News shocks, government subsidies and housing prices in Brazil

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Resumo

Os preços dos imóveis no Brasil apresentaram um crescimento surpreendente nos últimos anos. Uma questão importante é tentar entender quais elementos podem explicar este comportamento. Este artigo investiga a hipótese de que um otimismo generalizado, associado com políticas governamentais direcionadas ao setor de habitação, podem estar por trás do comportamento dos preços dos imóveis. Este artigo desenvolve um modelo Dinâmico Estocástico de Equilíbrio Geral para investigar essas questões. Os resultados mostraram que os subsídios combinados com a flexibilização das condições de crédito foram capazes de influenciar positivamente os preços dos imóveis. Além disso, os choques não antecipados tiveram maior impacto nos preços das habitações que os choques antecipados.

Palavras-Chave: Preços dos imóveis. Choques antecipados. Subsídios.

Abstract

Housing prices in Brazil have shown a surprising growth in recent years. An important issue is trying to understand what elements can explain this behavior. This article investigates the hypothesis that a generalized optimism associated with government policies directed to the housing sector may be behind the behavior of real estate prices. This article develops a Dynamic Stochastic General Equilibrium model to investigate these issues. The results showed that subsidies combined with the easing of credit conditions were able to positively influence real estate prices. In addition, unanticipated shocks had a greater impact on housing prices than anticipated shocks.

Keywords: Property Prices. News shocks. Subsidies.

JEL: C11, E00, E61

Área 4: Macroeconomia, Economia Monetária e Finanças

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1 Introduction

The period following 2003 was marked by a boom in commodity prices, and Brazil was one of the countries that have benefited from this cycle. However, the subprime crisis contributed to the reversal of this cycle in 2009, causing the Brazilian government to adopt expansionary policies in order to stimulate internal aggregate demand aiming to offset the negative effects of the global crisis. Within this context, public policies aimed specifically at the real estate sector emerged in Brazil.

In 2007, the Programa de Aceleração do Crescimento (PAC) was implemented with public investments focused on logistics, energy, social and urban infrastructure. The Minha Casa, Minha Vida (MCMV) program, launched in 2009, was an integral part of PAC, with an initial goal of building one million homes, with investment of R$ 60 billion, of which R$ 28 billion in subsidies.

In addition to the housing program aimed at the acquisition of real estate by low income individuals, there were a number of public works directed to the adequacy of host cities of the World Cup in the years before 2014 and the Olympic Games, carried out in 2016 (in Rio de Janeiro). Besides these events, giant oil discoveries (pré-sal or pre-salt) in Brazil also helped to create optimistic expectations regarding the Brazilian economy. This period coincides with a steep increase in housing prices leading some economic commentators to associate the housing boom to this wave of "good news", optimistic behavior and expansionist fiscal policy in Brazil.

The optimistic perspectives regarding the Brazilian economy were evidenced by the British magazine "The Economist", in which:

> "*(...) China may be leading the world economy out of recession but Brazil is also on a roll. It did not avoid the downturn, but was among the last in and the first out. Its economy is growing again at an annualised rate of 5%. It should pick up more speed over the next few years as big new deep-sea oilfields come on stream, and as Asian countries still hunger for food and minerals from Brazil's vast and bountiful land. Forecasts vary, but sometime in the decade after 2014 - rather sooner than Goldman Sachs envisaged - Brazil is likely to become the world's fifth-largest economy, overtaking Britain and France.* " (Prideaux, 2009).

The news shocks approach has been extensively explored in the context of DSGE and VAR models. This hypothesis was proposed originally by Pigou (1927) and revisited by authors such as Beaudry e Portier (2006), Jaimovich e Rebelo (2009), Barsky e Sims (2011), Milani e Treadwell (2012), Schmitt-Grohé e Uribe (2012), Khan e Tsoukalas (2012), Kilian e Hicks (2013) with the intention of showing the importance of news shocks as a relevant source of aggregate fluctuations.

However, as highlighted by Mendicino et al. (2015), there are few studies aimed at analyzing the effects of news shocks on the housing market and the implied spillovers to the rest of the economy. Given the forward-looking nature of housing prices, news about future economic conditions would presumably be reflected in the determination of such a variable.

Based on this, we develop a DSGE model to analyze the relationship between economic agents' expectations about future economic developments, also known in the literature as "news shocks", expansionary fiscal policy and housing prices in Brazil. Besides the changing in fiscal policy, in 2010, there were changes to the housing financing rules with reductions in Loan-to-Value (LTV) and income needed to finance real estate. Altogether these events - optimistic behavior by economic agents, expansionary fiscal policy and credit deepening in the housing sector - might offer an explanation to the steep increase in housing prices in Brazil.

Our results show that both price subsidies and subsidized interest rates exerted a positive influence on housing prices in Brazil. In response to a housing demand shock, housing prices display a greater increase the greater are the subsidies to low income families. We also show that anticipated shocks have a larger impact on housing prices than unexpected shocks. Therefore, our results support the idea that the wave of good news, optimistic behavior and government policies aimed at the housing sector were behind the behavior of housing prices in Brazil.

There are some studies applied to the Brazilian economy that mention some of these stimuli. We highlight the studies proposed by Mendonça et al. (2011), Mendonça (2013), Silva et al. (2014) e Besarria et al. (2016). In general, the authors show that there is a negative relationship between monetary policy instruments and real estate prices. This paper differs from these authors by taking into account the effects of government subsidies, subsidized interest rates and anticipated shocks from a DSGE model, explicitly addressing their effects on housing prices in Brazil.

In addition to this introduction, the article presents four other sections. In the next, we present the DSGE model, followed by the methodological discussion. In the fourth section, we show the results. Finally, in the last section, we discuss some final considerations.

2 News shocks and Brazilian housing market

Expectations about future economic conditions are one of the key ingredients in the economic agents' decision-making process. Agents are forward-looking and hence changing in belief about future economic results may generate excessively optimistic or pessimistic expectations about the future and this impact their current behavior.

In the housing sector could not be different. The behavior of housing prices today, for instance, reflect not only current economic conditions, but also expectations about the future. Based on this discussion, the literature has attempted to investigate how and to what extent the housing market responds to news about future economic fundamentals.

Among the studies that associated changes in the real estate market with expectations about future economic fundamentals or news shocks, we highlight: Lambertini et al. (2013a), Ng e Feng (2016), Lambertini et al. (2017) and Abildgren et al. (2018).

