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# HOUSING PRICES IN BRAZIL AND THEIR IMPACTS ON INTEREST RATE AND INCOME IN THE INFLATION TARGETING REGIME BETWEEN 2007 AND 2017

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**Abstract**

*This paper aims to assess housing prices' impact on economic growth and the basic interest rate under the inflation targeting regime between 2007 and 2017. To measure these effects, we used the method of Vector Error Correction (VEC) and the monetary transmission model by Bogdanski et al. (2000). Thus, the behavior of the model's endogenous variables (housing IPCA, Brazilian policy interest rate (Selic), Output Gap, and Exchange rate) was observed through the impulse response function and variance decomposition. With the estimated model, it was possible to identify that the Broad Consumer Price Index (IPCA) significantly influences the Selic variations. However, the housing IPCA does not respond to Selic shocks, which leads to the idea that there is an inertial component in Brazilian inflation, and this corroborates for the maintenance of high interest rates in the country in the analyzed period.*

**Keywords:** Housing Prices; Inflation Targeting; Monetary Policy; VEC.

**JEL Classification:** E43, E52, E58.

## 1. INTRODUCTION

The reality of the housing deficit in Latin America is characterized by many empty properties in large urban areas that are not used for housing policies. This situation is due to real estate speculation, which ends up directing the construction of social housing in places far from large centers and with little infrastructure, promoting social segregation (RUBIN, 2013).

In Brazil, housing issues are marked by inequality, where families with a monthly income of up to three minimum wages correspond to most of the housing deficit (KRAUSE; BALBIM; NETO, 2013). A small portion of the families owns one or more properties, while the large part does not own a property or lives in poor conditions (ALVES; CAVENAGHI, 2016).

In the country, the housing deficit indicator, according to Viana and Souza (2016), consists of precarious housing, family cohabitation, excessive rent charges, and excessive density in rented households, which is calculated from secondary data from the National Household Sample Survey (PNAD).

In recent years, the indicators calculated from the PNAD showed a decrease in the housing deficit, but the behavior of the components was different when analyzed separately (NETO; FURTADO; KRAUSE, 2013). There was a decrease in precariousness, family cohabitation, and excessive density, but there was an increase in the excessive charges with rent, which in 2015 corresponded to 3.189 million units or 51.5% of the deficit. As a result, the increase in household expenses may be due to increases in rent values caused by the real estate valuation (VIANA; SOUZA, 2016).

This situation creates one of the problems with housing policies, which does not consider the substantial stock of households building new homes, favoring large construction companies' lobby. There is a concentration of empty households in the central areas of large cities, as a result of the high price of rent, property tax, and other fees for the tenant and the net result of small rent for tenants due to expenses with real estate, income tax and the maintenance of the property (ALVES; CAVENAGHI, 2016).

According to the Household Budget Survey (POF), in 2008-2009, housing expenses account for 35.9%, corresponding to the largest share in household consumption expenses at the national level. The group's most significant shares are rental, "services and fees"[3], which correspond to 12.8% and 7%, respectively. In families with lower income, these expenses can reach 17.5% and 8.9% of the total housing expenses (IBGE, 2010).

Therefore, it is essential to analyze the Brazilian real estate market prices since housing expenses have a relevant influence on household consumption. In addition, these expenses have a high weight in the calculation of the Broad Consumer Price Index (IPCA), an index used to measure inflationary targeting. Given these conditions, it is very important to try to understand what the impact of macroeconomic variables would be, above all, such as interest rates, exchange rates, and income on housing prices, given that there are severe deficiencies and structural difficulties to be faced in this market. Since a large part of family expenditure often needs to be allocated to household expenses, which weigh heavily on the IPCA - official inflation index. Thus, there is great relevance in seeking ways to understand how these prices related to housing are affected by the Inflation Targeting Regime (RMI), operating in the country since 1999.

The inflation index chosen to guide the targeting regime is the IPCA, which aims to measure the general price movement in the retail market and is also an indicator of inflation according to personal consumption. The index has been used by the Central Bank of Brazil (BCB), since January 1999, as the main parameter in monitoring the inflation targeting system in Brazil, and it geographically covers the metropolitan regions of Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Rio de Janeiro, São Paulo, Curitiba, Porto Alegre, in addition to Brasília and the municipalities of Goiânia and Campo Grande. Its target population is composed of families with monthly income from 1 to 40 minimum wages (IBGE, 2014).

