Real estate market, credit and Real Business Cycles: evidences from a DSGE model for the US economy

Vinícius Phillipe de Albuquerquemello[a] and Cássio da Nóbrega Besarria[b]

[a] *Graduate Program in Economics (PIMES), Pernambuco, Brazil.*
[b] *Graduate Program in Applied Economics, Paraíba, Brazil.*

Área 4 - Macroeconomia, Economia Monetária e Finanças

Resumo

Este artigo tem como objetivo investigar o efeito dos mercados imobiliário e de crédito no Ciclo de Negócios Real. Especificamente, testamos a inclusão de aluguel habitacional para a análise de algumas políticas econômicas, por exemplo, uma mudança no valor dos empréstimos concedidos em relação à garantia, dada pelo parâmetro Loan to value (LTV). Para responder a esse objetivo, são utilizados modelos de Equilíbrio Geral Dinâmico e Estocástico (DSGE) com características da economia dos EUA. Como resultado, pode-se observar que a adição de aluguéis destaca os efeitos de alguns choques nas variáveis econômicas, como o consumo e a produção agregada. Este fato se deve à introdução da possibilidade de decidir entre a compra ou locação de imóveis e suas conseqüências para a economia. Outra constatação importante foi que a disposição dos banqueiros em emprestar se torna o segundo fator mais relevante para o desempenho da economia no curto e médio prazo, perdendo apenas para a Produtividade Total dos Fatores.

Palavras-chave: Mercado imobiliário; Alugueis; Ciclo Real de Negócios; DSGE.

Abstract

This paper aims to investigate the effect of real estate and credit markets on the Real Business Cycle. Specifically, we test the inclusion of housing rent for the analysis of some economic policies, for example, a change in the amount of loans granted in relation to collateral, given by Loan-to-value (LTV) parameter. In order to respond to this goal, Dynamic and Stochastic General Equilibrium (DSGE) models with characteristics of the US economy are used. As a result, it can be seen that the addition of rents highlights the effects of some shocks on economic variables, such as consumption and aggregate output. This fact is due to the introduction of the possibility of deciding between the purchase or rental of real estate and its consequences for economy. Another important finding was that the bankers' willingness to lend becomes the second most relevant factor for the performance of the economy in the short and medium term, second only to Total Factor Productivity.

Key-words: Real estate market; Rents; Real Business Cycle; DSGE.

JEL Classification: E20, E32, E37.

1 Introduction

The importance of asset prices on financial variables and their consequent macroeconomic implications is increasingly discussed in the academic world and by policy makers. Specifically, this new focus began with the work of Bernanke e Blinder (1988), which demonstrated the credit channel of monetary policy [1] and their respective importance. Then came the studies of Bernanke e Gertler (1995), Kiyotaki e Moore (1997) and Bernanke e Gertler (2000) which investigated the role of stock prices on the total amount of loans and the instability that the price volatility of those assets could cause.

From the mid-2000s, with the appearance of signs of a housing bubble in the United States, detected by the work of Case e Shiller (2003), McCarthy e Peach (2004), Zhou e Sornette (2006), Goodman e Thibodeau (2008) (Subprime crisis). [2], much of the empirical literature has turned to the analysis of the role of real estate assets.

In this sense, the seminal article of Iacoviello (2005) interrelated for the first time the value of housing to the total credit of the economy, through collateral of loans. Then, Greiber e Setzer (2007) tested the existence of interactions as causality and co-integration between the demand for money and the variables of the housing market of the United States and the Euro Zone. Then, Goodhart e Hofmann (2008) found the existence of a financial accelerator in periods of *boom* in home prices. Later, Iacoviello e Minetti (2008) proved the existence of the relationship between the credit channel of monetary policy and the price of housing in several countries, for example, Finland, Germany, Norway and the United States, which was also transcribed in the work of Cesa-Bianchi (2013) for 17 countries. Soon after, Iacoviello e Neri (2010) examined the spillover effect of a valuation on real estate prices for non-durable consumer spending. Finally, we mention the work of Iacoviello (2015), which emphasized the importance of real estate assets for macroeconomics by demonstrating how mortgage defaults led to the general breakdown of the American financial system. For this, the author modelled the process of financial inter-mediation based on the papers of Gertler, Kiyotaki et al. (2010) and Gerali et al. (2010).

Adding a little more to the investigation of the role of real estate prices on the economy, Musso, Neri e Stracca (2011), Xiao (2013), Sun e Tsang (2014), Mora-Sanguinetti e Rubio (2014), Ngo (2015) and **??**) articulated models for monetary policy; Li et al. (2015) examined the co-movement and causal relationships between the real estate market and the US stock market; Mora-Sanguinetti e Rubio (2014) and Alpanda e Zubairy (2016) illustrated the effects of housing policies, for example, subsidies on home-ownership acquisition; Rubio e Carrasco-Gallego (2016) and Falagiarda e Saia (2017) investigated macroprudential policy, such as changes in the Basel rules 1,2 and 3, and endogenous Loan-to-value (LTV parameters with systemic and idiosyncratic risks), respectively; Anundsen (2015) and Suh e Walker (2016) enumerated new *ex-post* explanations for the Subprime crisis.

According to Iacoviello (2010), this incessant search for a greater understanding of the relationship between the real estate market and the aggregate economy comes as no surprise when considering seven important facts. Firstly, almost half of the family wealth in developed countries is in the form of housing. Secondly, housing wealth is higher than GDP, in the United States, for example, it represents, on average, 1.5 times. Thirdly, the time series of consumption expenditures and housing value co-move over time, with an average correlation of 0.47. Fourthly, movements in housing wealth are highly related to changes in housing investment. Fifthly, movements in house prices are little related to fluctuations in the overall level of prices of non-durable goods and services

[1] The credit channel of monetary policy consists of the transmission mechanism in which a flexibilization of remuneratory interest rate on government securities leads to changes in agents' savings decisions in the form of demand and savings deposits with bankers. With this, there is an oscillation in the amount available for loans, increasing or decreasing the economic level.

[2] The Subprime crisis occurred in the United States between 2007 and 2009 when mortgage defaults led many banks to bankruptcy, with a consequent worldwide repercussion through the stock exchange.

and should be taken into account separately when analyzing inflation. Sixthly, housing investment drives non-housing investment. Finally, in the last 45 years, there is a strong upward trend in property prices in the United States.

