its assets in home loans and credit for developers of housing projects for low-income households. Loans have lower interest rates that are set in accordance to different government housing programs and borrowers' eligibility criteria such as income. Besides, loans of affordable housing programs like *Minha Casa, Minha Vida* are partially funded by the federal government. The fund does not lend directly to households or construction firms but it uses commercial banks, mainly the state-owned bank *Caixa Econômica Federal* (*Caixa*), to conduct its operations[9].

[9]The *FGTS* fund is managed by a council composed of the representatives of workers, employers and the federal government. The bank *Caixa* administer the resources of the fund following the guidelines of the fund's council.

3.3 Data and Summary Statistics

We use four different datasets for our empirical study: balance sheet data of bank branches, consolidated balance sheet data of banks or banking groups, data on home loans and house prices at the municipality level, and municipality socio-economic data. Our sample is from 2012Q1 to 2015Q4. This period encompasses an increase in outstanding loans and house prices followed by a severe economic downturn in 2015.

The balance sheet data of bank branches are provided by the Central Bank of Brazil on a monthly basis (*Estban*). The dataset contains data on the main asset and liability items of the branch's balance sheet. Banks usually have more than one branch per municipality and the data on bank branches are aggregated at the municipality level. The main variables of interest are home loans and savings deposits. We combine the data on bank branches with the balance sheet data of the respective parent bank. Parent bank data are provided on a consolidated basis and refer to individual banks or to banking groups for financial institutions with subsidiaries. Both datasets are publicly available at the Central Bank of Brazil website.

There are approximately 130 banks and banking groups in Brazil, but we select deposit taking institutions with housing credit portfolios. We exclude from the analysis banks that do not lend for home purchases, banks without retail operations, small banks specialized in niche markets, development banks and investment banks. Based on these criteria our sample reduces to six institutions: the five largest banking groups deemed domestic systemically important banks, which have branch networks covering all states of Brazil, and one mid-sized bank with branches restricted to a few states. Despite the reduction in the number of banks, the sample is still relevant since these banks held 83% of the commercial banking assets and 87% of banking deposits, as of December 2016.

In Panel A of Table 3.1 we show some descriptive statistics of the branch network and balance sheet data of parent banks. The sample contains the largest banks in Brazil with very extensive branch networks. The median bank holds more than R$1 trillion in assets and has near 3,500 branches. They operate in all states of Brazil (26 states) and the Federal District and on average in 1,516 of 5,571 municipalities. Credit constitutes on average 39% of total assets and savings deposits, 32.6% of total deposits. The median capital ratio (16.6%) is well above the minimum requirement. In Panel B of Table 3.1 reports summary statistics of balance sheet data of bank branches in December 2015. The data on branches are aggregated at the municipality level and because we are considering banks with extensive branch networks, the variance of the data is large. The median branch holds R$119 million in assets. On average, home

Table 3.1: Summary statistics of bank branch and parent bank variables, as of December 2015.

	Mean	Median	Min	Max	St. Dev.
A. Parent bank data					
Balance sheet					
Total assets (billion $)	980	1,169	68	1,437	515
Credit/Assets (%)	39.0	36.4	30.2	55.5	9.5
Savings dep./Deposits (%)	32.6	31.6	17.8	49.2	11.4
Capital ratio	16.6	16.6	13.5	19.0	2.0
Branch network					
Num. of branches	3,469	3,438	536	5,440	1,818
Num. states of operation	24.2	27	10	27	6.9
Num. municipalities	1,516	1,387	383	2,930	964
B. Bank branch data					
Total assets (million $)	1,434.6	119.8	4.6	726,393	17,999
Home loans/Assets (%)	10.4	4.5	0.0	68.0	11.7
Savings dep./Liabilities (%)	22.1	18.6	0.1	96.0	14.0

loans represent 10.4% of total assets and savings deposits represent 22.1% of total liabilities of the branch.

In Figure (3.3) we show the distribution of bank branches across municipalities in Brazil. The presence of bank branches in municipalities varies significantly. Most of branches are located in southeastern states and in state capitals. Due to their low economic development, the majority of municipalities without bank branches are located in the northern and northeastern states.