The index is subdivided into nine groups: food and beverages, housing, household items, clothing, transport, health and personal care, personal expenses, education, and communication. The housing group is the third-largest weight in the IPCA with 14.27%, and its most essential sub-items are "rent and fees," which corresponds to 6.38% in the IPCA, cylinder gas represents 1.09% of the IPCA and, finally, residential electricity, corresponding to 3.55% of the index. Of the three sub-items, the first is indexed to the variation of the General Market Price Index (IGP-M), and the last is regulated prices, representing 11.02% of the IPCA (IBGE, 2014). In other words, there is a massive weight of housing prices in the composition of the IPCA, highlighting the fact that a portion of it is managed.

According to the BCB (2016, p. 5), the administered prices "refer to prices that are less sensitive to the conditions of supply and demand because they are established by contract or by a public agency." For Aidar (2006), the regulated prices have a more significant variation and higher increases than the other prices. In addition, the IPCA has a memory component due to these prices, hindering the fulfillment of inflation targets, since containing demand inflation can slow the economy down. Also, like most prices administered by the IPCA, it is not affected by the increase in interest rates, which reduces its effectiveness (VILAÇA, 2015).

Consequently, discussions regarding the impact of housing prices become relevant due to their importance in the IPCA and its sub-items, with monitored prices, since the RMI uses the index to measure inflation. The IPCA influences rental prices, a variable with considerable weight in the housing deficit. In this context, the following question arises that this article aims to analyze: what is the impact of changes in housing prices on interest rates and income under the context of the RMI?

As well as Martinez and Cerqueira (2013) and Vilaça (2015), this work aims to show the limited effect that inflation targets have on some groups of IPCA assets. However, different from those works, studies are analyzing the impact of a specific group of the IPCA on the RMI. For example, Carrara, Carvalho, and Sbarai (2016) analyzed the impact of transport prices on inflation and interest rates in Brazil.

In the present work, the analysis aims to study the behavior of the Brazilian real estate market in the last decade and to measure the impact of housing prices on interest rates and the growth of the economy and also the impact of these variables on the price of Brazilian housing, between 2007 and 2017, within the context of the Inflation Targeting Regime. This period was chosen because interest rates in the country remain high, and it is the moment when housing policies were changing their configuration due to the economic crisis. Specifically, it is intended: i) to describe the evolution of the Brazilian real estate market and the issue of the housing deficit; ii) to identify the impact of economic growth and interest rates on the variation in housing prices and on inflation measured by the IPCA and; iii) to analyze the impact of changes in housing prices on interest rates and economic growth.

The work is structured in five sections, including this introduction that deals with the problem of housing, housing prices (their weight in the IPCA), and the importance of this study. The second section will address the theoretical basis of the study, presenting the RMI and the transmission mechanisms of monetary policy and a literature review highlighting works that seek to highlight the effects of adopting the targeting regime. The third section will present the estimated model. In the fourth section, the results obtained through the research will be presented. Finally, the final considerations and references used in this paper will be shown.

## 2. LITERATURE REVIEW

### 2.1 The Inflation Targeting Regime and the New Macroeconomic Consensus

With the theoretical divergences that permeate economic theory, a non-generalized consensus emerged at the end of the 1980s. This New Macroeconomic Consensus (NCM) has a common asset: controlling inflation as the main objective of monetary policy (PIZA; DIAS, 2006). As a result, central banks from different countries started to adopt the RMI, which, according to Sartori (2014, p. 19), “acts as a type of rule that was theoretically designed under the framework of the NCM.”

NCM seeks to synthesize the theories of neoclassical schools, such as the monetarist, new-classical, real business cycle, and the new Keynesian, in order to define which of these are the most accepted in the academy and by policymakers to be used as a guide for conducting the economic policy of several central banks (TEIXEIRA; MISSIO, 2011).

This policy presents concepts of macroeconomics that would serve as central pieces for the understanding of economic growth in capitalist economies, prevailing the ideas that macroeconomic policies are: ineffective on the real side of the economy; effective demand is not a determining factor for long term balance, and monetary policy must be applied to maintain a low and stable inflation rate (NEVES; OREIRO, 2008).

