

# Loan-To-Value Policy and Housing Loans: effects on constrained borrowers

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# Loan-To-Value Policy and Housing Loans: effects on constrained borrowers<sup>\*</sup>

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## Abstract

This paper explores the effects on constrained borrowers of an LTV limit implemented on September 2013 on two segments of housing loans that constitute the bulk of housing loan originations in Brazil. LTV limits and related policies entail identification challenges, since constrained individuals are no longer directly observed after the regulation. We use comprehensive credit register information of individual housing loans augmented with a detailed, granular employment register. We focus on the average treatment effect on the treated borrowers, defined as the ones that would violate the LTV limit if allowed to do so. Partially observed treatment status is overcome by the use of an adjusted difference-in-difference method. In the housing loan segment that was subject to a sudden increase in demand due to broader eligibility rules, constrained individuals borrow housing loans with higher interest rates, shortened maturities, and, as expected, reduced loan amounts and LTV. These borrowers also purchase more affordable homes and are less likely to be in arrears 12 months in the future. In the other housing loan segment, subject to more stringent eligibility criteria, constrained borrowers also meet the LTV threshold, but the resulting contract terms stay roughly the same.

**Keywords:** LTV, loan-to-value ratio, mortgage, credit register, housing loans, macroprudential policy

**JEL Classification:** G21, G28

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## 1. Introduction

Macroprudential policies related to the housing sector represent a relevant share of the macroprudential tools used in several jurisdictions (Jacome and Mitra, 2015). One of the most common policies targeting the housing sector is imposing loan-to-value (LTV) limits for housing loans. The higher equity stake and lower leverage required by these policies are designed to increase borrower resilience and to lower bank losses during downturns. These expected effects of the policy are consistent with theoretical models (e.g. Campbell and Cocco (2003)) and empirical evidence (e.g. Demyanyk and Van Hemert (2011)). However, there are important transmission channels of LTV limits at the borrower level not well explored in the literature, including the impact on delinquencies and on contract terms at loan origination<sup>1</sup>.

We argue that imposing LTV limits may endogenously shift several characteristics of the loan contract and therefore influence borrower behavior. Indeed, financial intermediaries may change loan terms in response to the policy, i.e. loan amounts, maturity and interest rates. As a result, otherwise highly leveraged households may settle with different loan terms, housing alternatives and repayment incentives. In fact, the impact of LTV limits on housing loan origination and repayment outcomes can vary across different borrower segments.

This paper contributes to the literature by focusing exactly on these changes in contract terms and in borrower behavior after the imposition of an LTV limit. In all cases, we focus on the effect of the policy on the subset of borrowers that are constrained by the policy, that is, the average treatment effect on the treated (ATT). However, the estimation of this effect requires a novel identification. In our setting, it is natural to define constrained borrowers as the ones that would violate the LTV limit if allowed to do so. However, this creates a difficulty, since treatment status is observed only before the policy limit is imposed. In principle, one could use data from the period before the policy to estimate the propensity of borrowers being constrained and somehow use this information to recover the ATT parameter. Indeed, Botosaru and Gutierrez (2016) show this intuition is correct, proposing consistent and efficient estimators for the case of partially observed

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<sup>1</sup> Regarding delinquencies, Campbell et al. (2015) is an exception to the statement, although they consider risk weights conditional on LTV, while we consider hard LTV limits - which requires a considerable departure in the methodology.

treatment status. This paper uses their estimator to recover the ATT effect of LTV limits on contractual terms and borrower behavior.

The empirical contribution of the paper, building on this identification strategy, is the estimation of how contract terms and borrower behavior respond to a new regulation establishing an LTV cap of 90% for housing loans in Brazil in September, 2013. We consider two segments of housing loans and conduct independent estimation for each segment. The “SFH” segment, comprising mostly middle class borrowers, is the one addressed in the original regulation. The LTV limit is also contemporaneously adopted by the “FGTS” segment, a collection of housing loans directed to low- and middle-income households. The main difference between both segments is the eligibility criteria, based on different house price ceilings and on borrower characteristics, so each segment concentrates very different borrowers. In addition to the LTV limit, the same regulation established more stringent underwriting procedures for all housing loans and, eased the eligibility criteria for the SFH segment. The repetition of the experiment in two independent segments offers a rare opportunity to compare the estimated effects.

We use a unique borrower-level dataset from the Brazilian supervisory credit register with loan contract information and loan repayment history for all housing loans originated in the period. We merge this data with the official employment register to augment the set of individual borrower control variables, such as wage, job type, years of education etc. The wage is not only a highly significant predictor of treatment status in both segments, but is also crucial for identifying the parameters of interest. The dataset has over 1.3 million loans spanning a three-year period around this policy change, although we restrict the empirical analysis to subsets of this data to ensure the validity of some assumption necessary for identification.

We find evidence suggesting that treated borrowers in the SFH segment purchase more affordable houses, default less, and settle with housing loan contracts with less favorable terms, that is, higher interest rates and lower maturity. Reproducing the estimation procedure in the FGTS segment, treated borrowers obtain loan terms that are fairly similar to old characteristics, while also coping with the new LTV limit. These results document microeconomic effects of macroprudential policy.

The policy measures in Brazil and our empirical approach are relevant to several similar policies adopted elsewhere. Indeed, most countries have some form of explicit or implicit LTV limit (Cerutti et al. (2015)). Yet, the international experience is

heterogeneous (Darbar and Wu (2015)). Some jurisdictions implement simple, hard LTV limit as in Brazil in September 13; others combine LTV limits to complementary policies such as taxation and capital requirements; others still apply differentiated LTV limits by price buckets or geographical region. The methodology developed here for hard LTV limits can be adapted to other regulatory events by defining proper segments or isolating segments not affected by complementary policies<sup>2</sup>.

This quantity of policy interventions motivates a growing empirical literature that accommodates different approaches. A large part of the literature investigates the aggregate impact of LTV policies. For example, Igan and Kang (2011) find that the tightening of the LTV cap in South Korea results in lower transaction activity and lower price increases. Funke and Paetz (2012) find a small effect of LTV policy on housing prices, and a more lasting one in indebtedness. Similar results hold for other macroprudential measures (e.g. Akinci and Olmstead-Rumsey (2015)).

The empirical literature most closely related to this paper considers the impact of regulation on mortgage risk. Demyanyk and Van Hemert (2011) show high-LTV loans originated in the run-up to the US subprime crisis were more likely to be delinquent during the bust. Hallissey et al. (2014) document the same effect in Ireland, where mortgages with higher LTV and loan-to-income (LTI) ratios at origination are more likely to be in arrears in the future. Campbell et al. (2015) show that risk weights conditional on LTV in India affect loan delinquencies. Although these results suggest that a hard LTV limit would reduce mortgage risk, there is no evidence, as explored in this paper, of actual effects on delinquencies of policy-induced hard LTV limits, much less on house choice and loan contract terms.