The source of data on house prices and home loans of banks at the municipality level is the Credit Information System (*SCR*) which is the credit register managed by the Central Bank of Brazil. Financial institutions must report detailed information of all loans above a certain threshold. They report data on individual loans including loan value, price of the house (collateral), interest rate, maturity and location of the lender (municipality). Data also include the risk score assigned by lenders[10] to each loan ranging from AA (less risk), A to H (default). We use the data aggregated at the municipality level and restrict our analysis to home loans originated by banks. The participation of other financial institutions such as housing finance companies is negligible, since housing loans in Brazil are almost entirely originated by banks.

In Table 3.2 we present the descriptive statistics of loans aggregated by municipality

[10]Financial institutions make loan loss provisions for the expected losses in accordance to this score and other borrower/loan characteristics.

Table 3.2: Summary statistics of loans originated from 2012Q1 to 2015Q4, aggregated by municipality.

	Mean	Median	25%	75%	St. Dev.
Loan ($ thousand)	189.0	183.4	155.4	215.2	57.5
House price ($ thousand)	228.2	220.0	181.3	262.5	72.9
Interest rate (%)	9.01	8.98	8.60	9.45	0.77
Maturity (years)	26.93	27.69	24.84	29.41	3.44
Minimum loan loss prov. (%)	2.05	1.68	1.25	2.27	1.77

and originated from 2012Q1 to 2015Q4. The value of the average loan is R$189,000 and the average price of the house is R$228,200, which means a loan to value of 0.83. The average interest rate is 9.01% and loan maturity is 26.9 years.

The primary political and administrative division of the Brazilian states is the municipality. In Brazil there are 5,571 municipalities and 3,582 of them have at least one bank branch[11], as of December 2015. Although we restrict our analysis to municipalities served by bank branches, we observe a large number of localities where new housing loan originations are very low. Hence, to reduce the variance of estimates in localities with low loan originations we consider only municipalities which accounted for at least 0.025% of loan originations during the 2012–2015 period. Based on this threshold, the sample reduces to 409 municipalities which in aggregate are responsible for 87.4% of the origination of home loans [12], as of December 2015.

We use some socio-economic data such as population, income per capita and the value-added in industry and services as share of GDP of the municipality to control for local characteristics in the regressions. The data are provide by the Brazilian Institute of Geography and Statistics (*IBGE*) on a yearly basis. In Table 3.3, we present some descriptive statistics of these variables. In Panel A, we show the sample of all municipalities and in Panel B, we show the sample of selected municipalities where loan originations are higher than the 0.025% threshold. It is possible to see that these municipalities are more populated (median population is 132,000) and more economically developed. The median income per capita is R$30,690 and the value added in industry and services as share of GDP is 80.9%.

[11]Although near 2,000 municipalities do not have a bank branch, statistics of the Central Bank of Brazil show that all municipalities have access to financial services through banking service outposts, ATMs, or "banking correspondents", which are partnerships between retail agents and commercial banks to deliver services in localities without bank branches.

[12]These municipalities account for 58.9% of the Brazilian population and 74.2% of the GDP, as of 2015.

Table 3.3: Summary statistics of municipality variables in 2015Q4.

	Mean	Median	Min	Max	St. Dev.
A. All municipalities					
Population (thousand)	36.8	11.5	.8	11,970	215.9
Income per capita($)	21,180	15,940	3,657	557,100	21,303
Value-added (% GDP)	46.9	42.0	5.4	97.6	20.3
B. Selected municipalities					
Population (thousand)	294.4	132.1	19.2	11,970	747.4
Income per capita($)	36,220	30,690	6,602	300,700	26,144
Value-added (% GDP)	78.9	80.9	45.7	96.2	9.8

3.4 Methodology

The growth of house prices across municipalities exhibits substantial heterogeneity (see e.g. Ferreira and Gyourko, 2012). This local heterogeneity in house prices may be correlated with both demand and supply factors such as credit supply, local income, demographics, new housing supply and construction costs. In this work we investigate whether the dispersion in house prices could be explained by differences in credit supply.