The RMI is a monetary regime that aims to ensure that significant inflation remains around a pre-established target (BCB, 2016). The objective of the regime is to use monetary policy to maintain the inflation rate, keeping it at low levels, seeking price stability and, in more flexible regimes, product stability at levels close to the potential growth rate, but only if price stability is not violated (CARVALHO et al., 2007).

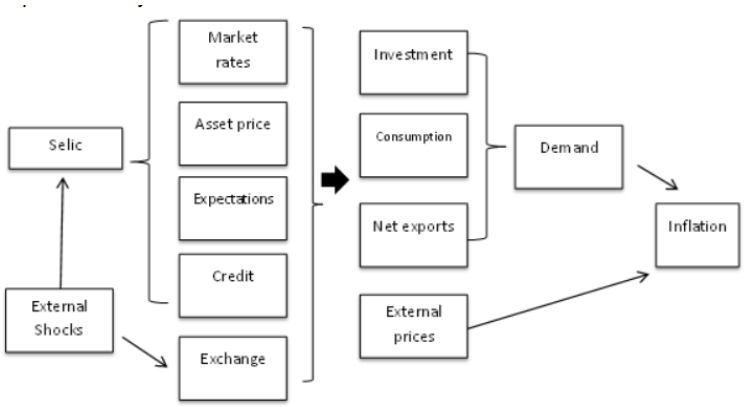
In Brazil, the RMI was implemented in 1999 due to the Real Plan's application in 1994, which aimed to stabilize the national currency and stimulate the Brazilian economy's opening. The regime was chosen to combat speculative attacks on the national currency and mitigate domestic crises by containing the high inflation process experienced by the country (CARRARA; CORREA, 2012).

In order to achieve this goal, an inflation target is announced, which may be unique or by a fluctuation band, in which a period is also established for the target to be reached, occurring between one year or in the moveable window system, in which the target is analyzed every month considering the accumulated inflation. Within this specified period, the short-term interest rate is used as the primary monetary policy instrument to make inflation tend to the previously established target (CARVALHO et al., 2007). The Central Bank uses the average interest rate adjusted to the daily financings computed in the Settlement and Custody Special System (Selic) to calculate the rate. The daily financings settled and registered in Selic itself, or the clearing and settlement providers are considered (BCB, 2018).

Transmission channels are mechanisms that affect inflation and output through monetary policy, so the Central Bank can model its monetary policies with the short-term interest rate (Selic) that will have an effect on market rates, asset prices, expectations, and credit (MENDONÇA, 2001). In open economies, the interest rate can also affect the exchange rate. In Brazil, the Selic affects the exchange rate, and both can be affected by external shocks that interfere with other transmission mechanisms (TAYLOR, 1995).

The scheme presented in Figure 1 explains the effects of the main monetary policy transmission mechanisms presented in this section on inflation and income in an open economy.

Figure 1 – Main monetary policy transmission mechanisms.




Source: Mendonça (2001, p. 72).

Figure 1 shows that the basic interest rate (Selic) influences market rates, asset prices, expectations, credit, and the exchange rate. These factors are decisive on aggregate demand and, consequently, on inflation in an economy.

### 2.2 Empirical Models of Monetary Policy Transmission

According to Sicsú (2002), only the RMI cannot explain the control of inflation in developed countries that adopted it, such as New Zealand, Canada, and the United Kingdom. In these cases, the downward behavior of price levels is due to the economic situation of the 1990s, since developed countries that did not adopt the targeting regime, for example, the United States, Japan, and Norway, achieved the same success in controlling inflation. The average annual inflation in the years 1990-98 in countries with

targeting regimes was 3.4%, and in countries that do not follow the same regime, it was 3.2%. Thus, the difference cannot be considered significant (SICSÚ, 2002).

Among the emerging countries, Brazil is one of the least efficient in controlling inflation based on the targeting regime, since the increase in prices is not always related to demand shocks. Thereby, the use of the interest rate, in most cases, is not efficient to contain the cause of inflation (FONSECA; PERES; ARAÚJO, 2016).

According to Noronha (2008), the RMI move created a reduction in external shocks and an external balance, but external shocks became longer, increasing the restrictive monetary policy cycles, generating large interest rates and low economic growth. Thus, the objective of lowering interest rates with the adoption of the RMI in 1999 has not been achieved, as these have remained at high levels.

Campedelli and Lacerda (2014) believe that combating inflation must consider that consumption is more related to the economy's cultural and income aspects than interest rates. Besides, high interest rates affect the marginal efficiency of capital and reduce the investment level, thereby reducing the level of economic activity and the level of income.