Lambertini et al. (2013b) use a vector-autoregression (VAR) model and data from the University of Michigan Survey of Consumers and provide evidence on the importance of news and consumersâ beliefs for housing-market dynamics and aggregate fluctuations. The VAR model was estimated using U.S. quarterly data over the sample period 1965:Q1-2009:Q4. The results show that unexplained changes in News on Business Conditions have statistically significant implications for the future path of private consumption, inflation, house prices and the federal funds rate. In short, this study was limited to empirical analysis.

Subsequently, the literature sought to introduce elements that could reflect more faithfully the way the news shocks influence the housing market through a dynamic stochastic general equilibrium (DSGE) models. Iacoviello (2005) and Iacoviello e Neri (2010) used the DSGE models to address the causes and consequences of fluctuations in the US real estate market. These studies were limited to analyzing the effects of unanticipated shocks on housing demand and housing technology on US real estate price changes and housing investment. In addition to pioneering discussion, these articles are the basis of recent studies that address the role of news shocks.

Lambertini et al. (2017) included in the model proposed by Iacoviello e Neri (2010) one rule of news shocks and find that expectations of a future increase in housing demand lead to a housing price boom but fail to generate co-movement between business investment and all other aggregate variables. In addition, only expectations of future expansionary monetary policy that are not met, both regarding the policy rate and the central banks inflation target, are likely to cause a boom-bust cycle and a macroeconomic recession. Thus, a high degree of transparency in monetary policy reduces uncertainty about future monetary policy actions and thereby the occurrence of cycles.

In addition, the authors investigated the role of credit conditions as a source of housing market fluctuations. Survey data suggests that current favorable credit conditions as well as expected future tighter credit conditions are important reasons for consumers to judge house buying conditions as good. These suggest what a current unanticipated increase in the access to credit raises on impact house prices and all other macroeconomic variables but fails to generate hump-shaped dynamics.

Although the recent literature has reported the importance of including news shocks to explain the behavior of the real estate market, there are still no studies applied to the Brazilian economy that include this component. Recently, Besarria et al. (2018) explored the significance of overoptimism for house prices in Brazil using a theoretical model that establish that, in the absence of a bubble, a long-run equilibrium relationship should be observed between the market price of an asset and its dividends. The authors implement two methodologies. First, the authors assess whether there is a cointegration relationship between housing prices and housing rental prices. Second, the authors test whether the price-to-rent ratio is stationary.

Results show that there is evidence of a bubble in housing prices in Brazil. However, given the short span of the data, the authors perform a Monte Carlo simulation and show that the cointegration tests may be biased in small samples. Therefore, the results should be analyzed with caution. This study represents an attempt to to capture the sentiment of economic agents regarding the future behavior of real estate prices. However, the model proposed by the authors is unable to capture the real estate market response to news.

The initial challenge of this article is to show that there is an association between feelings not based on fundamentals or news and the behavior of housing prices. To illustrate this possible relationship will be used data on consumer expectations and real housing prices in Brazil. There is a vast literature reported that aggregate consumer confidence indices reflect sentiments view on confidence shocks[1]. This transmission channel is due to the fact that consumption represents 63% of GDP and an optimistic or pessimistic expectation regarding this indicator may anticipate the future results of the spending, investment decisions and aggregate product.

[1]For more details, see the review of the literature presented by Abildgren et al. (2018).

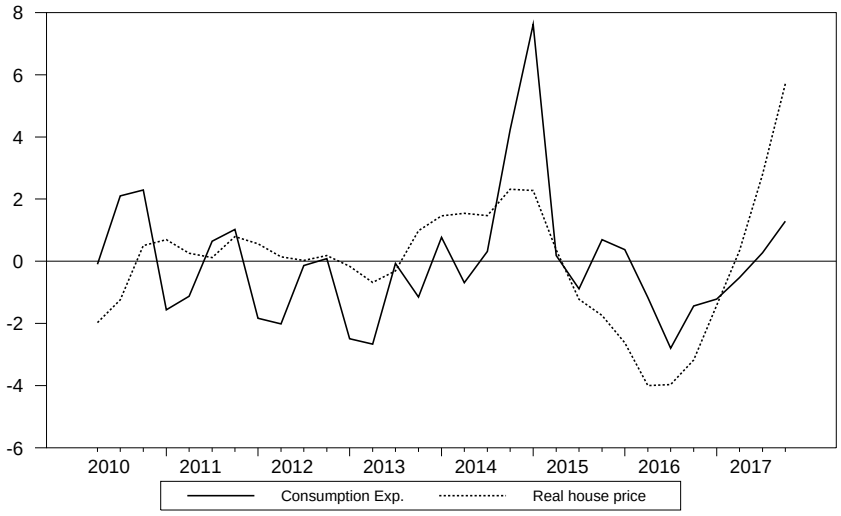

Figure 1: Real house prices and consumer expectations in Brazil

Figure 1 shows the development in consumer expectation and house prices in Brazil since the second quarter of 2010 to the first quarter of 2018. The real housing price is from the Bank for International Settlements (BIS) and consumer expectation data are from Instituto de Pesquisa Econômica Aplicada - IPEA. As noted by Abildgren et al. (2018) in the case of Denmark, there seems to be a strong correlation between consumer expectations and real housing prices in Brazil. This reflects that both house prices and consumer confidence respond to business cycle factors. Additionally, we will model the exogenous sentimental shocks that contribute to the movements in house prices.

3 Model

The economy is made up of families, entrepreneurs, final goods firms, a financial sector and a fiscal authority. Families are divided into two groups: patients or savers and impatient or debtors. They differ in terms of their intertemporal discount factors. Both provide labor for firms producing non-durable goods. Impatient families are restricted in the amount of borrowing they can take.

The production side of economy model is given by the consumer goods production sector. The financial sector is composed of a representative bank that pays the deposits made by patient families and channels resources for the granting of housing loans, with the accumulation of assets subject to regulatory restrictions.

3.1 Patients families

This economy is populated by two types of households, a fraction Ω, where $0 < \Omega < 1$, is formed by impatient households and the remaining fraction is formed by patient households. Impatient households discount the future more heavily than patients households. Both households receive utility when consuming goods (c_t), housing stock (h_t) and leisure. In addition, both agents provide work services to the production sector.

In this scenario, patients families are the creditors and the impatient debtors. Due to the presence of financial frictions, borrowers face a credit constraint in relation to the amount of financing that can be acquired in each period, using housing stock as collateral.