However, we cannot consistently estimate the parameters of the regression since credit supply is not exogenous to home prices. To solve the problem of not having consistent least squares estimators, we apply the method of instrumental variables. Our aim is to find an additional variable that is correlated with credit supply (relevance condition) but is not correlated with the disturbances (exogeneity condition). The identification strategy relies on the banking regulation that earmarks 65% of the amount deposited in savings accounts for home loans and the fact the growth of savings deposits is to some extent exogenous to banks as interest rates on deposits are not set by depositary institutions and, consequently, deposits growth depends mainly on the macroeconomic conditions. So, we use the change in savings deposits at the parent bank level as instrument for the supply of credit at the municipality level.

We identify savings deposits as a variable correlated with changes in the municipality's credit supply but not otherwise associated with the local housing market. The correlation between savings deposits and local housing markets is a concern since to have a valid instrument, savings deposits at the parent bank level should not be related to local factors that also affect the price of houses in municipalities where the banks' branches are located. To minimize the possibility that total savings deposits at a bank are driven by the economy of one or a few municipalities, we consider only banks with extensive branch networks. For banks in this category, savings deposits aggregated at the municipality level account on average for only 0.1% (s.d. = 0.6%) of the savings deposits of the respective parent bank. It is unlikely that changes in savings deposits at the parent bank are related to the conditions of the local economy or the local housing market, since they are based on the average of countrywide economic conditions.

Intuitively, the regressions compare changes in the price of houses located in municipalities that have branches of distinct banks. We observe that when a large bank establishes in one municipality it almost does not exit. For this reason, the distribution of bank branches across municipalities is quite stable over time. From 2012 to 2015, the number of banks in 392 municipalities, or 96% of the sample of 409 localities, remained the same. There was an increase of one bank in 16 municipalities while in one locality there was a reduction. These 17 municipalities are less economic developed and the exclusion of them from the sample does not affect our results. Hence, to the extent that savings deposits generate exogenous variation in the supply of credit, the estimated differences in the growth of house prices can be plausibly attributed to differences in credit supply.

Specifically, the instrument is obtained by aggregating total savings deposits of all banks located at municipality j

$$Dep_{jt} = \sum_{i \in S_{jt}} DepBank_{it} \,,$$

where S_{jt} is the set of banks with branches at municipality j in quarter t, $DepBank_{it}$ is the total savings deposits of the parent bank i, and Dep_{jt} is the sum of the total savings deposits of all banks with branches at municipality j. The parameters of the regressions are estimated by 2SLS as follows

$$Y_{jt} = \alpha \Delta \widehat{ln\, Loan}_{jt} + \mathbf{X}_{jt}\boldsymbol{\beta} + \lambda_t + \nu_j + \epsilon_{jt} \tag{3.1}$$

$$\Delta ln\, Loan_{jt} = \gamma \Delta ln\, Dep_{j,t-1} + \mathbf{X}_{jt}\boldsymbol{\delta} + \zeta_t + \eta_j + \varepsilon_{jt} \,, \tag{3.2}$$

where Y_{jt} represents the dependent variable which is the change in house prices, loan terms, or loan loss provisions. $\Delta ln\, Loan_{jt}$ is growth of new loans originated by bank branches located at municipality j, $\Delta \widehat{ln\, Loan}_{jt}$ is the prediction associated with the first-stage regression, and $\Delta ln\, Dep_{j,t-1}$ is the lag of the growth of the sum of total savings deposits of banks with branches at municipality j. We include a set of municipality control variables $\mathbf{X}_{jt}$. The coefficient of interest is α, which measures the effect of changes in credit supply instrumented by changes in savings deposits on the dependent variable, after controlling for municipality specific characteristics.

We estimate the regressions with loan originations and savings deposits in first differences to eliminate the heterogeneous trends in the variables of interest. We regress loan originations on the lag of savings deposits to account for the time that banks take to approve new loans. We include municipality fixed effects (ν_j) to control for unobserved, time invariant characteristics of municipalities and quarter fixed effects (λ_t) to control for time-varying conditions such as macroeconomic or seasonal factors that affect the entire cross section of localities in any given quarter.

In our first empirical test we show that our instrument, the change in savings deposits, has a positive and significant effect on credit supply at municipalities where banks have branches. We then proceed to estimate the effect of credit supply on the growth rate of house prices. We also evaluate the effect of credit supply on loan terms such as interest rates and maturities. Finally, based on the risk assessment of borrowers we also investigate whether the expansion in the supply of credit led to a relaxation of lending standards.