Costa, Campos, and Castro Júnior (2015) show that actions to control inflation in Brazilian economic policy have little effect in the long run. Based on an estimated Vectors Error Correction (VEC) model, the authors concluded that the IPCA is not very sensitive in the long run to changes in interest rates and that the index is impacted in the long run by the country's internal debt of the public sector. One possible explanation is the increase in government spending that discourages private investment, causing inflationary pressures.

In the Brazilian economy, the exchange rate values and the IPCA index itself are the main variables that explain the evolution of the IPCA, and the interest rate, the RMI mechanism, has little influence in determining the price index (SARTORI, 2015).

According to Martinez and Cerqueira (2013), the effect of the inflation targeting on some groups of goods is limited, with their prices having a significant influence on the IPCA. It can be seen in housing prices, according to Vilaça (2015), of the 14.2% of the housing weight on the IPCA, 10.95% are monitored prices, and that these are not affected by interest rates, sub-items, such as rent and tax, which have their prices indexed in other indexes, are also not affected. As a result, inflation control actions become ineffective in controlling price increases with aggregate demand.

Mendonça (2007), using a VAR model, shows that the use of the IPCA for the RMI is inefficient because, in the case of regulated prices, inflation is not caused by excess demand, but by administrative or cost inflation, which means that the expectation of inflation is also influenced by prices' behavior on the supply side (CARRARA; CORREA, 2012). Thus, the monetary policy's effectiveness of insuring the price increase containing aggregate demand is limited, since its effect is inefficient on administered prices (MARTINEZ; CERQUEIRA, 2013).

As in the works described above, in this research, a Vector Autoregressive model will be used to analyze the issue of housing prices and how it influences and is influenced by macroeconomic variables (interest rate, income, and exchange rate).

## 3. METHODOLOGY

### 3.1 Macroeconomic Model

According to Bogdanski et al. (2000), the Central Bank estimated a structural model in order to identify and simulate the transmission policy mechanisms. According to the authors, the basic structure for simulating and making consistent projections has the following equations:

I. An IS curve that explains the output gap due to its lag and interest rate:

$$h_t = \beta_0 + \beta_1 h_{t-1} + \beta_2 h_{t-2} + \beta_3 r_{t-1} + \varepsilon_t^h \quad (1)$$

Where $h_t$ is the output gap (Hodrick-Prescott Filter)[4]; $r$ is the real interest rate and $\varepsilon^h$ is the demand shock.

II. According to its lags and inflation expectations, a Philips curve expresses the current inflation rate, the output gap, and the nominal exchange rate. The equation is used to analyze the supply of the economy.

$$\pi_{hab_1} = \alpha_1^b \pi_{hab_{t-1}} + \alpha_2^b \pi_{hab_{t-2}} + \alpha_3^b h_{t-1} + \alpha_4^b \Delta \left(p_t^F + e_t\right) + \varepsilon_t^b \quad (2)$$

Where the $\pi_{hab_1}$ is the housing price inflation (adapted for work)[5]; $h_t$ is the output gap (Hodrick-Prescott Filter); $p^F$ is the foreign producer price index; $e$ is the exchange rate; $\Delta$ is the difference operator and $\varepsilon$ is the supply shock.

The sum of domestic producer prices and the nominal exchange rate were applied to capture the effects of a temporary shock on the exchange rate more accurately.

III. An equation with the difference between domestic and foreign interest rates with the expected exchange devaluation rate and the risk premium, relating the balance condition to the exchange market;

$$\Delta e_t = \Delta i_t^F + \Delta x_t - \Delta i_t + \eta_t$$

Where $e$ is the exchange rate; $i^F$ is the international interest; $x_t$ is the risk premium; $i$ is the nominal interest (Selic); $\Delta$ is the first difference operator and $\eta_t$ is the white noise.

IV. An interest rate rule containing the future exogenous trajectory of nominal and real rates, a Taylor rule, or an optimal reaction rule. In this case, a linear combination of system variables will be used, similar to Taylor's rule, where $\gamma \in (0, 1)$ is a softening of the interest rate.

$$i_t = (1-\gamma) i_{t-1} + \gamma \left(\alpha_1 \left(\pi_{hab_1} - \bar{\pi}_{hab}\right) + \alpha_2 h_t + \alpha_3\right) \quad (4)$$

Where $i$ nominal interest (Selic); $\pi_{hab}$ is the housing price inflation; $\bar{\pi}_{hab}$ is the annual avarage house prices; $\pi_{hab_1} - \bar{\pi}_{hab}$ is the deviations in housing prices from the year average and $h_t$ is the output gap (Hodrick-Prescott Filter).