The problem of optimization faced by patient and inpatient families are similar, they both seek to maximize a lifetime utility function:

$$E_0 \sum_{t=0}^{\infty} \beta_t^{'} \left[\log(c_t^{'} - \phi_c c_{t-1}^{'}) + j_t \log h_t^{'} - \frac{(L_t^{'})^{1+\varphi}}{1+\varphi} - \frac{(L_{h,t}^{'})^{1+\varphi}}{1+\varphi} \right] \tag{1}$$

in which the term superscript (′) indicates patient family; $c_t^{'}$ is consumption; $h_t^{'}$ represents housing; , while $L_t^{'}$ and $L_{g,t}^{'}$ stand the labor supplied to the consumer goods sector and housing sector; ϕ_c is the habit persistence coefficient; φ the specification of the disutility of labor; j_t is the preference shock for real estate; in addition, the parameter $\beta^{'}$ represents the discount factor.

The restriction of the patient agent is given by:

$$\begin{aligned}(1+\tau^c)c_t^{'} + q_t(h_t^{'} - h_{t-1}^{'}) + k_t - k_{t-1} + k_{h,t} - k_{h,t-1} + d_t = (1-\tau^l)[W_t^{'} L_t^{'} + W_{h,t}^{'} L_{h,t}^{'}] + \\ (1-\tau^k)(R_t - \delta)k_{t-1} + (1-\tau^k)(R_t^h - \delta_h)k_{h,t-1} + R_{t-1}^d d_{t-1}\end{aligned} \tag{2}$$

where q_t is the price of the housing asset; k_t represents the capital stock for the production of consumer goods; $k_{h,t}$ represents the housing capital; R_t^h, R_t^d and R_t are the rates of return on housing, capital and deposits, respectively; δ is the rate of capital depreciation; d_t denotes deposits; τ^c, τ^l and τ^k represent, respectively, the tax rates on consumption, wages and capital rents. $W_t^{'}$ and $W_{h,t}^{'}$ represents the wages paid by the private sector and housing sector, respectively.

The first order conditions are given by:

$$\frac{\partial \Lambda_t^{'}}{\partial c_t^{'}} \Rightarrow \left[\frac{1}{(c_t^{'} - \phi_c c'_{t-1})} - \frac{\phi_c \beta_t^{'}}{(c_{t+1}^{'} - \phi_c c_t^{'})} \right] \left(\frac{1}{1+\tau^c} \right) = \lambda_t^{'} \tag{3}$$

$$\frac{\partial \Lambda_t^{'}}{\partial h_t^{'}} \Rightarrow \frac{j_t}{h_t^{'}} = q_t \lambda_t^{'} - \beta_t^{'} E_t \lambda_{t+1}^{'} q_{t+1} \tag{4}$$

$$\frac{\partial \Lambda_t^{'}}{\partial L_t^{'}} \Rightarrow L_t^{'\varphi} = (1-\tau^l) W_t^{'} \lambda_t^{'} \tag{5}$$

$$\frac{\partial \Lambda_t^{'}}{\partial L_{h,t}^{'}} \Rightarrow L_{h,t}^{'\ \varphi} = (1-\tau^l) W_{h,t}^{'} \lambda_t^{'} \tag{6}$$

$$\frac{\partial \Lambda_t^{'}}{\partial k_t} \Rightarrow \lambda_t^{'} = \beta_t^{'} E_t \lambda_{t+1}^{'} [1 + (1-\tau^k)(R_{t+1} - \delta)] \tag{7}$$

$$\frac{\partial \Lambda_t^{'}}{\partial k_{h,t}} \Rightarrow \lambda_t^{'} = \beta_t^{'} E_t \lambda_{t+1}^{'} [1 + (1-\tau^k)(R_{t+1}^h - \delta_h)] \tag{8}$$

$$\frac{\partial \Lambda_t^{'}}{\partial d_t} \Rightarrow \lambda_t^{'} = R_t^d \beta_t^{'} E_t \lambda_{t+1}^{'} \tag{9}$$

$$\frac{\partial \Lambda_t^p}{\partial \lambda_t^{'}} \Rightarrow (1+\tau^c)c_t^{'} + q_t(h_t^{'} - h_{t-1}^{'}) + k_t - k_{t-1} + d_t = (1-\tau^l)[W_t^{'} L_t^{'} + W_{h,t}^{'} L_{h,t}^{'}] + (1-\tau^k)(R_t^h - \delta_h)k_{h,t-1} + (1-\tau^k)(R_t - \delta)k_{t-1} + R_{t-1}^d d_{t-1} \tag{10}$$

in addition, the term $\lambda_t^{'}$ represents the lagrange multiplier.

3.2 Impatient families

Impatient families seek to maximize their lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta_t^{''} \left[\log(c_t^{''} - \phi_c c_{t-1}^{''}) + j_t \log h_t^{''} - \frac{(L_t^{''})^{1+\varphi}}{1+\varphi} - \frac{(L_{h,t}^{''})^{1+\varphi}}{1+\varphi} \right] \tag{11}$$

where ($''$) indicates impatient families and ($0 < \beta^{''} < \beta^{'} < 1$), subject to the budget constraint given by:

$$(1+\tau^c)c_t^{''} + (1-\tau^q)q_t(h_t^{''} - h_{t-1}^{''}) + R_t^b b_{t-1} = (1-\tau^l)[W_t^{''} L_t^{''} + W_{h,t}^{''} L_{h,t}^{''}] + b_t \tag{12}$$

where ϕ_c is the habit persistence coefficient; τ^q is a government subsidy. In the period t, the impatient family makes a loan (b_t), which is indexed to the interest rate R_t^b. Differently from patient households, the government subsidizes housing of impatient families. This feature is to capture the effects of "Minha Casa, Minha Vida", a federal government program that subsidize housing acquisition for low income families, in our model, impatient households.

Impatient households face a collateral constraint, given by:

$$R_{t+1}^b b_t \leq m_h E_t[q_{t+1} h_t^{''}] \tag{13}$$

The expression (13) shows that the debt service cannot exceed a fraction $m_h \in [0,1]$ of the expected value of the housing asset, given as collateral. The term m_h or *LTV* allows the model to accommodate the recent increase in household indebtedness in Brazil. Although real estate mortgage rates for low-priced real estate in Brazil are not associated with leverage or collateral of borrowers, banks respect the minimum *LTV* indices to meet the demand for home loans. For this reason, a collateral restriction was imposed on this credit segment, as proposed by Carvalho et al. (2014).