Despite all the aforementioned studies relating the real estate market and the macroeconomics, there is a considerable gap with the absence of studies that include the rental market. By reviewing the empirical literature, it was verified that only Mora-Sanguinetti e Rubio (2014) presented a model of economy with residential rents. However, it was only to evaluate the effects of subsidies on the acquisition of own house or of the deduction in income tax on housing acquired, in Spain and the euro area. Thus, it neglected the important role that this secondary market has in most developed or emerging economies.

Thus, this paper has the purpose of developing a macroeconomic model that takes into account the secondary market of rents. Next, it seeks to verify the effects of some economic policies and exogenous shocks on the economy, to mention: an increase in total factor productivity (TFP); a change in the preference for real estate; a variation in the willingness to borrow from the bankers, given by the LTV.

In order to accomplish the objective proposed, Dynamic and Stochastic General Equilibrium (DSGE) models were constructed with characteristics of the US economy. Then we computationally simulated it using parameters estimated by other authors, reviewed in the empirical literature. Next, we made a comparison between two versions, one with the inclusion of the secondary market of rents and another without. Thus we pointed out the main differences regarding the behavior of the variables in relation to economic policies or exogenous shocks, to mention: a TFP shock; variations in the preference for real estate; and, a positive shock in the LTV. Finally, we made some economic interpretations of the results regarding economic policy.

In short, the inclusion of the rental market has brought the following results. In the first place, it is assumed that under the presence of the tested economic policy shocks, the economic variables of the proposed structure maintained behavior (sign and trajectory) as expected by the review of the empirical literature. That is, this study does not contradict traditional papers involving Real Business Cycles. Second, the addition of the rental market has allowed us to examine how the decision between buying and renting housing influences the economy as a whole. Hence, one has an important finding, which is the role of credit in the economy. According to the study, this one becomes the second major definer of the short and medium term oscillations, being captured by variations in the willingness to borrow from the bankers, given the LTV parameter.

The rest of the paper is organized as follows. Section 2 states the methodology of the work and the empirical model; section 3 points out the results of the research; section 4 expresses the final considerations about the study.

2 Methodology

In this section, the methodological development of the study is recorded. Firstly, it was built two economy models, one including rental market and another without it. Then we simulated computationally their dynamic and stochastic equilibrium. Finally, we analyzed the results of impulse-response functions and variance decomposition.

The economies described here have a stochastic dynamic general equilibrium (DSGE) format, with characteristics of the US economy. The dynamics of these models were calibrated and simulated according to parameters estimated in the recurrent empirical literature. The behavior of the endogenous variables was examined by means of impulse-response functions and analysis of the variance decomposition.

2.1 Model economy

As mentioned earlier, two canonical models were created, one with the inclusion of rents and another without it. Below, we presented only the version with rents, once the other has similar structure. To schematize the economic model below, we consulted some recent works that made use of DSGE structure. Notably, we extracted the financial inter-mediation from Iacoviello (2015), the real estate market format from Mora-Sanguinetti e Rubio (2014) and Rubio e Carrasco-Gallego (2016), and the family structure from Alpanda e Zubairy (2016). In addition, we made some changes in the functioning of this economy by including loans based on household wages.

In general, the economy proposed here records the following agents: patient households, who are savers and owners of capital and own housing; impatient households, who are spenders and take loans based on their housing; renters, who are also spenders and take loans based on their real wages. [3]; firms producing consumer goods; bankers.

The households act rationally and maximize their utility through consumption, leisure (or even labor supply), and housing. Since the patient households can save the remaining fraction of their income in the form of deposits with bankers, the impatient households can anticipate inter-temporal consumption through loans. These concessions are granted in proportion to wages or real estate, given as collateral. In this way, borrowers receive an amount that represents only a fraction of their value. This percentage is regulated by the monetary authority, and is known as loan-to-value, LTV.

The firms maximize their profits through the production of consumer goods required by households. For this, they hire labor and capital, remunerating these factors of production with salaries and rents, respectively.

The bankers are the financial intermediaries of this economy and hold the savings of patient households as deposits. These funds are used to grant loans to other economic agents, receiving an interest rate in exchange. Due to the custody of money, bankers pay an interest rate to patient households.

In the economy model proposed here, there is no monetary policy rule, since it intends to approach the effects of economic policy from the perspective of the credit channel of the economy. In this way, the Central Bank acts only as a regulatory and supervisory body of the national financial system.

The functioning of this economy is outlined in the figure below.

[3] It is assumed that the renters do not buy their own housing due to lack of financial resources and not by personal decision. Another assumption we undertook was that there is no mobility of families between their classifications.

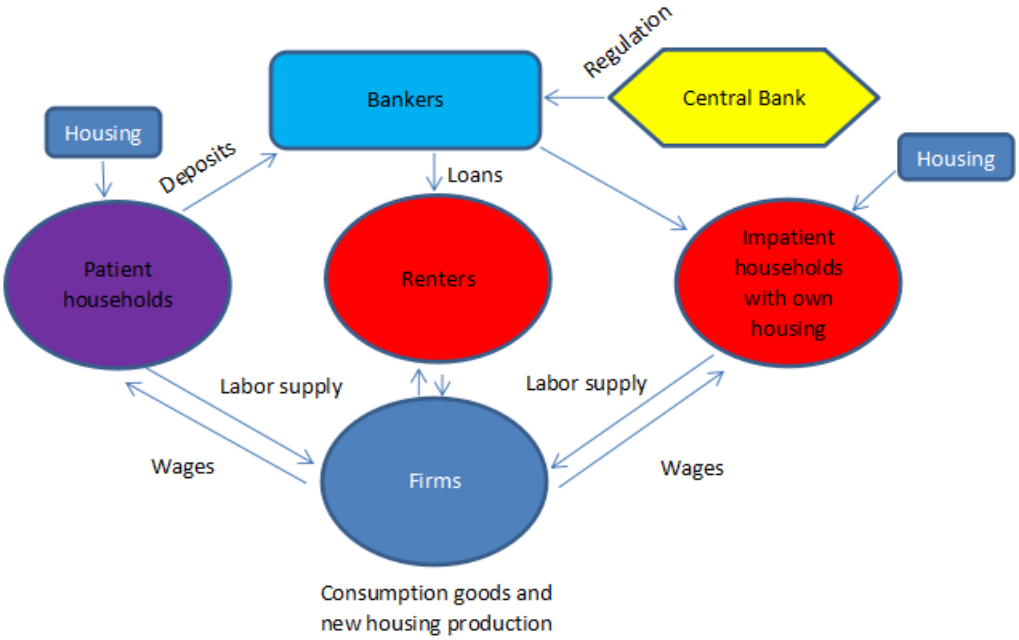

Figure 1: Model economy

Source: authors' elaboration.