### 3.2 Database

In order to estimate the monetary transmission model and observe the behavior of the variables in the face of macroeconomic shocks, the following variables described in Table 1 will be used, all of which were collected monthly from January 2007 to December 2017.

Table 1 – Description of the variables used in the model.

| Variable | Denomination | Description |
|---|---|---|
| Risk premium | $x_t$ | The EMBI+ (Emerging Market Bond Index) is an index calculated based on a portfolio of public bonds issued by emerging countries. The index shows the difference in these countries' financial returns compared to public bonds offered by the American Treasury, released by Bank JP Morgan. |
| Exchange rate | $e_t$ | The free exchange rate for sale in R$/U$, according to the PTAX800 series published by Sisbacen. |
| Output gap | $h_t$ | The gap was calculated from the potential GDP estimated using the Hodrick-Prescott Filter and the real GDP, released by the Central Bank. $h_t = \frac{100(PIBreal - PIBpotencial)}{PIBpotencial}$ |
| Housing IPCA | $\pi hab_t$ | The accumulated monthly values of the housing IPCA, released by IBGE, will be used. |
| Nominal interest (Selic) | $i_t$ | Selic monthly average was released by the Central Bank of Brazil. |
| Real Interest | $r$ | The IPCA inflation index deflates nominal interest. |
| International interest | $i^F$ | The interest rate on US Treasury bonds, released by the International Monetary Fund (IMF). |
| Deviations in housing prices | $\pi_{hab_t} - \bar{\pi}_{hab}$ | Deviations were calculated from the difference in monthly rates concerning the annual average. |
| PPI | $p^F$ | Producer Price Index Industrial is an index that measures changes in the average selling prices of American industries' goods and services, released by the Bureau of Labor Statistics. |

Source: prepared by the author from the data sources consulted.

### 3.3 Vectors Autoregressive

There are two factors that justify the frequency that VAR models are used in the empirical study of the targeting regime: i) the VAR approach presents a simple path in the study of macroeconomic dynamics because it does not require a complete specification of the structure of the economy; ii) the VAR technique offers a very appropriate study of predictions. They also allow the analysis of dynamic statistical interrelationships between macroeconomic variables and their shocks (SILVA; MAIA, 2004).

When using the VAR methodology, we highlight the specification of the variables included in the system. After the VAR model is specified and identified, dynamic interrelationships between variables can be analyzed using the impulse response function.

In addition to the impulse response function, as described in Enders (1995), the results of the model can be analyzed by decomposing the variance, that is, identifying which percentage of the variance in the prediction error results from each endogenous variable specified by the model over the prediction horizon t+h.

In a situation in which non-stationary but cointegrated variables of order d (I(d)) are found, the model to be estimated consists of a Vector Error Correction (VEC). According to Lutkepohl (2004), the VEC model consists of a VAR whose coefficients undergo reparametrization for the cointegration relations, represented by:

$$B\Delta y_i = \prod y_{t-1} + \Gamma_1 \Delta y_{t-1} + \cdots + \Gamma_{k-1} \Delta y_{t-k+1} + u_t \qquad (5)$$

Where $\prod = -\left(I_k - A_1 - \cdots - A_k\right)$ and $\Gamma_i = -\left(A_{i+1} + \cdots + A_k\right)$ for $i = 1, \ldots, k-1$.

In this case, it is assumed that all variables are integrated in the order I(1), so that Δyt does not contain a stochastic trend and that $\prod y_{t-i}$ is the only term that can contain variables I(1) and I(0). Therefore, this is the term that accommodates cointegration relations. The difference terms $\Gamma_j$ do not have long term relations, being called short term expressions, while the term $\prod y_{t-i}$ is known as long-term expression.

By assuming that differentiation is sufficient to make the series stationary, it is possible to state that all terms in equation (05) are stationary, except $\prod y_{t-1}$. Therefore, for the system to be stationary, $\prod y_{t-1}$ must be stationary; for this, the matrix $\prod$ must present a structure with stationary linear combinations. Thus, the matrix $\prod$ controls the system's stationarity properties, and, when there are stationary linear combinations, the variables are cointegrated.