3.5 Results

3.5.1 The effect of saving deposits on credit supply (First Stage)

This section estimates the effect of the growth of saving deposits on the supply of credit at the municipality level during the 2012Q1 - 2015Q4 period. We show that our instrumental variable – savings deposits – has a significant impact on loan originations.

We perform tests of both underidentification and weak identification for the relevance of the instrument. The underidentification test checks whether the equation is identified and the rejection of the null means that the instruments are correlated with the endogenous regressors (Hall et al., 1996). The weak identification test checks whether the instruments are only weakly correlated with the endogenous regressors (Stock and Yogo, 2002). The Anderson–Rubin test of identification strongly reject that the model is underidentified and the F statistic of the weak identification test, which takes values above the conventional threshold for a strong instrument, provide evidence of the relevance of savings deposits as an instrument for credit supply.

Table 3.4 presents the results of the first stage regression (Equation 3.2). Column (1) reports the fixed effects (FE) estimates and in Column (2) we add municipality control variables to account for the difference in the observable characteristics of localities. In Column (3), we report the pooled OLS estimates for comparison. The municipality control variables[13] are the following: log of population ($ln\, Pop_{jt}$), log of income per capita ($ln\, Income_{jt}$), value added in industry and services as share of GDP ($ValueAdded_{jt}$), and the ratio of total assets of bank branches (excluding housing credit) located at the municipality to its population ($AssetsPop_{jt}$). These variables control for municipality heterogeneity that may affect the local housing market.

Table 3.4: First stage regressions of the effect of savings deposits on credit supply.
The table shows the effect of changes in savings deposits of banks on housing loans measured at the municipality level. The dependent variable is changes in credit originations at municipality j in quarter i ($\Delta lnLoan_{it}$). The regressions include municipality control variables and quarter and municipality fixed effects. The sample is from 2012Q1 to 2015Q4. The table reports robust standard errors, clustered at the municipality level (in parentheses). *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)
$\Delta lnDep_{t-1}$	0.265***	0.265***	0.309***
	(0.028)	(0.028)	(0.026)
$ln\, Pop_t$		-1.386***	0.079***
		(0.404)	(0.019)
$ln\, Income_t$		-0.025	-0.090***
		(0.079)	(0.019)
$ValueAdded_t$		-0.578	0.292**
		(0.468)	(0.115)
$AssetsPop_t$		-0.029	0.003
		(0.024)	(0.009)
Munic. FE	Y	Y	N
Quarter FE	Y	Y	N
Observations	5704	5704	5704
R^2	0.346	0.347	0.059

The estimated α is positive and significant – Columns (1) and (2) – which indicates that the increase in savings deposits affects credit supply in municipalities where banks have branches. The inclusion of municipality control variables does not affect the estimate of the effect of savings deposits growth on loan origination ($\alpha = 0.265, s.e. = 0.028$) and the coefficient remains statistically significant. Thus, a one percent increase in the growth rate of banks' savings deposits results in a 0.27 percent increase in the growth rate of loan origination at the local level. Column (3) shows the OLS estimates

[13] The municipality control variables are provided on a yearly basis and to get the quarterly frequency we interpolate the yearly values.

without the inclusion of municipality and quarter fixed effects. The estimated α is significant and slightly higher that the FE estimates.

The results show that elasticity estimates are rather stable even not controlling for unobserved heterogeneity that might bias the results. As expected, the increase in credit supply at the local level are correlated to the increase in savings deposits of parent banks.

3.5.2 The effect of credit supply on house prices

In this section, we investigate the effect of the increase in credit supply on house prices using as instrument the changes in total savings deposits of banks. House prices are measured by the median value of all houses sold that were financed by banks in one particular locality. Since we do not have data on home characteristics, it is not possible to control for attributes that affects home value as it is done in a hedonic regression model (see e.g. Autor et al., 2014). Nonetheless, considering that median values are calculated over the universe of loans to individuals that are secured by residential properties, we expect that they reflect houses' current market price and price trends in the municipality. Besides, since the sample contains all home loans originated in one municipality, it is more probable that quarterly changes in the median price of houses reflect local housing market conditions than a shift in the quality of houses in the market or in the composition of buyers.