The solution to the problem of impatient families is given by:

$$\frac{\partial \Lambda_t^{''}}{\partial c_t^{''}} \Rightarrow \left[\frac{1}{(c_t^{''} - \phi_c c''_{t-1})} - \frac{\phi_c \beta_t^{''}}{(c_{t+1}^{''} - \phi_c c_t^{''})} \right] \left(\frac{1}{1+\tau^c} \right) = \lambda_t^{''} \tag{14}$$

$$\frac{\partial \lambda_{1,t}^{''}}{\partial h_t^{''}} \Rightarrow \frac{j_t}{h_t^{''}} = [\lambda_{1,t}^{''}(1-\tau^q)q_t] - \beta_t^{''} E_t[\lambda_{1,t+1}^{''}(1-\tau^q)q_{t+1}] - \lambda_{2,t}^{''}\lambda_{1,t}^{''} m_h E_t \left(\frac{q_{t+1}}{R_{t+1}^b} \right) \tag{15}$$

$$\frac{\partial \Lambda_t^{''}}{\partial L_t^{''}} \Rightarrow L_t^{''\varphi} = (1-\tau^l) W_t^{''} \lambda_{1,t}^{''} \tag{16}$$

$$\frac{\partial \Lambda_t^{''}}{\partial b_t} \Rightarrow \lambda_{2,t}^{''}\lambda_{1,t}^{''}R_{t+1}^{b} = \lambda_{1,t}^{''} - \beta_t^{''}E_t(R_{t+1}^{b}\lambda_{1,t+1}^{''}) \tag{17}$$

$$\frac{\partial \Lambda_t^{''}}{\partial \lambda_{1,t}^{''}} \Rightarrow (1+\tau^c)c_t^{''} + (1-\tau^q)q_t(h_t^{''} - h_{t-1}^{''}) + R_t^b b_{t-1} = (1-\tau^l)W_t^{''}L''_t + b_t \tag{18}$$

$$\frac{\partial \Lambda_t^{''}}{\partial \lambda_{2,t}^{''}} \Rightarrow R_{t+1}^{b}b_t = m_h E_t[q_{t+1}h_t^{''}] \tag{19}$$

where $\lambda_{1,t}^{''}$ and $\lambda_{2,t}^{''}$ are the Lagrange multipliers. It should be emphasized that the multiplier associated with the loan restriction was normalized by the marginal utility of consumption, as proposed by Iacoviello (2015).

3.3 Bankers

As is Iacoviello (2015) there is a representative banker that solves the following problem:

$$\max E_0 \sum_{t=0}^{\infty} \beta_t^{'''} log(c_t^{'''} - \phi_b c_{t-1}^{'''}) \tag{20}$$

where $\beta_t^{'''} > \beta_t^{''}$, subject to

$$(1+\tau^b)c_t^{'''} + R_{t-1}^{d}d_{t-1} + b_t = d_t + R_t^b b_{t-1} \tag{21}$$

where $c_t^{'''}$ depicts the representative banker's, ϕ_b is the habit persistence coefficient; d_t denotes deposits made by patient families; b_t are loans made by impatient families and τ^b is the tax rate on consumption.

Iacoviello (2015) stresses that the restriction of the banker's cash flow (21) implicitly assumes that deposits can be freely converted into loans. Thus, to make the discussion more realistic, we assume that the bank is limited in the ability to issue liabilities by the value of equity (assets less liabilities) in its portfolio. This restriction may be motivated by problems of limited commitment or regulatory concerns.

Denoting $k_{b,t} = b_t - d_t$ as the bank's capital at the beginning of the period, thus, the capital adequacy constraint can be reinterpreted as a standard loan constraint, described by:

$$d_t = \gamma b_t \tag{22}$$

In the expression (22) the left side denotes the bank liabilities, while the right side denotes the fraction of bank assets that can be used as collateral, where γ is the capital adequacy constraint.

The first order conditions are represented by:

$$\frac{\partial \Lambda_{1,t}^{'''}}{\partial c_t^{'''}} \Rightarrow \left[\frac{1}{(c_t^{'''} - \phi_b c'''_{t-1})} - \frac{\phi_b \beta_t^{'''}}{(c_{t+1}^{'''} - \phi_b c_t^{'''})}\right]\left(\frac{1}{1+\tau^b}\right) = \lambda_t^{'''} \tag{23}$$

$$\frac{\partial \Lambda_{1,t}^{'''}}{\partial d_t} \Rightarrow \lambda_{2,t}^{'''}\lambda_{1,t}^{'''} = \lambda_{1,t}^{'''} - \beta_t^{'''}R_t^d\lambda_{1,t+1}^{'''} \tag{24}$$

$$\frac{\partial \Lambda_{1,t}^{'''}}{\partial b_t} \Rightarrow \lambda_{1,t}^{'''} = \gamma \lambda_{2,t}^{'''} \lambda_{1,t}^{'''} + \beta_t^{'''} R_{t+1}^b \lambda_{1,t+1}^{'''} \tag{25}$$

$$\frac{\partial \Lambda_{1,t}^{'''}}{\partial \lambda_{1,t}^{'''}} \Rightarrow (1+\tau^b) c_t^{'''} + R_{t-1}^d d_{t-1} + b_t = d_t + R_t^b b_{t-1} \tag{26}$$

$$\frac{\partial \Lambda_t^{'''}}{\partial \lambda_{2,t}^{'''}} \Rightarrow d_t = \gamma b_t \tag{27}$$

being $\lambda_{1,t}^{'''}$ and $\lambda_{2,t}^{'''}$ the lagrange multipliers and, as pointed out earlier, these were normalized by the marginal utility of consumption.

3.4 Firms

There is firms that produce consumption goods and housing using two technologies. Firms operate under perfect competition, with flexible prices and produce non-durable goods, Y_t. To produce non-durable goods, firms use the labor provided by both types of households and capital as inputs. The production technology is given by:

$$Y_t = A_t(k_t)^{\mu}[(L_t^{'})^{\alpha(1-\mu)}(L_t^{''})^{(1-\alpha)(1-\mu)}] \tag{28}$$

where α represents the participation of the workforce from the patient families; μ represents the share of capital in the production function; A_t is the productivity shock for the consumer goods sector. Productivity shocks and preferences are defined as:

$$ln(A_t) = \rho_c ln(A_{t-1}) + v_t \tag{29}$$

with ρ_c being the autoregressive coefficient; v_t follows a process $AR(1)$ (innovations with zero mean, uncorrelated and with standard deviation σ_A).