2.1.1 Patient households

Patient households maximize their utility according to the following equation:

$$maxE_t \sum_{t=0}^{\infty} \beta_1^t (C_{1,t}, H_{1,t}, N_{1,t})$$

where β_1^t denotes the discount factor of this representative agent, informing how much it values utility in the present time in the detriment of future utility. $C_{1,t}$, $H_{1,t}$ and $N_{1,t}$ represent the consumption, demand for housing and labor supply that the family will perform.

The problem of utility maximization of the patient families is subject to the following budget constraint:

$$\begin{aligned} C_{1,t} + K_t + D_t + Q_t^H[(H_{1,t} - H_{1,t-1}) + (H_{2,t} - H_{2,t-1})] \\ = [R_{1,t} + (1-\delta)]K_{t-1} + R_{2,t-1}D_{t-1} + W_{1,t}N_{1,t} + Q_t^Z H_{2,t}. \end{aligned} \tag{1}$$

where K_t represents the stock of capital that the patient family owns and receives a rate of return $R_{1,t}$ and depreciates at a rate δ, after each period; Q_t^H denotes the price of houses; Q_t^Z is the rent received by the patient families of the tenant families; $W_{1,t}$ is the real wage; D_t is the portion of the income that is not spent and is saved in the form of deposits with the bankers ; $R_{2,t-1}$ is the remuneration received from deposits from the previous period ,D_{t-1}, being recorded at the end of each period.

Taking the partial derivatives of each time variable and performing some algebraic manipulation, we obtain the following First Order Condition - FOC, whose meaning of each one is in parentheses:

$$\frac{\partial \mathcal{L}}{\partial C_{1,t}} : \lambda_{1,t} = \frac{1}{C_{1,t}}; \tag{2}$$

(Shadow price 1)

$$\frac{\partial \mathcal{L}}{\partial H_{1,t}} : \frac{A_{j,t}}{H_{1,t}} + \beta_1 E_t \left(\frac{Q^H_{t+1}}{C_{1,t+1}} \right) = \frac{Q^H_t}{C_{1,t}}; \tag{3}$$

(Patient households housing demand)

$$\frac{\partial \mathcal{L}}{\partial N_{1,t}} : \frac{W_{1,t}}{C_{1,t}} = \frac{1}{1 - N_{1,t}}; \tag{4}$$

(Patient households labor supply)

$$\frac{\partial \mathcal{L}}{\partial K_t} : E_t \left(\frac{C_{1,t+1}}{C_{1,t}} \right) = \beta_1 E_t [R_{1,t+1} + (1 - \delta)]; \tag{5}$$

(Rental rate of capital)

$$\frac{\partial \mathcal{L}}{\partial H_{2,t}} : Q^H_t - Q^z_t = \beta_1 E_t \left[\left(\frac{C_{1,t}}{C_{1,t+1}} \right) Q^H_{t+1} \right]; \tag{6}$$

(Housing rents)

$$\frac{\partial \mathcal{L}}{\partial D_t} : R_{2,t} = \frac{1}{\beta_1} E_t \left(\frac{C_{1,t+1}}{C_{1,t}} \right). \tag{7}$$

(Bank deposits return)

$$\frac{\partial \mathcal{L}}{\partial \lambda_{1,t}} : C_{1,t} + K_t + D_t + Q^H_t [(H_{1,t} - H_{1,t-1}) + (H_{2,t} - H_{2,t-1})] = \\ [R_{1,t} + (1 - \delta)] K_{t-1} + R_{2,t-1} D_{t-1} + W_{1,t} N_{1,t} + Q^Z_t H_{2,t}. \tag{8}$$

(Patient households budgetary constraint)

2.1.2 Impatient households with own housing

Impatient households with own housing maximize their utility according to the following equation:

$$max E_t \sum_{t=0}^{\infty} \beta_2^t (C_{2,t}, H_{3,t}, N_{2,t})$$

where $\beta_2 < \beta_1$. Which means this family values more the present utility than a future utility gain.

We emphasize that the problem of this type of family is analogous to that of the patient families. However, these do not have capital, nor do they receive rents. Moreover, as they prefer to

consume today in detriment of savings, they borrow against the value of their homes and current real wages. So, their utility maximization problem is restricted by the following budgetary constraint.

$$\begin{aligned} C_{2,t} + Q_t^H(H_{3,t} - H_{3,t-1}) + R_{3,t-1}L_{1,t-1} + R_{3,t-1}L_{2,t-1} \\ = W_{2,t}N_{2,t} + L_{1,t} \end{aligned} \tag{9}$$

where $L_{1,t}$ is the total of loans obtained by impatient households for consumption, giving as guarantee their housing; $L2_t$ are the loans based on salary. For this received amounts, this representative agent pays the bankers an interest rate, $R_{3,t}$, on the amount every period.

The total amount received as loans represents a portion of the value of households plus a fraction of the wages of impatient households. In addition, it also depends on the amount taken in the previous period. This percentage is defined by a parameter known as Loan to value - LTV, and is established by the Central Bank as a measure of credit risk control and follows the equation described below.

$$L_{1,t} \leq \rho_1 L_{1,t-1} + (1-\rho_1)E_t\left[\left(\frac{m_1 Q_{t+1}^H H_{3,t}}{R_{3,t}}\right) + m_2(W_{2,t}N_{2,t})\right] \tag{10}$$

where ρ_1 denotes the weight that is given to the amount taken in the previous period, hence $1-\rho_1$ is the proportion assigned to the current guarantees for the granting of new loans. m_1 and m_2 represent LTV for real estate and wages, respectively.