In summary, our main contribution to the literature is estimating borrower-level shifts in contract terms and borrower behavior resulting from LTV limit, along with the proposed empirical methodology to overcome the lack of observable treatment status when limits are binding. The estimated effects on delinquencies are in line with the priors suggested by the theoretical and empirical literature linking LTV with mortgage risk.

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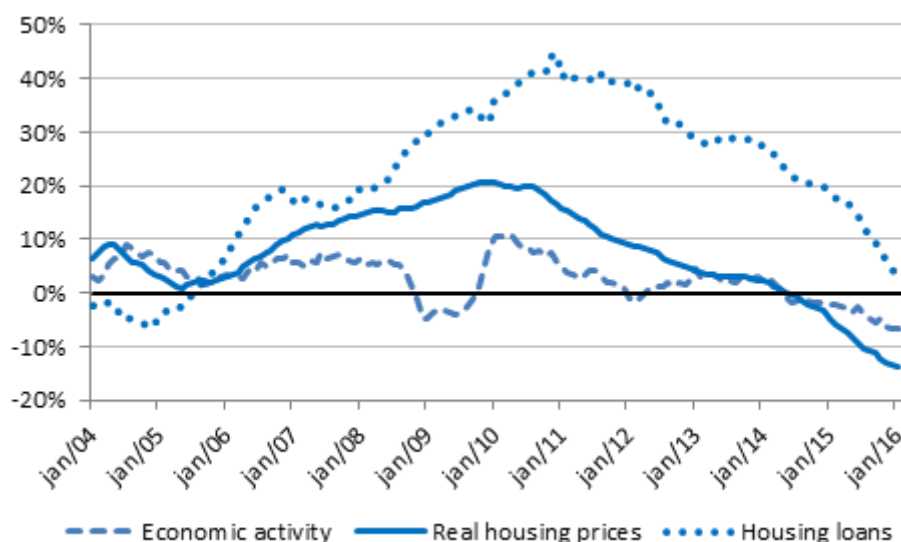
<sup>2</sup> For example, in our empirical exercise, the LTV limit came with changes in eligibility criteria, so we selected a subsample of our data not affected by that contemporaneous policy change. See below.

## 2. A Primer on Housing Finance in Brazil

According to Cerutti et al. (2015), Brazil is one of the few jurisdictions that experienced a credit boom in the aftermath of the financial crisis. This cycle arguably started around 2004, with lower macroeconomic uncertainty and the “Great Moderation” occurring in other relevant trade partners. In the housing sector, legal changes that improved time to repossession in case of foreclosure provided additional momentum to housing loans and prices from the lows of the previous years.

As a result, housing finance in Brazil grew significantly since 2001, from less than 1% of GDP to 7% in 2013, while delinquency rates decreased from 7% to 1.6% between 2004 and 2013. Pereira da Silva and Harris (2012) largely attribute this development to the legal improvements that promoted faster repossession processes, reducing the previously high loss-given-default for lenders and helped unlock the supply of housing loans. Figure 1 shows GDP growth, housing credit growth and real housing prices in Brazil to illustrate these developments, and highlights some relevant events.

Figure 1 - Economic activity, housing loans, and housing prices in Brazil, 2004-2015. All series are real annual growth rates.



The banking regulator responded to these developments by requiring lenders to follow stricter borrower monitoring processes for all housing loans, as well as by implementing an LTV limit to a particular segment of the mortgage market. Before



detailing this LTV regulation, we highlight the most important features of housing finance in Brazil.

The main lender in the housing loan market is the government-owned Caixa Econômica Federal (henceforth CEF), with a large but declining market share of 74.0% as of December 2015. CEF is widely considered to be specialized in housing loans, and has wide geographical coverage in Brazil. Other large banks in Brazil (Itaú, BB, Santander and Bradesco) are also important lenders, representing together 23.3% of the mortgage market. These other banks have a more universal bank profile, and have only recently began to allocate shares of their credit portfolios into housing loans. In Brazil, not only are the major lenders domestically-owned (the largest exception, Santander, has a 5.2% market share), but virtually all borrowers are domestic residents, and the loans are all denominated in local currency.

Housing loans in Brazil enjoy significant subsidy, which varies according to the funding source and borrower characteristics. Interest rates are subsidized, subject to borrowers meeting eligibility criteria for the particular subsidy. The most relevant segment is “SFH”<sup>3</sup>. In this case, deposit-taking institutions are required to channel a specific percentage of the amount deposited as savings accounts and invest it in SFH loans. These savings accounts are widely-spread retail deposit contracts that yield exactly the same rate independently of the lender<sup>4</sup>. We call the second group “FGTS”<sup>5</sup>, because it is a collection of various segments which share broadly similar funding and eligibility characteristics, regulated by the FGTS rulemaking body, CCFGTS. The FGTS group has less stringent rules in terms of debt service to income (DSTI) and LTV, and also lower interest rates than SFH, but unlike the SFH, the borrower must meet a maximum income limit. These credit segments were historically designed to foster homeownership to certain social strata, such as workers or low-to-middle classes. The most recognizable example of FGTS-segment credit lines are the Minha Casa Minha Vida (MCMV) housing loans, which comprise operations with different characteristics aimed at tackling housing deficit in Brazil. FGTS loans provide borrowers with substantially more subsidies than the SFH, particularly in terms of lower interest rates. More generally, SFH loans are designed for middle-income households, whereas FGTS loans caters to the same public

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<sup>3</sup> Portuguese acronym for National Housing System.

<sup>4</sup> This rate varies over time to reflect the general level of interest rates, but is the same for all banks. Also, note that SFH operates using only financial institutions as intermediaries.

<sup>5</sup> Portuguese acronym for Workers’ Severance Fund.

(subject to more strict criteria), but also includes programs targeted to low-income borrowers. Homes that are more expensive than the SFH price eligibility cap are financed by non-subsidized, less regulated contracts generally known as SFI<sup>6</sup>.

International readers may benefit from a parallel with the U.S. mortgage market. Unlike the U.S. case, government presence in the market for housing loans is through complete or partial ownership of lenders, and not by loan insurance or stimulus for secondary markets. Other important differences between CEF and both Fannie Mae and Freddie Mac is that the former lender is subject to the same prudential supervision and regulation by the BCB as other lenders and actually competes with them for clients, while the latter institutions are regulated by the Federal Housing Finance Agency and have a unique role in the U.S. mortgage market. Therefore, CEF is not directly comparable to Fannie Mae or Freddie Mac. SFH and “FGTS” loans are somewhat comparable to conforming agency loans in the U.S., which require a minimum level of documentation from borrowers and also impose other eligibility criteria. Some housing loan programs that we consider within the FGTS segment are more comparable to FHA loans, since they are directed towards lower-income households that satisfy a number of criteria. SFI loans, which finance homes priced above the maximum SFH price limit, are also funded (partially) with savings accounts proceeds, and follow broadly similar credit risk checks, which would render them comparable to jumbo loans.