The housing sector produces output with labor and capital public and private. The production technology is:

$$IH_t = A_{h,t}[(k_{h,t})^{\nu(\omega)}(k_{g,t})^{\nu(1-\omega)}][(L_t^{'})^{\Phi(1-\nu)}(L_t^{''})^{(1-\Phi)(1-\nu)}] \tag{30}$$

where ν represents the participation of the capital; $k_{g,t}$ represents public capital; Φ represents the share of workforce from the patient families in the production function; ω represents the participation of the private capital; $A_{h,t}$ is the productivity shock for the housing sector. Based on Cavalcanti et al. (2018), we assume capital may be public or private, with public capital being exogenously determined by the government. Public capital, which is made available at zero cost to all firms, is assumed to be productivity-enhancing.

3.5 Fiscal authority

The fiscal authority finances its expenditures through taxation on consumption, wages and capital rents. For simplicity we assume that the government does not emit money or issue bonds, and subsidizes the purchase of housing by low income households by transferring resources. Thus, government revenue is represented by:

$$T_t = \tau^c(c_t^{'} + c_t^{''}) + \tau^b(c_t^{'''}) + \tau^l(W_t^{'}L_t^{'} + W_t^{''}L_t^{''}) + \tau^k(R_t - \delta)k_t \tag{31}$$

and government spending are

$$G_t = \tau^q q_t(h_t^{''} - h_{t-1}^{''}) + B_t \tag{32}$$

where B_t follows an autoregressive process; $\tau^q q_t(h_t^{''} - h_{t-1}^{''})$ are subsidy spending.

The primary surplus (SP_t) is given by the difference between the total revenue and the total expenditure of the government during the same period:

$$SP_t = T_t - G_t \tag{33}$$

The government budget constraint states that:

$$d_t = r_{t-1}d_{t-1} - SP_t \tag{34}$$

where d_t is the value of public debt at period t. Additionally, assuming that the government decides to subsidize the real estate financing rate, causing the interest rate of the loan to be represented by:

$$r_t^F = (1 - \tau_t^F)r_{bi} \tag{35}$$

where τ_t^F is time variant, representing an unanticipated shock of subsidized interest rate.

3.6 Equilibrium

The equilibrium in this economy is characterized by a set of allocations $\{h_t^{'}, h_t^{''}, L_t^{'}, L_t^{''}, c_t^{'}, c_t^{''}, c_t^{'''}, b_t, k_t\}_{t=0}^{\infty}$, prices $\{R_t^d, w_t, q_t\}_{t=0}^{\infty}$, taxes rates such that all the optimality conditions associated to the above maximization problems are satisfied, given initial values $\{h_0^{'}, h_0^{''}, b_0, k_{-1}\}$, a sequence of shocks and that the following market clearing conditions are satisfied:

$$\text{(Housing Market)} \qquad h_t^{'} + h_t^{''} = 1 \tag{36}$$

$$\text{(Goods Market)} \qquad Y_t = c_t^{'} + c_t^{''} + c_t^{'''} + i_t + G_t \tag{37}$$

3.7 News shocks

As in Christiano et al. (2010), we assume that the shock error term consists of an unexpected component (ϵ_t) and an anticipated component (ϵ_{t-n})

$$v_t = \epsilon_t + \epsilon_{t-n} \tag{38}$$

where ϵ_t is a white noise process. Thus, at time t, agents receive a signal on future macroeconomic conditions that will occur in time $t + n$. If the expected motion does not occur, then $\epsilon_t = -\epsilon_{t-n}$ and $v_t = 0$. It is assumed that the news shock is anticipated two periods in advance, that is, n = 2. In addition, it will include anticipated shocks in productivity of non-durable consumer goods sector (A_t) and preference for real estate.

In addition, we have included four exogenous shocks: a housing preference, $\epsilon_{j,t}$; a public capital shock, $\epsilon_{k,t}$; a loan-at-value shock, $\epsilon_{ltv,t}$ and a risk credit (Basel) shock, $\epsilon_{rc,t}$. It is assumed

that all shocks are $iid(0, \sigma_l)$ in which $l = j, k_g, m_h, \gamma$. The stochastic processes that define the evolution of $\epsilon_{j,t}$, $\epsilon_{k,t}$, $\epsilon_{ltv,t}$ and $\epsilon_{rc,t}$ are given by the following expressions:

$$j_t = \rho_b j_{t-1} + \epsilon_{j,t} \tag{39}$$

$$k_{g,t} = \rho_c k_{g,t-1} + \epsilon_{k,t} \tag{40}$$

$$m_{h,t} = \rho_d m_{h,t-1} + \epsilon_{ltv,t} \tag{41}$$

$$\gamma_t = \rho_w \gamma_{t-1} + \epsilon_{rc,t} \tag{42}$$

4 Econometric Methodology

4.1 Data

For the estimation of the DSGE model, we employ quarterly series of GDP obtained from the IBGE (quarterly national accounts), housing financing, collected at the Brazilian Chamber of Construction Industry (CBIC) and real estate prices obtained at the Central Bank of Brazil (BCB), covering the period from April 2001 to March 2018.

4.2 Estimation

Table 2 presents the mean values, standard deviations and values corresponding to the lower and upper limits of the 90% Highest Posterior Density interval of the estimated parameters, using the Bayesian inference technique. Some parameters are fixed during the estimation process. The fixed parameters are from Iacoviello (2015) and are standard in the literature. Table 1 presents a description of the parameters that were kept fixed. The parameter of subsidy was established based on the ratio between the government subsidy and the ceiling for the value of the property.