Taking the partial derivative of each time variable from the above equation, we arrive at the following FOC:

$$\frac{\partial \mathcal{L}}{\partial C_{2,t}} : \lambda_{2,t} = \frac{1}{C_{2,t}}; \tag{11}$$

(Shadow price 2)

$$\frac{\partial \mathcal{L}}{\partial H_{3,t}} : \frac{A_{j,t}}{H_{3,t}} + \frac{\phi_{2,t}}{C_{2,t}}(1-\rho_1)m_1 E_t\left(\frac{Q_{t+1}^H}{R_{3,t}}\right) + \beta_2 E_t\left(\frac{Q_{t+1}^H}{C_{2,t+1}}\right) = \frac{Q_t^H}{C_{2,t}}; \tag{12}$$

(Impatient households housing demand)

$$\frac{\partial \mathcal{L}}{\partial N_{2,t}} : \frac{W_{2,t}}{C_{2,t}} + \frac{\phi_{2,t}}{C_{2,t}}(1-\rho_1)m_2 W_{2,t} = \frac{1}{1-N_{2,t}}; \tag{13}$$

(Impatient households labor supply)

$$\frac{\partial \mathcal{L}}{\partial L_{1,t}} : R_{3,t} = \frac{1}{\beta_2}E_t\left(\frac{C_{2,t+1}\,(1-\phi_{2,t})}{C_{2,t}}\right) - E_t\left(\phi_{2,t+1}\rho_1\right); \tag{14}$$

(Loan interest rate)

$$\begin{aligned} &\frac{\partial \mathcal{L}}{\partial \lambda_{2,t}} : C_{2,t} + Q_t^H(H_{3,t} - H_{3,t-1}) + R_{3,t-1}L_{1,t-1} = W_{2,t}N_{2,t} + L_{1,t} \\ &-\phi_{2,t}\left[L_{1,t} - \rho_1 L_{1,t-1} - (1-\rho_1)m_1 E_t\left(\frac{Q_{t+1}^H}{R_{3,t}}H_{3,t}\right) + m_2(W_{2,t}N_{2,t})\right]; \end{aligned} \tag{15}$$

(Impatient households budgetary constraint)

$$\frac{\partial \mathcal{L}}{\partial \phi_{2,t}} : L_{1,t} \leq \rho_1 L_{1,t-1} + (1-\rho_1) m_1 E_t \left(\frac{Q^H_{t+1}}{R_{3,t}} H_{3,t} \right) + m_2 (W_{2,t} N_{2,t}). \tag{16}$$

(Impatient households' loans demand)

2.1.3 Renters

Impatient households without own housing, also named as renters, obtain utility by consumption of goods, leisure time, and habitation. Just as follows.

$$max E_t \sum_{t=0}^{\infty} \beta_3^t (C_{3,t}, H_{2,t}, N_{3,t})$$

This problem is constrained by the following budget:

$$C_{3,t} + Q^Z_t H_{2,t} + R_{3,t-1} L_{2,t-1} = W_{3,t} N_{3,t} + L_{2,t} \tag{17}$$

Since this agent does not have a home, he can only take loans based on his salary. And the collateral constraint is now denoted by the expression below.

$$L_{2,t} \leq \rho_2 L_{2,t-1} + (1-\rho_2) m_2 (W_{3,t} N_{3,t}) \tag{18}$$

Considering a logarithmic instantaneous utility function in each input and applying dynamic optimization, we obtain the following FOCs:

$$\frac{\partial \mathcal{L}}{\partial C_{3,t}} : \lambda_{3,t} = \frac{1}{C_{3,t}}; \tag{19}$$

(Shadow price 3)

$$\frac{\partial \mathcal{L}}{\partial H_{2,t}} : Q^Z_t = \frac{C_{3,t} A_{j,t}}{H_{2,t}}; \tag{20}$$

(Rental housing demand)

$$\frac{\partial \mathcal{L}}{\partial N_{3,t}} : \frac{W_{3,t}}{C_{3,t}} + \frac{\phi_{3,t}}{C_{3,t}} (1-\rho_2) m_2 W_{3,t} = \frac{1}{1-N_{3,t}}; \tag{21}$$

(Renters labor supply)

$$\frac{\partial \mathcal{L}}{\partial L_{2,t}} : R_{3,t} = E_t \left(\frac{C_{3,t+1}}{C_{3,t}} \right) \frac{1}{\beta_3} (\phi_{3,t} - 1) - E_t (\phi_{3,t+1} \rho_2); \tag{22}$$

(Loans interest rate)

$$\frac{\partial \mathcal{L}}{\partial \lambda_{3,t}} : C_{3,t} + Q_t^Z H_{2,t} + R_{3,t-1} L_{2,t-1} = W_{3,t} N_{3,t} + L_{2,t} \\ -\phi_{3,t} \left[L_{2,t} - \rho_2 L_{2,t-1} - (1-\rho_2) m_2 (W_{3,t} N_{3,t}); \right. \tag{23}$$

(Renters budgetary constraint)

$$\frac{\partial \mathcal{L}}{\partial \phi_{3,t}} : L_{2,t} \leq \rho_2 L_{2,t-1} + (1-\rho_2) m_2 (W_{3,t} N_{3,t}). \tag{24}$$

(Renters demand for loans)

2.1.4 Bankers

Bankers solve their utility maximization problem in order to optimize banking consumption, as shown below.

$$max E_t \sum_{t=0}^{\infty} \beta_4^t log C_{4,t}$$

this problem is subject to the following budgetary constraint

$$C_{4_t} + R_{2,t-1} D_{t-1} + L_t = D_t + R_{3,t-1} L_{t-1} \tag{25}$$

and to the following capital adequacy condition, originating from the Basel Committee for Banking Supervision. This establishes that bank capital must in the limit be equal to the total amount lent.

$$D_t \leq \gamma L_t \tag{26}$$

, where $L_t = L_{1,t} + L_{2,t}$ and γ is a parameter established by macro-prudential policy to control systemic banking risk. Applying dynamic optimization, we have the following FOCs:

$$\frac{\partial \mathcal{L}}{\partial C_{4,t}} : \lambda_{4,t} = \frac{1}{C_{4,t}}; \tag{27}$$

(Shadow price 4)

$$\frac{\partial \mathcal{L}}{\partial D_t} : \phi_{4,t} = 1 - \beta_4 E_t \left(\frac{C_{4,t} R_{2,t}}{C_{4,t+1}} \right); \tag{28}$$

(Banking deposits gross return)

$$\frac{\partial \mathcal{L}}{\partial L_t} : \phi_{4,t} = \frac{1}{\gamma} \left[1 - \beta_4 E_t \left(\frac{R_{3,t} C_{4,t}}{C_{4,t+1}} \right) \right]; \tag{29}$$

(Loans interest rate)

$$\frac{\partial \mathcal{L}}{\partial \lambda_{4,t}} : C_{4_t} = D_t + R_{3,t-1}L_{t-1} - R_{2,t-1}D_{t-1} - L_t + \phi_{4,t}[D_t - \gamma L_t]; \tag{30}$$

(Bankers budgetary constraint)

$$\frac{\partial \mathcal{L}}{\partial \phi_{4,t}} : D_t = \gamma L_t. \tag{31}$$

(Compulsory reserves)