The most relevant difference between the Brazilian and the U.S. housing loan market is the funding structure, much less flexible in the former than in the latter case<sup>7</sup>. In Brazil, a specific percentage of all proceeds invested in savings accounts (which also have regulated rates that are independent of the deposit-taking institution;<sup>8</sup>) are automatically required to be directed to SFH loans. The FGTS segment loans, on the other hand, are funded by specific FGTS programs, the supply and characteristics of which are ultimately defined by the government through a complex set of legal and infra-legal norms.

The regulated (subsidized) interest rates applicable to the SFH and FGTS loans are often lower than the yield of sovereign bonds, providing a significant incentive for households to borrow in either segment, if eligible. SFH loans are available to prospective borrowers of their first house and that are not homeowners in the same city. They are

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<sup>6</sup> In this third segment, the number of SFI operations reaches a few thousands representing a tiny share of the housing finance. SFI is still partially subsidized by savings accounts.

<sup>7</sup> The reader must take into account the interest rate term structure in Brazil vis-à-vis the U.S. The Brazilian risk-free rate proxy, Selic, is historically higher than interest rates applicable to housing loans in all maturities.

<sup>8</sup> See Annibal (2012) for more information about savings accounts in Brazil

expected to borrow for residential purposes, and the house price must respect a maximum eligibility ceiling. This ceiling changes over time to accommodate changes in house prices, and in this particular event the eligibility cap was the subject of pressure from society entities representing the public and the housing sector, due to increasing housing prices. In fact, the same regulation that enacted the LTV limit for all SFH housing loans also increased the eligibility price limit up to R\$ 750,000 from R\$ 500,000<sup>9</sup>. As a reference, these values represent 32.8 and 21.9 times the median national income in the twelve months ending in September, 2013.

The vast majority of new SFH housing loans are non-recourse, compensated with a faster repossession process in case of default. Traditionally most housing loans follow a constant amortization schedule<sup>10</sup>. Unlike other jurisdictions, housing loans are not backed by governmental agencies, and interest rates are not deductible for tax purposes. Notice that the nature of the subsidy is on interest rates. Funds are (forcedly) redirected from savings accounts or provided by FGTS funds, but credit risk is carried by the banks operating these lines. In the case of SFH loans, banks (either private or public) are able to set a spread over the subsidized interest rate. In practice, the interest rates of SFH loans lay between their funding cost (i.e., the yield on savings accounts, which is approximately 6%) and the maximum rate allowed in the credit segment (approximately 12%)<sup>11</sup>. The SFH credit segment also allows workers with formal private-sector employment contracts to frontload social contributions made by their employers as down payment<sup>12</sup>.

The only housing loan segment that could offer competitive terms to the SFH is the FGTS segment. Although specific rules vary, these subsidized loans can be summarized by even lower interest rates than the SFH and stricter eligibility criteria: the maximum house price is considerably lower, and borrowers are also required to meet a

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<sup>9</sup> The new limit is R\$ 650,000 for the 23 States other than Distrito Federal, Minas Gerais, Rio de Janeiro or São Paulo.

<sup>10</sup> The LTV limit that we study, 90%, is valid for loans with this amortization schedule. Other amortization schedules, which are less prudent, were limited to a maximum of 80%. The relevance of these loans is not considered material for the period of our analyses.

<sup>11</sup> In practice, there is also a variable rate (*Taxa de referência*, or TR) that is equally added to both savings and SFH housing loan rates.

<sup>12</sup> This social contribution is a linear function of the wage earned, and is deposited by the employer in employee-specific accounts at the FGTS. These FGTS funds are used to fund temporary unemployment benefits, disaster reliefs, retirement, and other well-defined occasions where the individual worker may need to withdraw her previous savings (including as down payment for SFH housing loans). In addition to this person-specific uses, the FGTS also supports a variety of subsidies for the “FGTS” housing loan segment, large infrastructure investments, etc. The granular data we use enables us to control for factors that may influence the marginal propensity to compensate for more down payment requirements: the employment register of each borrower has the employment type (government or private sector), wage, and tenure at current employment. Borrowers without formal jobs are identified by exclusion.

wage cap. Borrowers that are not eligible for either segment – due to the price of the desired home, or willingness to finance a second unit, for example – have the outside option of a regular housing loan with market interest rates, the SFI. Overall, borrowers are strictly better by opting for the SFH loan if they are eligible, unless they are also eligible to FGTS loans.

### *LTV limit*

In the context of the growth in housing price and housing credit in the country, the National Monetary Council (CMN)<sup>13</sup>, introduced Resolution n. 4,271/2013 (CMN, 2013; henceforth “Resolution”) in September, 2013. The Resolution required that SFH loans with the widely-used constant amortization schedule have a maximum LTV of 90% (the limit is more conservative for other amortization schedules, at 80%). Home equity lines of credit also were limited to a 60% LTV. Segments other than the SFH are not addressed by the regulation and not mandated to comply with the LTV limit of 90%. However, the CCFGTS – the council that regulates the FGTS – has decided to incorporate this LTV limit from the SFH into its regulation with immediate effect<sup>14</sup>. Figure 2 illustrates the distribution of LTVs of new housing loans originated before the LTV regulation (January 2012 to September 2013) and after the regulation (until December 2014). Considering this fact, and the significance of the FGTS segment, we also incorporate this segment in our analyses.

Finally, it is important to highlight that the new regulation was unexpected to market participants. A simple, intuitive exercise illustrate that there was no frontloading of housing loans ahead of the policy action: the correlation between the relevance of high-LTV loans and the increase in number of originations in each of the 27 Brazilian states is very close to zero or even negative, depending on the time frame used. It is also important to note that, unlike other jurisdictions, regulators have not used hard LTV limits in Brazil.