Table 1: Calibrated parameters

Symbol	Value	Parameter
$\beta^{'}$	0.993	discount factor of patient families
$\beta^{''}$	0.940	discount factor of impatient families
$\beta^{'''}$	0.945	discount factor of bankers
ϕ_c	0.8	Coefficient of habit persistence
ϕ_b	0.8	Coefficient of habit persistence
m_h	0.7	Loan-to-value ratio impatient households
μ	0.35	Total capital share in production
ν	0.35	Total capital share in housing production
ω	0.80	Total private capital share in housing production
α	0.50	Labor share of the patient family in the production
Φ	0.5	Labor share of the patient family in the housing production
δ	0.025	Depreciation rate for physical capital
γ	0.9	Liabilities to assets ratio
τ_c	0.16	Tax rates on consumption
τ_b	0.165	Tax rates on bankers consumption
τ_l	0.17	Tax rates wages
τ_q	0.20	Subsidy rate
τ_k	0.08	Tax rates remuneration of capital

Table 2: Results of Bayesian estimation

Parameters	Mean prior	Mean post.	Int. credibility 90%		Prior distribution	St.dev.
ρ_a	0.80	0.4626	0.3708	0.6451	Beta	0.100
ρ_b	0.80	0.9365	0.7801	0.9994	Beta	0.100
ρ_c	0.80	0.8840	0.7880	0.9733	Beta	0.100
ρ_d	0.80	0.9890	0.9848	0.9976	Beta	0.100
ρ_e	0.80	0.8507	0.7482	0.9734	Beta	0.100
η	1.01	1.0092	0.9811	1.0297	Gamm Inv.	0.020
m_h	0.70	0.6999	0.6948	0.7048	Beta	0.003
μ	0.35	0.3518	0.3468	0.3568	Beta	0.003
$\epsilon_A(News)$	1.00	1.6760	1.3770	1.9750	Gamm Inv.	2.000
ϵ_A	1.00	0.4499	0.2682	0.6232	Gamm Inv.	2.000

The parameters were obtained from two independent sequences with each one being composed of 800.000 withdrawals using the Metropolis-Hastings algorithm. Mean acceptance along the two chains was 27%, and convergence was assessed using the methods proposed by Brooks e Gelman (1998). The first 400.000 withdrawals were discarded to ensure independence from the initial conditions. The statistics of interest were then calculated on the basis of the joint distribution of posterior ergodic probability of the structural parameters.

5 Results

5.1 Unanticipated shocks

Figure 2 presents the theoretical functions of response to the productivity shock in the non-durable goods sector. Positive technological shocks in the consumer goods sector promote an increase in investment, consumption and income. As a result of the expansion in income there is an increase in the demand for real estate, causing real estate prices to increase.

The increase in house prices relaxes the collateral constraints of impatient individuals, leading to an expansion in household indebtedness. Thus, in response to the increase in demand for loans, the bank resets the loan rate to a value above its steady state value.

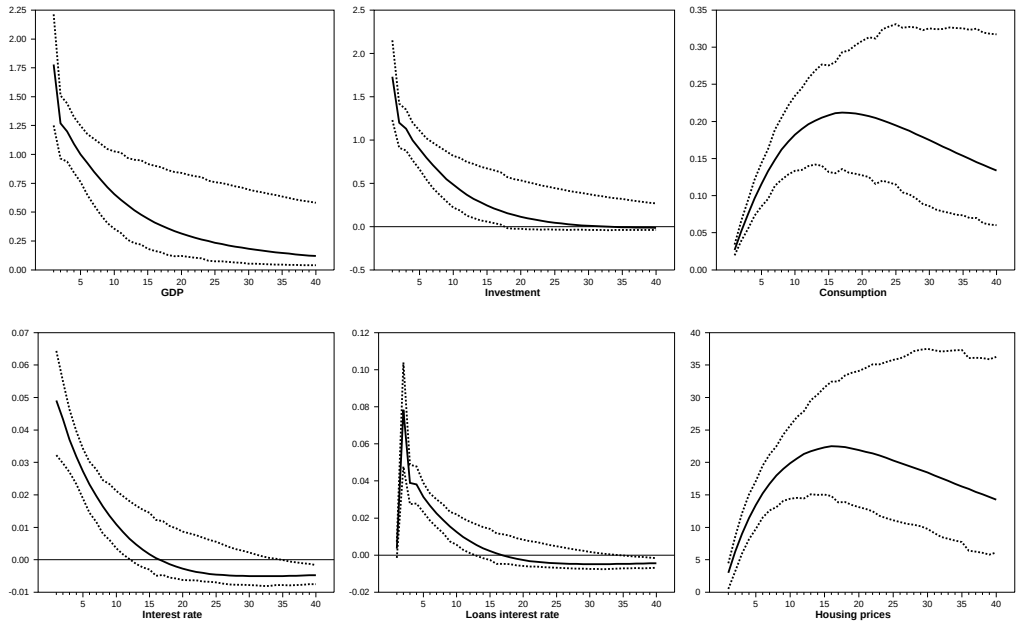

Figure 2: Impulse Response Functions to Productivity Shocks

These results suggest a positive spillover effect from the aggregate economy to the housing sector. Iacoviello (2005) and Iacoviello e Neri (2010) also find such positive effects.

5.2 The role of news shocks

In this section we focus our discussion on the response of our model to news shocks. The mechanism of transmission of the considered news shock is the following: Initially (time zero) the economy is in the steady state. At time one, unanticipated news arrives. Agents learn that there will be 1 percent permanent increase in A_t beginning one periods later, in period two. In other words, economic agents receive positive news about future income growth. Figure 3 illustrates the effects of a positive news shock to productivity.