2.1.5 Firms

Firms obtain utility by maximizing their profits, denoted by the difference between total revenues and production costs. In this way, they act according to the following equation.

$$\pi_t = P_t Y_t - W_t N_t - R_{1,t} K_t \tag{32}$$

, where Y_t is the output generated by the firm using the capital inputs, K_t, and labor, N_t, and has the format described below. P_t is the price received for each unit of output generated.

$$Y_t = A_{Z,t} K_t^{\alpha} N_t^{1-\alpha}. \tag{33}$$

$A_{Z,t}$ is the firm's productive technology, also known as Total Factor Productivity, TFP, and is characterized as an auto-regressive process of order 1, AR (1). N_t is the aggregate labor force, given by the following equation.

$$N_t = N_{1,t}^{\psi_1} N_{2,t}^{\psi_2} N_{3,t}^{\psi_3} \tag{34}$$

Finding the maximum of the function with respect to each input, the following first order conditions arise:

$$R_{1,t} = \alpha \frac{Y_t}{K_t}; \tag{35}$$

(Capital rental rate)

$$W_{1,t} = (1-\alpha)\frac{Y_t}{N_{1,t}}; \tag{36}$$

(Patient household wages)

$$W_{2,t} = (1-\alpha)\frac{Y_t}{N_{2,t}}; \tag{37}$$

(Impatient household with own housing wages)

$$W_{3,t} = (1-\alpha)\frac{Y_t}{N_{3,t}}. \tag{38}$$

(Renters wages)

2.1.6 Model equilibrium

The general equilibrium in this competitive environment can be obtained by considering all the budgetary constraints imposed on the economy. As well, two additional conditions. The first is the output of the economy is formed by consumption and investment. The second is to make the total amount of real estate in the economy, H_t, as a numeraire, allowing to find its price, Q_t^Z. As follows:

$$Y = C_{1,t} + C_{2,t} + C_{3,t} + C_{4,t} + I_t; \tag{39}$$

and

$$H_{1,t} + H_{2,t} + H_{3,t} = 1. \tag{40}$$

The parameters used for calibration and simulation of this model are listed in the Table 1, of the following subsection.

2.2 Calibration parameters

For simulation of the model, the posterior parameters were extracted from several recent papers where authors incurred in Bayesian estimation, as presented in Table 1.

Table 1: Calibration parameters

Symbol	**Description**	**Value**
α	Capital to output ratio	0.448
ψ_1	Patient households proportion on work force	0.19
ψ_2	Impatient households with own housing proportion on work force	0.54
ψ_3	Renters proportion on work force	0.27
β_1	Discount factor 1	0.9925
β_2	Discount factor 2	0.94
β_3	Discount factor 3	0.94
β_4	Discount factor 4	0.945
δ_{KC}	Capital depreciation rate (consumption goods sector)	0.015
δ^H	Capital depreciation rate (construction industry)	0.01
γ	Compulsory reserves	0.9
m_1	LTV on housing	0.9
m_2	LTV on wages	0.9
ρ_1	Loan 1 inertia	0.7
ρ_2	Loan 2 inertia	0.7
ρ_3	Consumption goods production inertia	0.988
ρ_4	Housing preferences inertia	0.992
ρ_5	Bankers willingness to lend inertia	0.873
σ	Relative risk aversion	0.52
ς	Labor elasticity of substitution	1

Source: authors' elaboration.

Most of the parameters were taken from the work of Iacoviello (2015), in order to maintain the simulation as close as possible, for later comparison of the results. The exceptions were the proportion

of the labor force of families 1, 2 and 3 in the labor force. These were taken from the work of Alpanda e Zubairy (2016).

To analyze the stochastic shocks on the economic variables, we considered disturbances in the auto-regressive processes of order 1, AR (1), mentioned above. In general, we took a standard deviation of 0.01, which corresponds to a variation of 1 %, per period. What is recurrent in the empirical literature, following papers such as in Gertler, Kiyotaki et al. (2010), Iacoviello (2015) and Suh e Walker (2016).

3 Results and discussion

In this section, we compare the results between models with and without the inclusion of rents, in order to examine the effect generated by the addition of this secondary market.

3.1 Canonical models with and without the inclusion of the rental market

The model without rental market follows the structure registered in the canonical version of Iacoviello (2015). The second model confronted is the expansion of it with real estate rent. Impulse-response functions were used to examine total factor productivity shocks in the production of consumption goods (TFP); housing preferences, which is basically a collision of demand for real estate; and bankers willingness to lend, which is understood as a shock on LTV. As an additional exercise, the variance decomposition between the versions were compared.

3.1.1 Impacts of a Total Factor Productivity shock

The analysis of a shock in total factor productivity is the most common exercise conducted in the Real Business Cycle - RBC models. Since the equation **??** is the simple denotation of a stochastic disturbance on the economy. In this case, it represents a technological advance that makes the means of production and economic agents more productive. This investigation was first carried out by Kydland e Prescott (1982) and Long e Plosser (1983), but also in the recent work of Iacoviello (2005), which includes a real estate market. Generally, it is driven by impulse-response functions and by the decomposition of the variance, determining the economic dynamics in the periods after the disturbance.

According to the aforementioned authors, a shock in the total factor productivity is expected to stimulate investment and hiring of more employees, generating more income for families and a higher level of consumption and output. In this way, the increase in the equilibrium income will also result in the possibility of a larger mortgage loan, which, in turn, will raise the price of housing. Consequently, there will also be a greater volume of demanded credit, higher interest rates and the remuneration of savings deposits.

Thus, in the figure 2 a comparison of the impulse-response functions between models with and without rental is made for a variation in total factor productivity. Hence, we verify whether the results are according to the empirical literature and what are the innovations generated by this new scheme on analysis of economic policy.