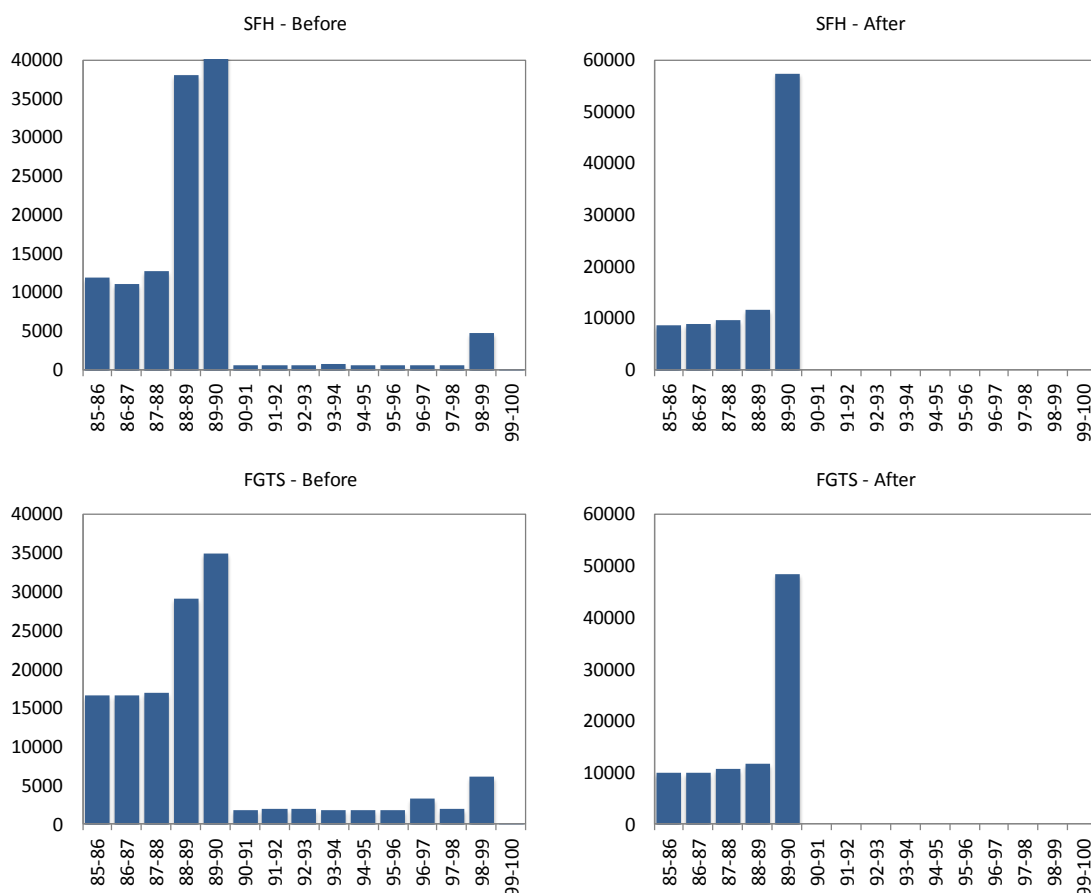
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<sup>13</sup> The CMN is the main regulator of the financial system. The three members of the CMN are the Minister of Finance (Chairman), the Minister of Planning, Budget, and Management, and the Governor of the Central Bank of Brazil.

<sup>14</sup> The CCFGTS is a council composed of the many different stakeholders in the FGTS, including a representative of the BCB. The proposal to incorporate the maximum LTV rule of 90% came from the representative of the Ministry of Cities (who is also the deputy chairperson of the CCFGTS), not from the BCB representative. Moreover, the decision to establish the same LTV limits as the SFH can be traced directly to the prudential limit established by the CMN Resolution, as can be seen in the CCFGTS meetings minutes.

Moreover, prior regulation strongly favored regulatory capital measures using risk weights (e.g. as a function of LTV or maturity for auto loans)<sup>15</sup>.

Figure 2. Frequency of new housing loans by LTV ranges.



In addition to the LTV limit for the SFH segment, the Resolution required lenders to follow sound underwriting practices in line with the FSB Principles for Sound Residential Mortgage Underwriting Practices (FSB, 2012) for all housing loan segments (FGTS, SFH or SFI).

<sup>15</sup> For example, see Martins and Schechtman (2013) and Afanasieff et al. (2015) for background and estimates for the impact of shifts in risk weights in auto loans made conditionally on loan maturity.

### 3. Methodology

This section presents the identification strategy. We follow Botosaru and Gutierrez (2016) very closely and refer to their paper for proofs and further conceptual elaboration on the particular differences-in-difference estimator adopted in this paper.

We define treated borrowers as the ones that would violate the LTV limit if allowed to do so. We consider two periods  $t \in \{0,1\}$  representing a set of months before the policy and after the policy, respectively. Each borrower has two potential outcomes:  $Y_t(1)$  if exposed to treatment and  $Y_t(0)$  if not exposed. The outcomes in our empirical application will refer to borrower repayment behavior 12 months in the future or loan contract terms, such as the LTV itself, loan amount, interest rate, maturity, and house price.

Notice that we can observe the treatment status of the borrowers before the macroprudential regulation. Indeed, treated borrowers have LTV greater than the limit (90% in our empirical application). However, after the policy shock, we can no longer distinguish constrained borrowers based on contract characteristics, since would-be high LTV borrowers that effectively enter loan contracts are now constrained into lower LTV outcomes. The methodology by Botosaru and Gutierrez (2015) is particularly designed for similar cases, where the treatment status is partially available.

Let then  $D \in \{0,1\}$  represent treatment status, which is, therefore, observed only for  $t = 0$ . The parameter of interest is the average treatment effect on the treated (ATT), defined by  $ATT \equiv E(Y_1(1) - Y_1(0)|D = 1)$ . If treatment status were observed in both periods, under usual identifying assumptions, the parameter would be identified by  $\theta \equiv [E(Y_1|D = 1) - E(Y_0|D = 1)] - [E(Y_1|D = 0) - E(Y_0|D = 0)]$  and one could use the sample analog of the expression for estimation and inference.

To be clear, the usual assumptions we refer to are (A1) parallel paths for treated and control group and (A2) no anticipation of the policy change. Our empirical strategy to ensure that both trends are parallel is to compare treated borrowers with non-treated borrowers with similar LTV levels, at different cutoff levels. Hence, our results are robust to the range of LTV considered in the analysis.

The problem with the LTV limit is that we have partially-observed treatment status. Therefore, a proxy variable for treatment status is needed. Let  $Z$  be a time invariant variable observed in both periods and consider the propensity score  $e_t(Z) \equiv Prob_t(D = 1|Z)$ . Consider the following additional assumptions: (A3) stationarity,

$e_0(Z) = e_1(Z) \equiv e(Z)$ , meaning the policy (or other time-varying outcomes) does not affect the propensity score within the relevant period; (A4) relevance,  $e(z_1) \neq e(z_2)$  for some  $z_1$  and  $z_2$ , meaning the proxy variable is actually relevant to forecast treatment status; (A5) conditional independence,  $E(Y_1(D)|D, Z) - E(Y_0(D)|D, Z) = E(Y_1(D)|D) - E(Y_0(D)|D)$ , meaning that, conditionally on treatment status, the proxy variable may only affect outcomes homogeneously in both periods.

We consider wage<sup>16</sup> as the proxy variable. Although we cannot test the identifying assumptions, we argue that they are plausible. Income should have an impact on the propensity to leverage and this relation should not be time-varying in the relevant time frame, at least as long as other joint determinants, such as debt levels, are not substantially different between the two periods for a specific candidate borrower. Additionally, we estimate the results in the subsample that has a formal employment contract; for these borrowers, income documentation is significantly easier than for other prospective borrowers. Since the Resolution requires more sound underwriting practices from lenders, including enhanced documentation procedures, we expect that this shift in risk management will not affect the relationship between a person's wage (conditional on being on a formal employment relationship) and her propensity to borrow with high LTV. From another, less structural perspective, we can also postulate the assumptions hold by definition, since we are considering a counterfactual definition of treated borrowers as the ones that would have behaved in a certain direction in the past.