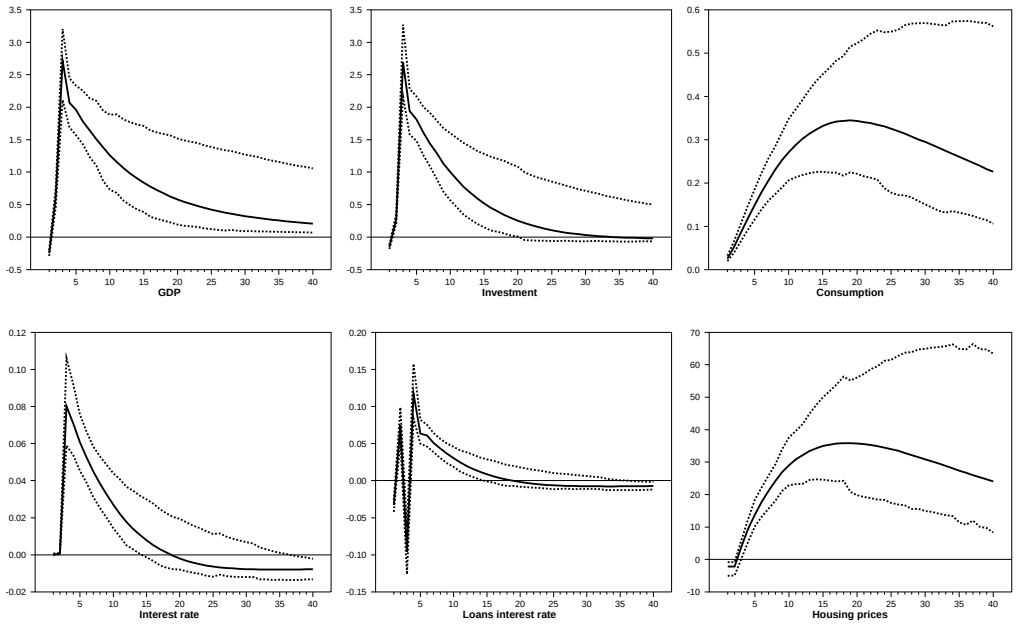

Figure 3: Impulse Response Functions to Anticipated Productivity Shock

This news shock causes housing prices and income to increase. This component makes impatient agents have greater access to credit, reinforcing an increase in current spending on housing and consumption. Due to higher demand for housing, current real estate prices also increase. In addition, due to credit limits, impatient families increase their labor supply to raise internal funds for housing investments. On the other hand, companies adjust the stock of capital at the moment the news comes. The stock of capital used as a production input in the consumer goods sector increases over time, thereby increasing the current investment. These effects were also observed in (Lambertini et al., 2013b; Ng e Feng, 2016).

5.3 Additional shocks

For completeness, we also consider other alternative shocks (housing preference, loan-to-value, public capital and capital adequacy). The top row of Figure 4 reports the impulse response of house prices to a positive innovation to housing preference and loan-to-value; the bottom row reports the impulse response to a shock to public capital and capital adequacy.

The housing preference shock is defined as an exogenous stochastic disturbance at the marginal rate of substitution between consumption goods and housing in the utility function of patient and impatient families. Given that housing supply is fixed, this shock is also known in the literature as a housing demand shock.

It is possible to perceive that the increase in the demand for real estate promotes an expansion in housing prices. In addition, as pointed out by Iacoviello e Neri (2010), this shock also eases the collateral restriction of impatient agents, allowing them to increase their indebtedness and consumption. Since impatient agents have a large marginal propensity to consume, then the effects of the preference shock on total consumption are positive, even if the consumption of creditors (not represented) decreases. It should be noted that, as occurred in the productivity shock, the increase in the demand for loans causes the bank to readjust the financing rate to values above the steady state.

The effects of the shocks on productivity and preferences in real estate prices, presented above, are already reported in the literature for different economies (Iacoviello, 2005; Iacoviello e Neri, 2010; Silva et al., 2014; Besarria et al., 2016).

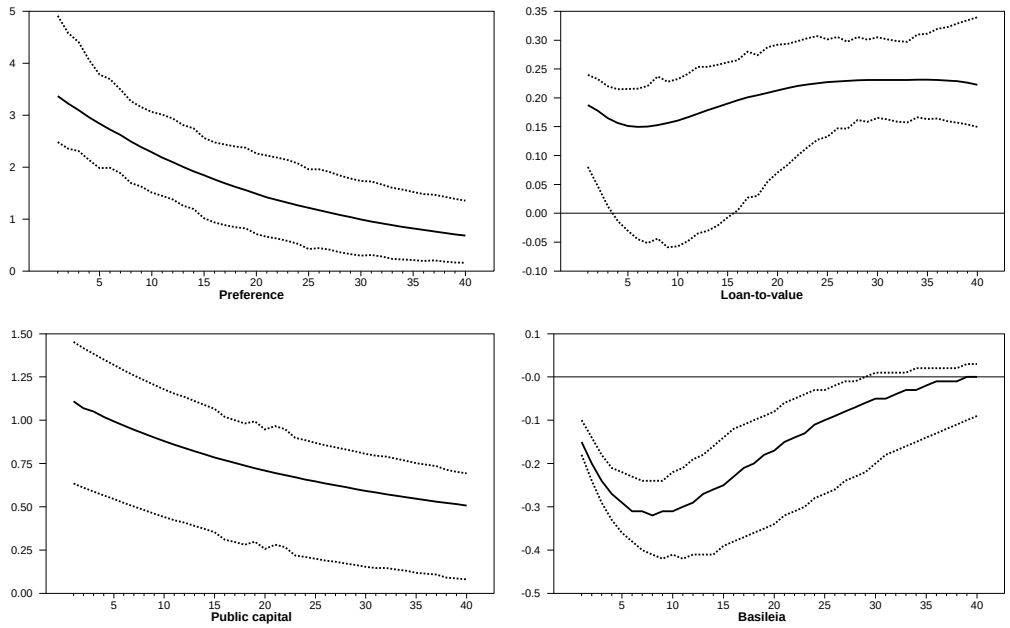

Figure 4: Effects of the shocks housing preference, loan-to-value, public capital and capital adequacy on the real estate prices

The effects of two financial shocks will also be described. The first is represented by imposed restrictions on the Loan-to-Value (LTV). This indicator is treated in the literature as a macroprudential policy measure that aims to control credit and an possible instability in the banking sector. In treating this indicator as an exogenous shock it is possible to perceive that our results reinforce the argument that the increase in households' indebtedness capacity stimulates the increase in housing demand, housing prices and consumption. On the other hand, the expansion in house prices, also used as collateral, reduces the possibility of default on bank loans and encourages banks to carry out a larger number of loans to households. This expansion in credit results in higher household indebtedness and an expansion in housing prices.

The second financial shock is represented by the increase (the higher γ) the utility cost of reducing loans. Intuitively, γ functions as a multiplier of the loans and magnification of this indicator implies that for each R$ 1.00 deposited, the lower the amount of loans made. In this case, the effects are contrary to those described by the credit expansion via the LTV shock.

In this case, as described in Iacoviello (2015), the increase in this indicator causes the banker to consume more today, reducing the availability of loans. By lending less, the bank tightens its borrowing constraint, since it reduces its equity. The result of this process is a reduction in the consumption of impatient families and the demand for housing and housing prices.

5.4 The impact of housing subsidies

Housing subsidies in Brazil are provided through programs such as MCMV and interest rate policies subsidized that reduce the cost of real estate credit in relation to market financing

costs. The subsidies for the acquisition of real estate by low-income individuals, adopted as a housing policy in Brazil, can be considered as one of the mechanisms that helped explain the increase in housing prices. In Brazil, the weight of the MCMV program, totaling government expenditures, was approximately 1,7%, representing 0,2% of GDP in 2015. In addition, in the period from 2011 to 2015 there was a real increase of 40% a.a. in capital expenditures of the MCMV program, according to data from the Ministry of Finance.