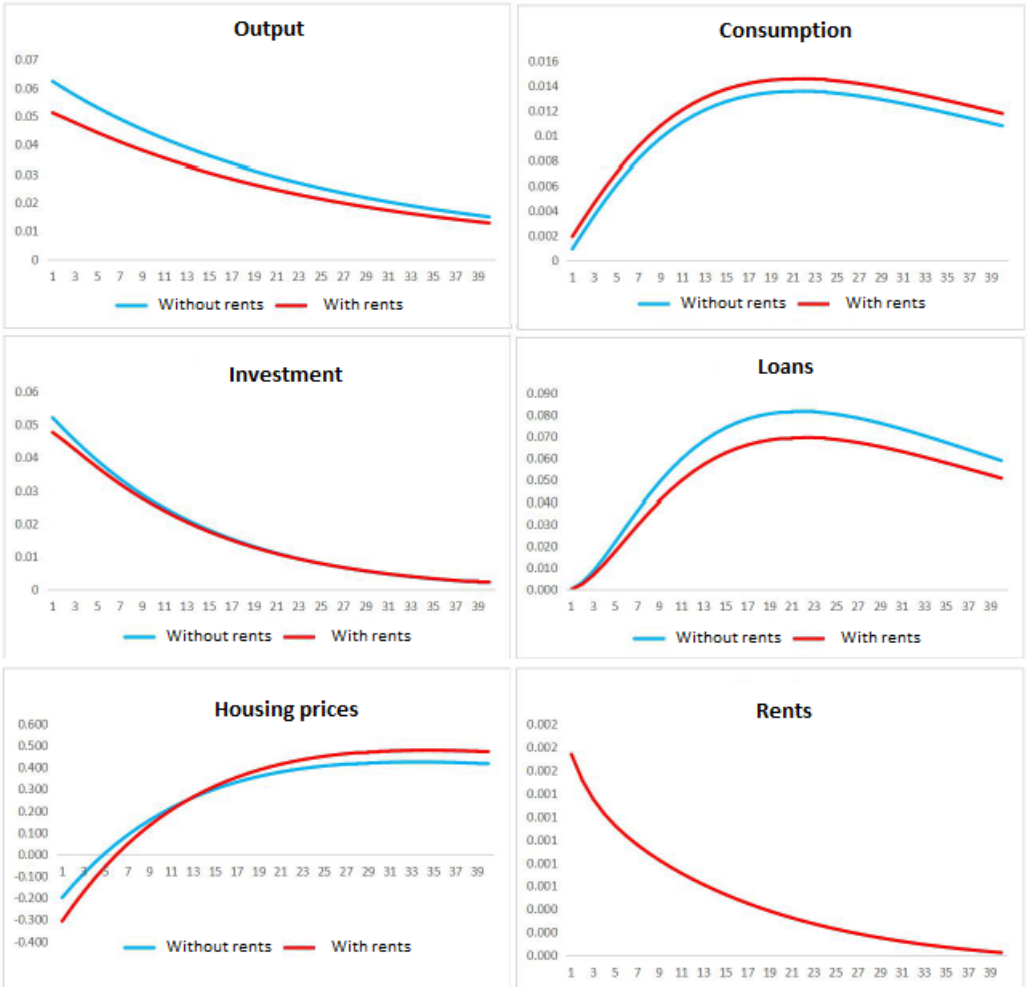

Figure 2: Comparison of impulse-response functions - TFP shock.

Source: authors' elaboration.

From the figure 2, it is noticed that the inclusion of rents does not change the behavior, sign and trajectory, of the variables before the TFP shock, following the result registered in Iacoviello (2005), presented in appendix A of the work. As the main differences, we can see the reductions in the effects on output, consumption, investment, loans and real estate prices. This is probably due to the fact that the inclusion of rents reduces by substitution effect the demand for real estate and, consequently, the prices of the same. It therefore reduces lending and the absolute effect of credit on consumption, investment and equilibrium output of the economy. The substitution between real estate and rental has already been verified in practice by several works, for example, Börsch-Supan e Pitkin (1988) Akerlof e Shiller (2015), Brando e Barbedo (2016).

3.1.2 Impacts of a housing preferences shock

A housing preferences shock can be understood as a sudden search of households for their own dwelling, or, according to the interpretation of Suh (2012), economic agents can obtain more utility by the use of housing services.

The housing preferences shock has its format modeled in the equation **??**. The analysis of its effect on economic policy was first carried out by Iacoviello (2005) and, according to this author, it is expected that they raise house prices, consequently, making possible a larger mortgage borrowing for consumption or demand of durable goods. Hence, having a positive effect on the aggregate output of the economy.

The comparison of the results for the models with and without the inclusion of rents, given a shock of preference for real estate, are shown in the figure below.