We exploit the variation in lending by different banks across municipalities to infer the effect on the price of houses that were pledged as collateral for new loans. In Equation (3.1), we estimate the effect of changes in credit supply on the median house prices and the dependent variable ($\Delta ln\, HousePrice_{jt}$) is the house price growth at municipality j in quarter t.

Columns (1) and (2) of Table 3.5 report the results of our instrumental variables analysis. The IV coefficients on changes in housing loans are positive and statistically significant. We find that a one percent increase in housing loan growth results in 0.17% increase in the growth rate of house prices. In Column (3), we show the results for the OLS estimation. Although the OLS results cannot rule out a reverse relationship, in which high house prices attract more housing credit, the coefficient is positive, statistically significant, and smaller than its IV counterparts. Overall, we find that credit supply always has a positive effect on house prices, even after controlling for reverse causality and for local heterogeneity.

Table 3.5: IV and OLS estimates of the effect of the growth of credit supply on median house price.
The table shows the effect of changes in housing loans on house prices at the municipality level, instrumented by savings deposits. The dependent variables is the growth of median house price at municipality j in quarter i ($\Delta ln\, HousePrice_{jt}$). The regressions include municipality control variables and quarter and municipality fixed effects. The sample is from 2012Q1 to 2015Q4. The table reports robust standard errors, clustered at the municipality level (in parentheses). *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	IV (1)	IV (2)	OLS (3)
$\Delta lnLoan_t$	0.173**	0.173**	0.097***
	(0.084)	(0.084)	(0.008)
$ln\, Pop_t$		0.284	-0.002
		(0.364)	(0.316)
$ln\, Income_t$		-0.054	-0.066
		(0.065)	(0.062)
$ValueAdded_t$		0.646	0.797**
		(0.423)	(0.400)
$AssetsPop_t$		0.011	0.008
		(0.025)	(0.025)
Munic. FE	Y	Y	Y
Quarter FE	Y	Y	Y
Observations	5707	5707	6120
R^2	0.077	0.069	0.085

3.5.3 The effect of credit supply on loan terms

This section investigates whether the expansion in credit related to the growth of savings deposits affects loan terms such as contractual interest rate and loan maturity. We estimate Equation (3.1) where the dependent variable Y_{jt} is alternatively the weighted mean spread between the loan interest rate and the risk-free rate in percentage points (p.p.) or the log of the weighted mean loan maturity in days[14], originated by branches of banks located at municipality j. We expect that in municipalities where the credit supply increases more, banks will impose loan contractual terms that are more favorable to borrowers. Therefore, we expect to see a reduction in interest rates and an

[14] The risk-free rate used to compute the spread is the benchmark interbank deposit rate, known as *CDI*. The mean spread and mean maturity are weighted by the amount borrowed and calculated for each municipality.

increase in loan maturities.

Table 3.6 reports the 2SLS and OLS estimates of Equation (3.1). The increase in the supply of credit has a negative and significant effect on the interest rate spread (Column 1). The inclusion of bank and control variables has only a slight effect on the estimated coefficients (Column 2). We find that an increase of one percent in loan origination growth results in a 0.28 percent point decrease in the interest rate spread of the new loans. The estimated effect of changes in loans not instrumented by savings deposits on the interest rate spread is not significant (Column 3).

The impact on the maturity of contracts due to an increase in home loans is less clear. The coefficient of the three specifications (Columns (4) to (6)) are positive but not statistically significant. One possible explanation is that even though banks have increased lending during the period of analysis, they have not extended the maturity of contracts above the limit of 30 to 35 years, which seems to be a prudent underwriting practice given the borrowers' capacity to service their debt obligations.

3.5.4 The effect of credit supply on risk taking

The banking regulation in Brazil determines that financial institutions must classify all credit operations in the following levels of risk: AA (less risky), A, B, C, D, E, F, G, and H (default)[15]. In accordance to these nine levels of risk banks must make loan loss provisions to cover expected losses of at least 0%, 0.5%, 1%, 3%, 10%, 30%, 50%, 70%, and 100% of the amount lent, respectively. For instance, the minimum loan loss provision for an A-rated loan is 0.5%. The risk assessment of the loan is made at the moment of the origination and should be reviewed frequently based on the loan and borrower characteristics.