Botosaru and Gutierrez (2016) show that, for partially observed treatment status, assumptions A1-5 are sufficient to identify the ATT parameter. The result is simple. Let  $\Delta E(Y|\cdot) \equiv E(Y_1|\cdot) - E(Y_0|\cdot)$ . It is clear that  $\Delta E(Y|Z) \equiv \Delta E(Y|Z, D = 1)e(Z) + \Delta E(Y|Z, D = 0)(1 - e(Z))$ . Using the conditional independence assumption,  $\Delta E(Y|Z) \equiv \Delta E(Y|D = 1)e(Z) + \Delta E(Y|D = 0)(1 - e(Z))$ . Stack this expression  $K$  times, one for each value  $\{z_k\}_{k=1..K}$  in the support of the proxy variable. This results in a linear system that can be solved for  $\Delta E(Y|D = 1)$  and  $\Delta E(Y|D = 0)$ , and therefore also for the  $\theta$  which identifies the ATT parameter.

The estimator they propose is just the sample analog of these stacked system considering the realized values of the proxy variable. Notice that this estimator, as in traditional differences-in-difference estimation, applies to a repeated cross-section

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<sup>16</sup> As detailed below, the source of wage information is the RAIS, the granular and detailed government employment register.

sample, which is the case of our dataset, as different borrowers enter housing loan contracts at each date. Botosaru and Gutierrez (2016) also show that this is numerically equivalent to a just-identified GMM estimator. The proposed GMM moment conditions allows one to deduce the asymptotic variance of the ATT parameter taking into account the uncertainty in the first step propensity score estimation. Our results are all based on this GMM estimator and associated asymptotic inference.

Botosaru and Gutierrez also show in Monte Carlo experiments and applications that results are not sensitive to the model specification in the first step, which can be performed by an ordinary least squares, probit, or logit models. They also argue that the F-statistic of the first step regression should corroborate strongly the relevance assumption for the proxy variable. When presenting our results, we emphasize the F-statistic of the first step equations, focusing on the OLS estimation of the propensity score<sup>17</sup>.

The methodology is designed to estimate the effect of a single policy intervention. In our application, the regulator also increased the price eligibility cap of the SFH housing loan segment, in addition to the establishment of the LTV limit in the same segment (followed by the same limit in FGTS loans). To avoid confounding effects of the increase in the SFH home price eligibility limit, we only estimate the models with the subset of loans for which the home price was below R\$ 450,000, below the previous limit of R\$ 500,000. As mentioned in the introduction, similar procedures might be feasible in other applications where LTV limits are used in conjunction with other measures.

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<sup>17</sup> Since the first-stage results with the OLS technique are able to successfully discriminate the propensity for taking loans with  $LTV > 90\%$ , we do not explore further specifications such as probit or logit.



## 4. Data

The Credit Information System (SCR), the credit register managed by Central Bank of Brazil (BCB), centralizes information about loans, endorsements, and lines of credit granted by all Brazilian financial institutions to individuals and corporate entities<sup>18</sup>. The SCR comprises characteristics of the borrower, the debt contract, and the collateral; this information undergoes rigorous verification processes to ensure quality and consistency. In practice, the SCR is extensively used both for supervisory purposes by the BCB, and by lenders, when considering the riskiness of prospective borrowers. Table 1 summarizes the information we use from the SCR regarding all housing loans originated in the years 2012 to 2014.

Table 1. Housing Loans in Brazil 2012-2014

Descriptive statistics for the sample restricted to LTV higher than 85% and house price lower than BRL 450,000, which is the largest subsample used in our estimation.

SFH						N =	216,413
	Mean	St.Dev.	25%	50%	75%		
Loan (Reais)	173,808	75,537	120,695	158,600	216,000		
House Price (Reais)	196,049	85,188	136,260	179,866	245,401		
Interest rate (p.p.)	9.08	0.48	8.85	8.85	9.14		
Maturity (years)	29.88	6.60	26.92	32.08	35.00		
	Yes	No					
Arrears next 12 months	2%	98%					
FGTS:						N =	228,313
	Mean	St.Dev.	25%	50%	75%		
Loan (Reais)	88,084	21,685	74,638	83,363	99,800		
House Price (Reais)	99,265	24,666	82,863	93,978	113,843		
Interest rate (p.p.)	5.56	1.04	4.59	5.11	6.16		
Maturity (years)	25.44	3.71	24.50	25.00	29.58		
	Yes	No					
Arrears first 12 months	2%	98%					

We merge loan-level information from the SCR with RAIS, the official employment register of the Brazilian Ministry of Labor and Employment. This database contains information about each natural person that has at least one documented

<sup>18</sup> The minimum threshold for granular information in the SCR is BRL 1,000 outstanding per borrower in each reporting month. Since this amount is very low for housing transactions, for practical reasons all housing loan contracts in Brazil are granularly detailed.

employment relationship in Brazil in a given year, and data about the employment contract with the employer. Self-employed persons, business owners and undocumented workers are not listed in the employment register. The individual data includes gender, age, years of education, and residential ZIP code. The employment information is described by employer identification, wage, tenure at current employment (as of end-year), and economic sector of employment. These two sources are merged with the unique personal tax identifier to enable the use of several controls at the borrower level, which are summarized by Table 2.

Table 2. Borrowers Characteristics in Brazil 2012-2014

Descriptive statistics for the borrowers characteristics in sample restricted to LTV higher than 85% and house price lower than BRL450,000 and borrowers with formal jobs, which is the largest subsample used in our estimation when using the controls.

SFH: <span style="float: right;">N = 85,525</span>					
	Mean	St.Dev.	25%	50%	75%
Income (Reais)	7,203	7,165	3,594	5,657	8,755
Education (years)	8.15	1.33	7.00	9.00	9.00
Job Duration (years)	9.29	8.80	2.55	5.74	13.81
	Yes	No			
Male	63%	37%			
Govn. Employee	55%	45%			
FGTS: <span style="float: right;">N = 78,577</span>					
	Mean	St.Dev.	25%	50%	75%
Income (Reais)	2,437	1,557	1,465	2,160	2,989
Education (years)	6.92	1.63	7.00	7.00	8.00
Job Duration (years)	5.28	5.76	1.82	3.31	6.11
	Yes	No			
Male	67%	33%			
Govn. Employee	77%	23%			

Note: Estimates also control for economic sector up to three digit and zip code up to three digits. There are at most 1138 sectors and 29,204 zip codes in the subsamples of the data considered in the paper.

## 5. Results

The results for the SFH and FGTS segments are shown in Table 3. These results control for borrower characteristics, informed in the employment register. Borrowers that do not have formal employment relationships are not used for estimation<sup>19</sup>, due to lack of information about control variables. Estimations without extensive borrower controls result in ATT that are broadly similar to the reported results, and are omitted for brevity. Figure 3 allows visual inspection of the data, informally supporting our parallel trends assumption.

For each segment, the different LTV cutoff levels restrain the set of control borrowers to the subsample whose LTV is higher than the cutoff, but lower than 90%. Each minimum cutoff level provides robustness checks against the possibility that the treated and control borrowers are not comparable. For this reason, our preferred specifications have higher LTV cutoffs, represented in the last columns of each table. The disadvantage of these higher cutoff levels is the corresponding reduction in sample size; in the case of the FGTS segment, the quality of the first stage estimation also falls accordingly, albeit still at sound levels.