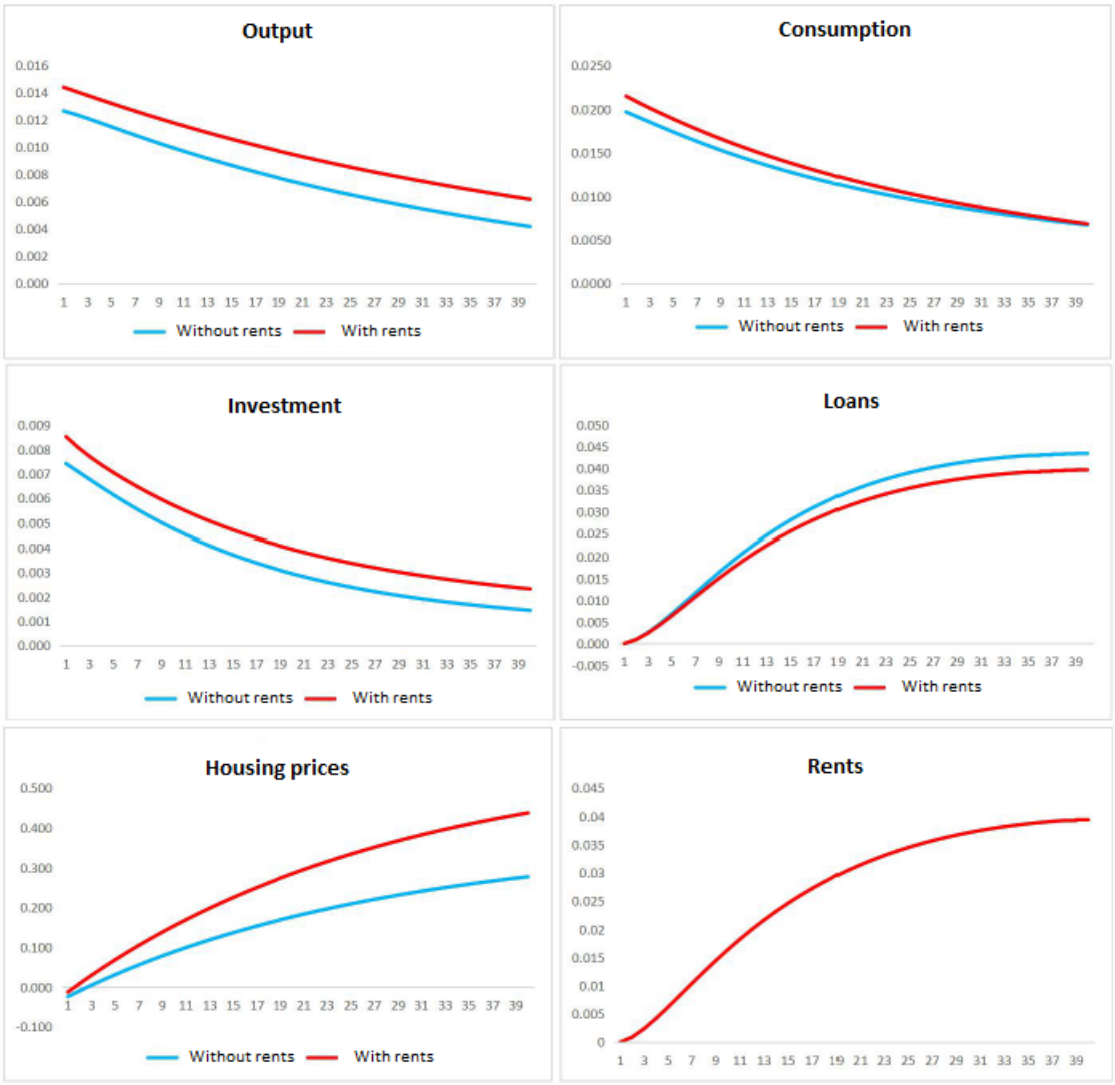

Figure 3: Comparison of impulse-response functions - Housing preferences shock

Source: authors' elaboration.

By the figure 3, it is observed that the behavior of the variables follows the pattern exposed by Iacoviello (2005). Thus, given a housing preferences shock, there is a rise in demand for real estate. Hence, as the housing supply is fixed, at least in short term, there is a sharp increase in real estate prices. For impatient families who own real estate, this means the possibility of a greater take of mortgage loans, these being used in the consumption of non-durable goods. Consequently, the aggregate output of the economy augments.

It is worth noting that the comparison between the versions with and without the rental market in the face of a housing preference clash shows an increase in the effect on consumption, investment, real estate prices and, lastly, the aggregate output. On the other hand, the demand for loans decreases. This change after the inclusion of rental is probably due to the fact that now the patient households have had their budgetary constraints amplified by the receipt of rents. Hence, they spend more demanding private and consuming property. As for the fall in the total amount borrowed in contrast to the version without rents, we affirm that the presence of tenant families mean a reduction in the collateral of mortgage loans. In this way, this representative agent only has

access to the credit giving as guarantee a portion of his salaries. This change in the household budget after receipt of rents was verified by Smith, Rosen e Fallis (1988) and Arnott (1995), when studying the effects of public controls on the rental market.

3.1.3 Impacts of a bankers willingness to lend shock

The LTV shock, here denoted as a variation on the willingness of bankers to lend to impatient households, was first recorded in Iacoviello (2015), from the introduction of financial inter-mediation into a DSGE model. This author points out that a loosening of credit conditions favors borrowing, increasing consumption, demand for real estate and, consequently, the aggregate output of the economy. In contrast, it has the negative effect of increasing the interest paid.

In this sense, in the figure 4, by comparison between the basic models with and without rental, it is checked if there is any change in the effect of a shock on the LTV.

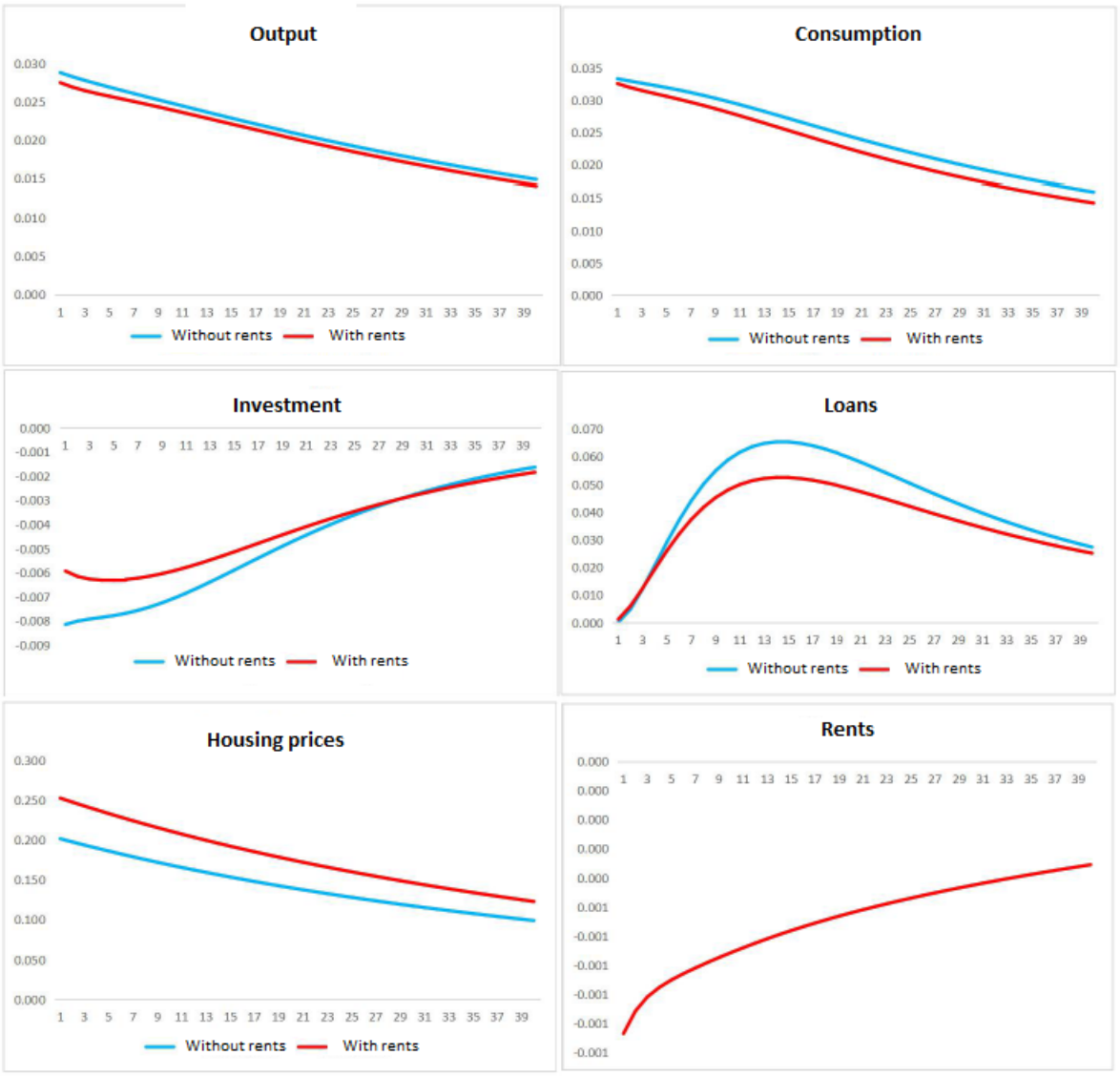

Figure 4: Comparisons of impulse-response functions - Bankers willingness to lend shock

Source: authors' elaboration.