The subsidies, through the MCMV program, are related to the income brackets of individuals. According to the current rules, there are four income bands for financing, which are: Range 1: for families with monthly income of up to R$ 1.8 thousand; Range 1.5: monthly income limit of R$ 2.600; Range 2: monthly income limit of R$ 4 thousand and; Range 3: Monthly income limit of R$ 9 thousand. The subsidies on the purchase value of the property are differentiated between the bands. For Range 1, for example, the subsidy amount can reach 90% and these values change between the bands.

In the case discussed in this article, the hypothesis to be considered is that in the short term the supply of real estate is fixed and the subsidy to demand promotes an increase in real estate prices. Based on that, two scenarios will be considered: the first will admit an average real estate subsidy rate of 20% (this being the rate considered in previous years) and the second will assume that the government does not subsidize the purchase of real estate.

These scenarios will be used to verify if the adoption of a housing subsidy policy has potentiated the effects of the aggregate shocks (produtivity, news, housing preference, loan-to-value, public capital and capital adequacy) on the behavior of real estate prices in Brazil.

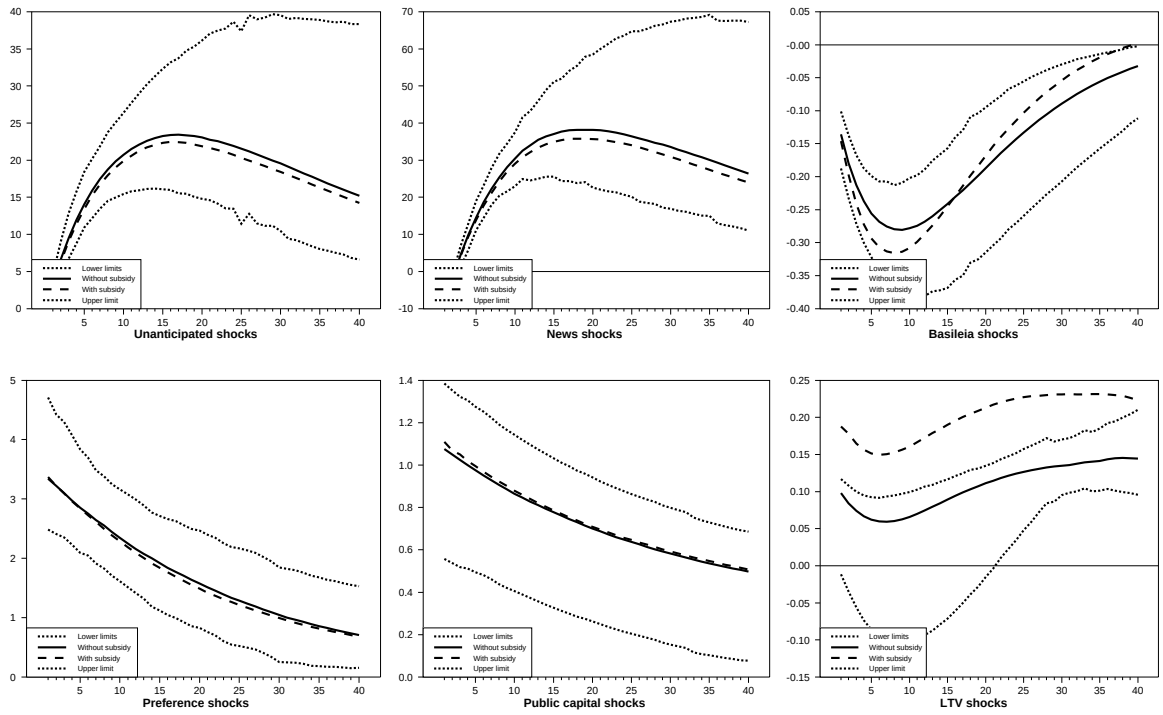

Figure 5: Effects of shocks housing preference, loan-to-value, public capital and capital adequacy on real estate prices

An analysis of the impulse response functions indicates that the inclusion of housing subsidies in the model little changes the transmission of aggregate shocks on the behavior of house

prices. As can be seen, only the combination of the government subsidy rate and the LTV shock brought different effects to the behavior of real estate prices. This is a result that is not surprising for the Brazilian economy.

In addition to the implementation of the policy of subsidies for the purchase of real estate, in 2010 there was a reduction in costs and expansion of access to housing finance, with, for example, maximum LTV passing from 70% to 80%. This mechanism can be seen as another explanation for the rapid growth of real estate prices in Brazil, suggesting that adjustments inthe subsidy rate with easing credit conditions may influence the price cycle.

5.5 Forecast error variance decomposition

Table 3 shows the quantitative importance of unanticipated, anticipated news, housing preference, public capital, risk credit and LTV shocks in explaining the cyclical movements of deposits, housing prices, loans, GDP and interest rates on loans will be described from the decomposition of variance.

Table 3: Forecast error variance decomposition for the stochastic process

	Unanticip.	Anticip.	Housing pref.	Pub. capital	Risk credit	LTV
Deposits	31.96	44.72	0.30	0.54	9.00	13.48
Housing prices	51.07	48.9	0.02	0.01	0.00	0.00
Loans	33.78	47.27	0.31	0.57	3.81	14.25
GDP	50.16	49.83	0.00	0.00	0.01	0.00
Interest rate loans	31.64	45.74	0.03	0.01	18.68	3.90

Source: Authors.

The combination of unanticipated, anticipated news and LTV gives the largest contribution to the deposits of patient families. Thereafter, the housing prices in Brazil is explained by the combination of shocks unanticipated (above 51%) and anticipated news (about 49%). A similiar finding was also reported by Fujiwara et al. (2011) and Ng e Feng (2016).

6 Conclusion

In this paper we study the sources of fluctuations in housing prices in the Brazilian economy, using a DSGE model. We focus on assessing the effects of subsidies and news shocks and unanticipated shocks on the cyclical behavior of housing prices.

The results show that productivity (anticipated and unanticipated) shocks and preferences for real estate positively affect the demand for real estate, promoting the expansion of housing prices. As a result of this expansion in prices, there is a relaxation in the collateral restrictions of impatient agents, allowing to increase their indebtedness and consumption. Therefore, our results support the idea that the wave of good news, optimistic behavior and government policies aimed at the housing sector were behind the behavior of housing prices in Brazil.

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