In this section, we investigate whether the expansion in the supply of credit has led to a relaxation of lending standards. Based on loan's risk scores assigned at the moment of the origination, we investigate whether banks have lent to risky borrowers due to a credit expansion. Banks have their internal risk rating system to rate loans/borrowers and our assumption is that the models for the risk assessment of credit operations were kept constant over the period of analysis. Hence, in our regression an increase in minimum loan loss provisions is attributed to an expansion of credit to risky borrowers and not to a change in the procedures or models for the assessment of borrowers.

In order to obtain our estimates, letters that represent the risk scores attributed to loans were converted to loan loss provisions based on the minimum provision determined by the regulation. The loan loss provisions of new loans serve as a measure

[15] *Resolução nº 2682, de 21 de dezembro de 1999.*

of the level of risk that the bank is willing to accept with respect to housing credit. Therefore, we estimate Equation (3.1) where the depended variable is the change in the ratio of loan loss provisions to new loans originated by bank branches located at municipality j. The coefficient α measures whether banks in municipalities where credit supply increased more have lent to lower rated borrowers.

Table 3.6 presents the results of the estimates. Column (7) and Column (8) show the IV estimates of the regression of the changes in loan loss provisions on the changes in housing loans. As in our previous results, the elasticity estimates are remarkably stable to the inclusion of municipality control variables. We show that an increase in loan origination by one percent increases the ratio of loan loss provisions to loans by 0.013 percentage points, or by 0.6% of the average cross-sectional loan loss provisions (2.05%, *s.d.*=1.78). This result suggests that banks increased provisions for loan losses due to an increase in loans to riskier borrowers. Column (9) shows the OLS estimates for comparison. In that case, the coefficient on the effect of credit supply on loan loss provisions is not statistically significant.

Taken together, our results show that the increase in credit supply is associated with a reduction in the cost of credit and an expansion of credit to less creditworthy borrowers. However, the data set does not allow us to investigate whether bank losses were higher than expected in the following months.

3.6 Conclusion

This chapter exploits the regulatory framework that governs housing lending in Brazil to estimate the effect of the supply of credit on house prices. In order to identify exogenous changes in the supply of credit, we develop a novel identification strategy in which changes in savings deposits of parent banks are used as an instrument for changes in credit supply at the local level. First, we show that our instrumental variable – savings deposits – has a significant impact on loan originations. Then, we show that an increase in loan origination leads to an increase in the growth rate of house prices based on a sample of 409 municipalities. The increase in credit supply is also associated with a reduction in the cost of credit measured by the spread of contractual loan rates and an increase in bank loan loss provisions due to an expansion of credit to less creditworthy borrowers.

Considering the importance of the housing sector to maintain economic activity and to preserve the stability of the financial system, proper monitoring of house prices is essential to policymakers. We show that credit supply has real effects on house prices and on bank loan loss provisions. Besides, as the core of the regulations dates back to the 1960s, it has been subjected to some updates since then. Recently, banks were allowed to issue covered bonds aim at promoting other sources of funding for home loans and some requirements imposed on banks about the use of savings deposits were excluded. We do not make an analysis of the home lending policy, but our results may have policy implications. We show the dependence of the supply of housing credit on savings deposits and its influence on house price growth and on the cost of credit.