The housing loan contract terms and the house price of the treated borrowers in the SFH and FGTS segments diverge materially. In both segments, prospective borrowers that are constrained by the LTV cap must manage a viable alternative to the increased down payment requirement. Treated borrowers in each segment obtain opposite outcomes in their housing loan contracts, even when controlling for individual borrower characteristics.

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<sup>19</sup> As mentioned above, using only borrowers with formal employment relationship for estimation mitigates concerns about different outcomes of more intense scrutiny during origination, related to the new requirements that were also set in the Resolution.

Table 3. Average treatment effect on constrained borrowers.

Treated households have unconstrained LTV > 90%. The table reports the Botosaru and Gutierrez (2016) two-stage estimator. The first stage estimates the propensity score to LTV > 90% using the pre-regulation sample, conditioning on borrower income. F statistics reported in the table refer to the first-stage equation, confirming that treated borrowers are successfully identified. The second stage uses the propensities to identify the effect of interest. Standard errors take into account the first stage estimation uncertainty. Columns show results when defining the population of interest according to minimum LTV cutoff levels. The closer this minimum is to 90%, the more likely the parallel trends assumption implicit in the estimator holds. In all cases, the population of interest has house prices lower than R\$ 450,000 reais to avoid confounding the effect of the LTV limit with the effect from the increase of house price eligibility cap. The sample is restricted to individuals with formal jobs that entered SFH or FGTS housing loans from January 2012 to December 2014. Controls include gender, years of education, tenure at current employment, dummy for public service employment, sector of employment, zip code.

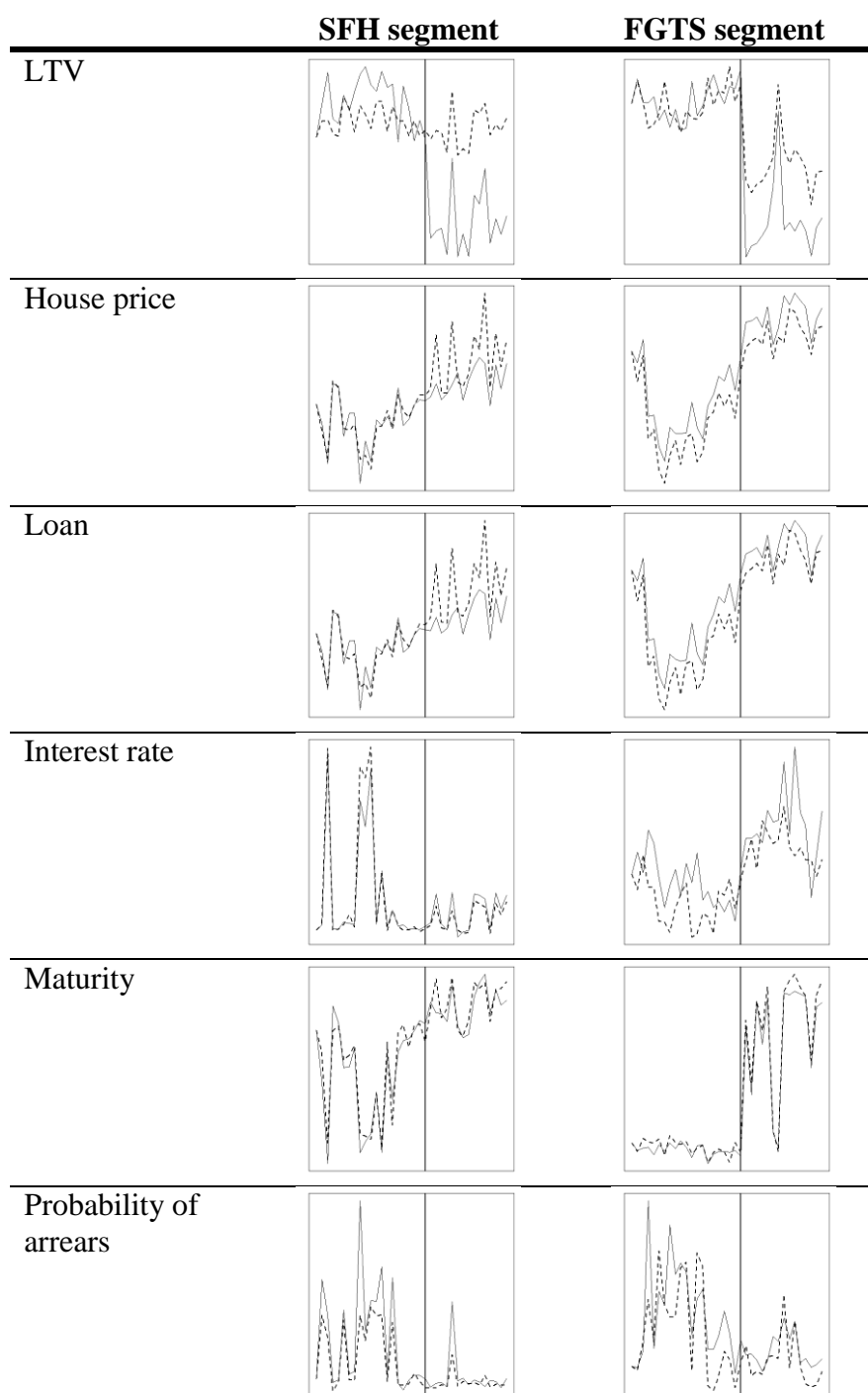
<b>SFH segment</b>	<b>LTV &gt; 80%</b>	<b>LTV &gt; 85%</b>	<b>LTV &gt; 87%</b>	<b>LTV &gt; 88%</b>
LTV (p.p.) <sup>/1</sup>	-11.76 *** (3.90)	-9.83 *** (2.11)	-8.70 *** (1.42)	-8.30 *** (1.11)
House price (log)	-0.51 *** (0.15)	-0.35 *** (0.07)	-0.36 *** (0.05)	-0.29 *** (0.04)
Loan (log)	-0.63 *** (0.19)	-0.46 *** (0.09)	-0.45 *** (0.06)	-0.38 *** (0.05)
Interest rate (p.p.)	0.40 *** (0.13)	0.35 *** (0.08)	0.26 *** (0.05)	0.21 *** (0.04)
Maturity (years)	-1.16 * (0.65)	-1.65 *** (0.50)	-1.82 *** (0.44)	-1.87 *** (0.40)
Probability of arrears (b.p.) <sup>/2</sup>	-15.81 *** (6.13)	-11.86 *** (3.19)	-10.76 *** (2.30)	-10.31 *** (1.89)
F	2,077	2,139	2,127	2,135
N	136,734	97,014	76,647	68,555

<b>FGTS segment</b>	<b>LTV &gt; 80%</b>	<b>LTV &gt; 85%</b>	<b>LTV &gt; 87%</b>	<b>LTV &gt; 88%</b>
LTV (p.p.) <sup>/1</sup>	-8.35 *** (0.98)	-5.37 *** (0.47)	-4.70 *** (0.35)	-4.54 *** (0.30)
House price (log)	0.19 *** (0.04)	0.07 *** (0.02)	0.01 (0.02)	-0.02 (0.01)
Loan (log)	0.09 *** (0.03)	0.01 (0.02)	-0.04 *** (0.01)	-0.07 *** (0.01)
Interest rate (p.p.)	0.28 *** (0.08)	0.05 (0.05)	-0.03 (0.05)	-0.05 (0.04)
Maturity (years)	1.30 ** (0.64)	-0.60 (0.38)	-1.25 *** (0.33)	-1.52 *** (0.32)
Probability of arrears (b.p.) <sup>/2</sup>	-2.87 ** (1.11)	-0.42 (0.80)	-0.19 (0.74)	0.44 (0.70)
F	2,480	1,839	1,514	1,296
N	144,122	91,849	70,521	59,365

<sup>/1</sup> Before the LTV limit, the average LTV for borrowers with LTV > 90% is 96.52% and 95.48% for the SFH and FGTS segments, respectively. Hence, the effect on the average LTV in each segment should be around 6.52 p.p. and 5.48 p.p.