As shown in figure 4, a LTV shock generates similar impulse response functions for both models, with and without the inclusion of rents. In the version with the rental market, the effect on the variables is reduced. This happens because the inclusion of tenant families means the absence of

real estate that can be given as collateral of loans for this group. In this way, borrowing is reduced. Hence, the demand for real estate, consumption and aggregate output of the economy.

Additionally, it is perceived that the greater ease of lending makes the patient and impatient families boost the demand for real estate and, consequently, the prices of the same. As the amount charged as rent is adjusted based on house prices, it also rises, reducing to your demand.

3.1.4 Variance decomposition analysis

Additionally, a comparative analysis of variance decomposition between the two models is made. With this, the effect of each shock on the standard deviation of the economic variables can be identified in relation to its steady state values, as shown in the table below.

Table 2: Comparison of variance decomposition (%)

	PTF		**Housing preferences**		**Bankers willingness to lend**	
Variable	**Without rents**	**With rents**	**Without rents**	**With rents**	**Without rents**	**With rents**
Y	59.84	64.29	5.28	5.75	34.88	29.96
C	16.37	18.48	16.09	16.6	67.54	64.91
I	88.42	91.62	5.49	3.08	6.09	5.3
H	35.93	7.99	33.52	24.27	30.56	67.74
QH	6.13	7.87	18.91	12.77	74.96	79.36
D	37.84	42.07	41.16	38.62	21	19.31
L	52.18	42.07	24.135	38.62	23.685	19.31
R1	33.73	34.29	16.42	16.16	49.86	49.55
R2	31.36	31.78	16.94	16.77	51.7	51.46
R3	49.73	53.36	9.87	9.02	40.4	37.62
N	18.95	36.23	63.77	31.74	17.28	32.02

Source: authors' elaboration.

According to Table 2, it can be seen that the inclusion of the real estate market significantly changes the results of the variance decomposition.

Specifically, with the presence of rents, the TFP shock has a greater effect on output, consumption, investment, savings - through deposits, labor supply, loan interest rates and real estate prices. At the same time, there is a reduction in the impact on real estate and the total amount of loans.

Of all these changes, the most striking feature was the drastic decline in the demand for real estate demand, with the total factor productivity swinging from 35.93 % to 7.99 %. This result is probably explained by the fact that the inclusion of the rental market allows impatient households to decide between renting rather than buying their own dwelling. As a result, the demand for own-housing starts to occur more in function of the interest rate charged by the loans and the credit availability of the economy, as reported in Akerlof e Shiller (2015).

Next, it is important to note the decrease in the effect on the demand for loans. The same went from 52.18 % to 42.07 %. As justification, there is the argument that the existence of impatient families without own dwelling, renters, reveals a worse composition of the patrimony of a portion of the population, who are borrowers.

Another important finding regarding the TFP shock is that there is a strong increase in labor supply variability for the real estate model, going from 18.95 % to 36.23 %. This phenomenon is due to the inclusion of the third household, which has no real estate and has its inter-temporal consumption obtained only from the salary received.

The housing preference shock does not change greatly the variance decomposition between the two models for most variables. Exceptions occur for housing demand, which went from 33.52 % to 24.77 % and the price of housing, which fell from 18.91 % to 12.77 %. These results are explained by the substitution of the acquisition of own dwelling by rents.

For the bankers willingness to lend comparison, it is evident that it increases its explanatory power on the variance of the labor supply, going from 17.28 % to 32.02%, and also becomes the main factor responsible for the oscillations of the demand for real estate, rising from 30.56 % to 67.74 % and real estate prices, rising from 74.96 % to 79.36 %. As an explanation, given a better credit condition on the economy, economic agents consume more and wish to offer more work. In this way, they earn greater wages and through the banking system, convert into inter-temporal consumption.

4 Conclusion

This paper aimed to analyze the effect of the inclusion of the real estate market on credit and the Real Business Cycle. For this, economic policy shocks have been examined in a structure containing the rental market, since this, although secondary to real estate, is quite significant for most economies. We investigated changes in the total factors productivity, housing preferences and bankers willingness to lend.

Specifically, the work begins with the construction of Dynamic and Stochastic General Equilibrium (DSGE) models. Then, we simulate the economy dynamics and test the effects of the above mentioned shocks. Then, a comparison is made between the results of economies with and without rental market. Finally, based on the previously mentioned steps, a debate is made on the economic relation evidenced, enunciating the conclusions of the study.

The analysis applied in this work allowed us to make some important considerations. In the first place, it is assumed that the inclusion of real estate rent maintained the behavior of the variables of the model in accordance with empirical literature review. Thus, the preservation of expected signals and trajectories means that the proposed structure does not contradict the traditional models of Real Business Cycles. Second, the addition of the secondary rental market allowed us to examine how the decision between buying or renting housing impacts on aggregate variables of the economy in the presence of stochastic shocks. This second point also leads to the third finding, which consists of the greater role of credit in the economy. Hence, bankers willingness to lend impatient households, captured by the shock on the LTV parameter become the second largest defining parameter on short and medium term fluctuations, second only to the Total Factor Productivity shock.

It is stated that this study has as main limitation the fact that it is carried out from a computational simulation with parameters estimated by other authors. Thus, future works that use the longitudinal observations of the proposed variables in the structure of this dissertation can capture more detailed information. In particular, if they are estimated by methods capable of capturing non-linearities and regime changes, such as Markovian models. Among many possibilities, it is mentioned: detection of thresholds of behavior change of families between short, medium and long term; investigation of the existence of intransivities in the decision between buying or renting housing; analysis of the speed of convergence and return to the steady state of the economic variables, after a stochastic shock; calculation of the compensatory variation of the substitution between rent and own dwelling, given by the income effect provided to the patient families, every time a new house is rented; examination of parametric differences between the models with and without rent inclusion, within a 95 % confidence interval.

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