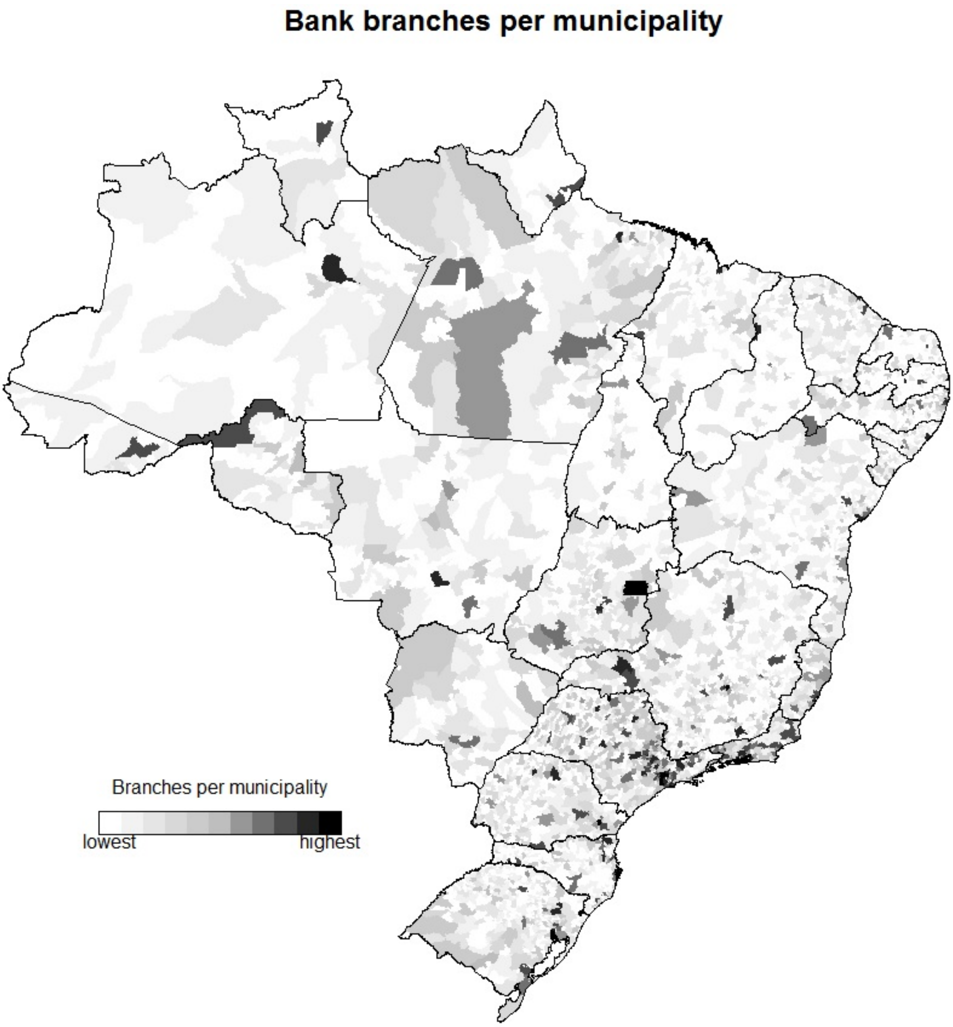

Figure 3.3: Map of Brazil divided by municipalities of the 26 states and the federal district, showing the number of bank branches per municipality, as of December 2015.

Table 3.6: IV and OLS estimates of the effect of the growth of credit supply on loan terms and loan loss provisions. The table shows the effect of changes in housing loans on loan terms and loan loss provisions at the municipality level, instrumented by savings deposits. The dependent variables are the changes in interest rate spreads ($\Delta Spread_{jt}$), loan maturities ($\Delta lnMaturity_{jt}$), and minimum loan loss provisions ($\Delta Provision_{jt}$). The regressions include municipality control variables and quarter and municipality fixed effects. The sample is from 2012Q1 to 2015Q4. The table reports robust standard errors, clustered at the municipality level (in parentheses). *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	$\Delta Spread_t$			$\Delta lnMaturity_t$			$\Delta lnProvision_t$		
	IV	IV	OLS	IV	IV	OLS	IV	IV	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta lnLoan_t$	-0.279**	-0.280**	0.006	0.009	0.009	0.011	0.013**	0.013**	0.001
	(0.123)	(0.123)	(0.038)	(0.030)	(0.030)	(0.007)	(0.006)	(0.006)	(0.001)
$ln\,Pop_t$		0.602	0.461		0.024	0.110		-0.021	-0.053**
		(0.766)	(0.461)		(0.189)	(0.128)		(0.028)	(0.021)
$ln\,Income_t$		-0.044	-0.021		0.011	-0.019		-0.006	-0.006*
		(0.147)	(0.082)		(0.036)	(0.021)		(0.005)	(0.003)
$ValueAdded_t$		0.754	0.594		-0.054	0.137		0.035	-0.009
		(0.857)	(0.482)		(0.211)	(0.132)		(0.032)	(0.022)
$AssetsPop_t$		0.045	0.046		-0.002	-0.005		0.001	0.000
		(0.065)	(0.029)		(0.016)	(0.004)		(0.002)	(0.000)
Munic. FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	5704	5704	6118	5704	5704	6118	5704	5704	6120
R^2	0.533	0.533	0.594	0.057	0.057	0.058	0.021	0.013	0.014