<sup>/2</sup> This proxy for credit risk is the probability that the borrower will be in arrears for at least 15 days, in any period during the first 12 months of the loan contract.

Figure 3. Pseudo treated (solid line) and pseudo-non-treated (dashed line) averages. The policy date is the vertical line. Borrowers with above-average propensity are defined as pseudo-treated. The propensity estimation is the same equation used in the first-stage regressions. The figures suggest the direction and significance of the effects. They also informally support the parallel trends assumption.



The imposition of a maximum LTV limit for new contracts causes the obvious reduction in average LTV for treated borrowers, to a level that is consistent with the

maximum allowed of 90%. Interestingly, the average reduction is a slightly more than the value needed to just conform with the 90% threshold in the case of SFH loans. Whereas the average LTV for the SFH treatment group before the Resolution was 96.52%, the ATT for this variable is around 9%, significantly more than the 6.52% needed to be just below the threshold.

Two nonexclusive explanations support this result. First, a subset of treated SFH borrowers could be more likely to borrow with alternative amortization schedules, subject to a more conservative 80% LTV limit, even if these alternative amortization schedules are not relevant as a group for the purposes of our analyses. Second, it is possible (and plausible) that treated borrowers would have continued to increase their average LTV, if left unconstrained. For the FGTS segment, the average LTV fell to levels that are broadly consistent with conformity. While we cannot formally test any hypothesis about potential borrowers being driven out of the market since our dataset does not cover loan applications, results suggest that this effect may not be significant in practice. If a relevant subset of treated borrowers decided not to apply (or were denied credit), the estimated ATT for the LTV would probably be lower than the difference between the previous unconstrained average and the 90% limit.

This verified reduction in LTV for treated borrowers is consistent with many different combinations of price of the financed home and the borrowed amount. Our results point to different outcomes for each segment. We estimate that treated SFH borrowers finance homes that are 30% to 50% cheaper than the counterfactual. For example, figure 3 suggests that these borrowers would preferentially purchase more expensive homes if left unconstrained, but had to settle with homes that were priced at the same level as before. This result is economically relevant, and suggests that the homes actually purchased by these borrowers are qualitative inferior to their (counterfactual) desired homes<sup>20</sup>. In the real world, several combinations of housing characteristics such as different location, lower number of bedrooms, distance from amenities, etc., could create a price differential in that scale. After the LTV limit, treated SFH borrowers must effectively choose to purchase, and finance, more affordable homes than they otherwise would. This result seems reasonable.

This surprising result is corroborated by the independent estimation of the effect on loan size. In this case, results show that the amount financed is 38% to 63% lower than

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<sup>20</sup> In a context of rising nominal housing prices, this fact may effectively result in qualitative differences between their desired and purchased homes.

the counterfactual. These levels are consistent within each cutoff level, and also with the estimated LTV effects. Therefore, treated SFH borrowers end up purchasing more affordable housing than they normally would had the previous trend continued, but even still, they only provide a down payment that accommodates to the minimum required amount.

In spite of these seemingly lower risk characteristics, treated SFH borrowers end up with less favorable housing loan contracts: the annual interest rate due on these loans is 20 to 40 basis points higher, and the loan maturity falls between one and two years on average. The joint effect is an increase in the value of the monthly installments, which might be one of the reasons driving treated borrowers to more affordable homes and, consequently, lower debt load. Since the amount available for funding SFH loans is not directly related to bank efforts to attract new loans (particularly considering the flat yield applicable to all lenders), the interest rate and maturity results probably reflect the surge in demand for subsidized SFH loans by newly-eligible borrowers. In fact, interest rates fall 15 b.p. and maturity rises one quarter as house prices double in the period after the regulation<sup>21</sup>, when the increased eligibility ceiling enabled several new applicants – arguably desirable clients for banks – to SFH loans (these results control for individual borrower characteristics). Results in the FGTS segment, which has not undergone a material, contemporaneous change in eligibility as the SFH loans, are line with the expected effect of LTV constraints: borrowers cope well with the newly required down payment, with a corresponding reduction in the loaned amount, according to high-cutoff estimates. The home price is not significantly changed for the treated FGTS borrowers. Another difference to treated SFH borrowers is that in the FGTS case, the evidence for an increase in the interest rate is weaker.

The repayment behavior of treated SFH borrowers improves after the new LTV rules: our empirical proxy for credit risk<sup>22</sup> decreases by approximately 10 to 15 basis points. Importantly, this result is statistically significant when controlling for tenure at current employment, economic sector of employment, and other borrower and employment characteristics that may correlate with job security and wage stability, and consequently, repayment ability. Therefore, LTV limits meaningfully reduce the credit

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<sup>21</sup> Both estimations control for individual characteristics.

<sup>22</sup> This proxy is the *ex post* probability of arrears of 15 days or more during the first twelve months of the loan. We claim that this proxy is reasonable due to the sharp reduction in the incentive to default in constant amortization schedule contracts. Therefore, for the purposes of this paper, this information would be a sufficient statistic to make inferences on borrower credit risk.

risk of treated borrowers, as expected. In the FGTS segment, the lack of observable improvement in credit risk may be related to the substantial benefit relative to outside options provided to eligible borrowers by the diversity of specific subsidy programs within what we call the FGTS segment. In other words, the incentive was always very high to keep current with obligations for FGTS borrowers. In any case, results for the FGTS segment should be interpreted with caution. This segment is composed of heterogeneous subsidy programs that cater to a diverse set of social strata. It is important to point to the reader that a set of robustness analyses performed with a placebo date (ie, pretending that the policy happened in October 2012, and flagging January 2012 to October 2012 as “before” and November 2012 to September 2013 as “after the regulation”) resulted in statistically significant changes for almost all of the FGTS results at all LTV cutoffs, compared to a small number of the SFH regressions. This fact does not invalidate the results (or the methodology), but rather serve as a caveat when interpreting our findings. To be sure, we also estimated the results with a shorter time span for each period that did not include the fake event date used for the placebo estimations. In this case, results suggest that treated FGTS borrowers faced similar interest rate and loan maturity consequences as their SFH counterparts.