3.A Appendix

3.A.1 The growth of savings deposits

To see how the growth of savings deposits is affected by macroeconomic variables, we estimate the following dynamic panel data model

$$\Delta ln\, Dep_{it} = \sum_{j=1}^{p} \alpha_j \Delta ln\, Dep_{i,t-j} + \mathbf{X}_{it}\boldsymbol{\beta} + \nu_i + \epsilon_{it}, \tag{3.3}$$

where $\Delta ln\, Dep_{it}$ is the change of bank i's savings deposits balance, $\mathbf{X}_{it}$ is a $1 \times k$ vector of macroeconomic variables such as GDP growth, inflation and central bank policy rate, and $\boldsymbol{\beta}$ is a $k \times 1$ vector of parameters to be estimated. The sample is from 2007Q1 to 2016Q4 and we consider only deposit-taking institutions with housing credit portfolios.

The GMM estimates are presented in Table 3.7. Columns (1) and (2) report the estimated coefficients of the regression including only the past changes in deposits and quarterly dummies to account for the apparent seasonal increase in deposits in year's ends. In Columns (3) to (9), we add macroeconomic variables to Equation (3.3). The standard Hansen test does not reject the null of joint validity of the instruments and the Arellano-Bond test indicates no serial correlation of the residuals.

Savings accounts are often used as a substitute to non interest-bearing demand deposits. Therefore, the increase in interest rates reduces the attractiveness of savings deposits as an investment option which may explain the negative and statistically significant effect of interest rates on savings deposits in all regressions. As expected, the increase in GPD has a positive and significant impact on deposits, but the effect of inflation is not statistically significant.

Table 3.7: The effect of macroeconomic conditions the growth of savings deposits.
The table presents the results of the GMM estimates examining the impact of macroeconomic variables on the changes in savings deposits. The dependent variable is the changes in savings deposits of bank i in month t ($\Delta lnDep_{it}$). Explanatory variables are interest rates ($Int.Rate_t$), GDP growth (ΔGDP_t), and inflation (ΔCPI_t). The sample is from 2007Q1 to 2016Q4. AR(2) test is the *p*-value of the Arellano-Bond test for second-order autocorrelation in the first-differenced errors and Hansen test is the *p*-value of the test for the exogeneity of the instruments. The table reports robust standard errors (in parentheses). *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta lnDep_{t-1}$	0.144*	0.281***	0.196***	0.242***	0.258***	0.188***	0.192***	0.234***	0.188***
	(0.077)	(0.057)	(0.047)	(0.051)	(0.036)	(0.051)	(0.042)	(0.041)	(0.047)
$\Delta lnDep_{t-2}$		0.125*	0.087	0.108	0.114*	0.083	0.084	0.104	0.083
		(0.066)	(0.082)	(0.070)	(0.068)	(0.082)	(0.082)	(0.071)	(0.081)
$Int.\ Rate_t$			-0.069***			-0.060***	-0.064***		-0.057***
			(0.022)			(0.020)	(0.017)		(0.016)
ΔGDP_t				0.645***		0.302**		0.535***	0.262
				(0.221)		(0.149)		(0.177)	(0.164)
ΔCPI_t					-1.227		-0.502	-0.739	-0.324
					(0.766)		(0.668)	(0.782)	(0.710)
Quarter dummy	Y	Y	Y	Y	Y	Y	Y	Y	Y
AR(2) test	0.232	0.515	0.627	0.690	0.412	0.891	0.622	0.926	0.836
Hansen test	0.960	0.951	0.961	0.900	0.875	0.930	0.930	0.95	0.93
Observations	194	186	186	186	186	186	186	186	186