With that in mind, several explanations can be found for the difference between outcomes of treated SFH and FGTS borrowers. FGTS borrowers may have a higher average stock of disposable wealth (relative to the desired home price) compared to SFH borrowers – enabling FGTS borrowers to meet their new down payment requirement. Alternatively, other characteristics that are observable to banks, but not to us, may play an important role: another possibility is that CEF (largely responsible for the origination of FGTS loans) knows its average FGTS borrower better than its average SFH borrower, since some of these SFH borrowers are likely to be new, opportunistic relationships during that period of relatively low real interest rates and a (then) booming economy. Considering that CEF is responsible for over 95% of all SFH and FGTS loans with LTV higher than 80% (which are those operations considered in our regressions), and that CEF is a bank that traditionally caters to a wider public, especially the lower-income households that are also the target of FGTS policies, this hypothesis is worthy of attention.

To a greater extent, this difference may also be a result of MCMV, a flagship public policy that started in 2009 to reduce housing deficit through a tiered subsidy that depends on social and economic characteristics. One could posit that the ATT on MCMV borrowers would be more favorable (vis-à-vis the ATT on a comparable SFH borrower)



to accommodate the contract characteristics for new, constrained borrowers, considering that MCMV has a strong social policy character.

Unfortunately, we are not able to specifically identify borrowers that took advantage of the MCMV program<sup>23</sup> to properly analyze the effect of this hypothesis, nor to incorporate data about previous relationships with CEF. To assess the effect of these hypotheses, note that both MCMV eligibility and relationship with CEF can be linked to the economic status of the borrower: lower-income borrowers are more likely to be served by CEF over time, and they would also justify a compensation of the LTV limit due to social concerns.

Two caveats to our results are worth mentioning. The LTV limit that we study was relatively high (90%) when compared to other caps established in several jurisdictions, ranging from 70% to 80%. The effect could be subject to nonlinear dynamics, and thus our results would not be directly translatable to other settings with more restrictive LTV limits. We are not able to control for prospective borrowers that were driven out of the housing loan market or postponed home ownership. The pre-regulation average LTV for treated borrowers were 96.52% and 95.48% for the SFH and FGTS segments, respectively – not far away from the regulatory limit.

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<sup>23</sup> We calculate that FGTS constrained borrowers have a probability of 50-64% of being a MCMV beneficiary.

## 6. Conclusion

We show evidence that unexpected LTV limit regulation affects housing loan contract terms and the subsequent behavior in the subset of borrowers constrained by the new regulation. There is evidence of improved repayment behavior, while loan contract terms other than LTV become less favorable to the borrower depending on the segment.

SFH borrowers apparently compensate the new down payment requirement, higher interest rates and shorter maturities by purchasing more affordable homes. The outcome is a reduction in average LTV consistent with the new maximum limit. The resulting outcome of all those shifts is an improved repayment behavior, as measured *ex post*. Treated FGTS borrowers, who are also constrained to the same LTV limit at the same time, settle with housing loan contracts reflecting little change, and finance homes at the same price level as before, with slight evidence of impact on repayment behavior.

The comparison between both segments studied in this paper suggests that LTV regulation may impact target borrowers differently. We view our exercise as a first step to explore these differential impacts, which may be related to observable or unobservable traits. In this particular case, the fact that loan contract terms became broadly less favorable, and house prices relatively lower, for treated SFH borrowers but not for treated FGTS borrowers probably reflects the surge in demand (with practically the same funding supply) for SFH funds after the contemporaneous increase of home price eligibility ceiling.

The methodology applied in this paper enables the study of policy measures that are both relevant and widespread: macroprudential policies that constrain the menu of possible debt contracts. These “asset-side macroprudential policies” (CGFS, 2012) constitute an important part of the supervisory toolbox to contain the buildup of systemic risk. The empirical approach suggested in the paper is therefore of broad relevance, and could be used to study other macroprudential policy interventions.

## References

Afanasiyeff, T, Carvalho, F.L.C.A, De Castro, E, Coelho, R.L, Gregório, J (2015): “Implementing Loan-to-Value Ratios: The case of auto loans in Brazil (2010-2011)”. Working Paper No. 380, Central Bank of Brazil, March.

Annibal, C.A. (2012): “Determinantes da Captação Líquida dos Depósitos de Poupança [*Determinants of net flows of Brazilian savings accounts*]”. Working Paper No. 301, Central Bank of Brazil, December.

Akinci, O., Olmstead-Rumsey, J. (2015) “How Effective Are Macroprudential Policies? An Empirical Investigation”, International Finance Discussion Papers No. 1136.

Botosaru, I. Gutierrez, F. (2016) “Difference-in-Differences when the Treatment Status is Observed in Only One Period”, Working Paper, May 11, 2016.

Campbell, John Y., Tarun Ramadorai, and Benjamin Ranish. "The Impact of Regulation on Mortgage Risk: Evidence from India." *American Economic Journal: Economic Policy* 7.4 (2015): 71-102.

Campbell, John Y., and João F. Cocco. "Household Risk Management and Optimal Mortgage Choice." *The Quarterly Journal of Economics* (2003): 1449-1494.

Cerutti, E.; Dagher J.; Dell’Ariccia, G. (2015) “Housing Finance and Real-Estate Booms: A Cross-Country Perspective”. *IMF Staff Discussion Note* SFN/15/12.

Committee on Global Financial Stability (CGFS) (2012): “Operationalizing the selection and application of macroprudential instruments”, CGFS Papers No. 48, December.

Darbar, S., Wu, X. (2015): “Experiences with Macroprudential Policy – Five Case Studies”. IMF Working Paper No. 123.

Demyanyk, Y., Van Hemert, O. (2011): “Understanding the Subprime Mortgage Crisis”. *Review of Financial Studies*, v. 24, n.6, p.1848-1880.

Financial Stability Board (FSB) (2012): “FSB Principles for Sound Residential Mortgage Underwriting Practices”, available at: [http://www.fsb.org/wp-content/uploads/r\\_120418.pdf?page\\_moved=1](http://www.fsb.org/wp-content/uploads/r_120418.pdf?page_moved=1).

Hallisey, N., Kelley, R., O'Malley, T. (2014): "Macro-prudential Tools and Credit Risk of Property Lending at Irish Banks", Economic Letter Series, No. 10.

Igan, D., Kang, H. D. (2011): "Do Loan-to-Value and Debt-to-Income Limits Work? Evidence from Korea", IMF Working Paper No. 297.

Jácome, L., Mitra, S. (2015): "LTV and DTI Limits-Going Granular", IMF Working Paper No. 154.

Martins, B, and Schechtman, R (2013): "Loan pricing following a Macro Prudential Within-Sector Capital Measure", Working Paper No. 323, Central Bank of Brazil, August.

Pereira Da Silva, L.A. and Harris, R.E. (2012): "Sailing through the Global Financial Storm: Brazil's recent experience with monetary and macroprudential policies to lean against the financial cycle and deal with systemic risks". Working Paper No. 290, Central Bank of Brazil, August.