Some points must be considered in the model (05) regarding the existence and the number of cointegration vectors, which is done by analyzing the rank (r) of the matrix $\prod$. In summary, according to Enders (1995):

a) If the rank of $\prod$ is zero, all elements of this matrix are zero. The Error Correction mechanism $\prod y_{t-i}$ in (05) disappears, meaning that there are no long term balance relationships between variables, that is, they are not co-integrated, and the model is a VAR in first difference; b) If $\prod$ has full rank, that is, if $r = K$, its lines are linearly independent, the variables are stationary, and no cointegration analysis can be performed. Thus, it is necessary to specify and estimate a level VAR; c) When the rank of $\prod$ fits in intermediate situations, $0 < r < k$, not all vectors are linearly independent, and it can be shown that the matrix $\prod$ can be written as:

$$\prod = \alpha\beta' \tag{6}$$

where $\alpha$ is the coefficient matrix $(K \times r)$ called the adjustment matrix, and $\beta$ is a parameter matrix \(($K \times r$\)) called the cointegration matrix. The rank of matrix $\prod$ defines the number of cointegration vectors, and the model formulated must be a VEC.

The model mentioned in (05) can generally be added with relevant deterministic terms in specific situations, using the inclusion of dummies, intercepts, and trends. Restrictions can also be included in the estimated model's matrices, most of which are based on economic theory. Such restrictions cause the estimation of restricted models such as structural VAR (SVAR) and structural VEC (SVEC). To perform and identify the most appropriate model, unit root tests (DF-GLS, KPSS, and NG Perron), cointegration (lambda trace), stability, normality, and autocorrelation were applied[6]. To perform unit root tests and other univariate procedures, the JMulTi software in version 4.21 was used.

## 4. RESULTS

### 4.1 Analysis of the Real Estate Market

Table 2 shows the absolute, relative housing deficit and its components in the Brazilian regions in 2015. Thus, we can conclude that the Southeast and Northeast regions have a high number of housing deficits, presenting an absolute total of 2,482,855 and 1,971,856, respectively. In the relative total, the North (12.6%) and Northeast (11%) regions have a higher percentage than the other regions.

Table 2 – Housing Deficit in the Regions of Brazil in 2015.

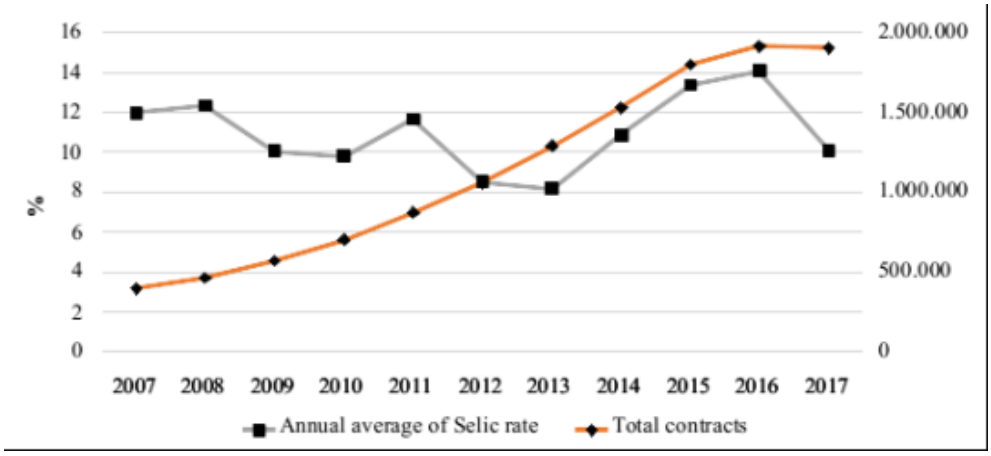
| Housing Deficit | | | | | | |
|---|---|---|---|---|---|---|
| Region | Absolute Total | Relative Total | Precarious Housing | Family Cohab. | Excessive charge with rent | Excessive densification |
| North | 645.537 | 12,6 | 157.050 | 270.719 | 179.258 | 38.510 |
| Northeast | 1.971.856 | 11 | 498.379 | 662.863 | 747.800 | 62.814 |
| Southeast | 2.482.855 | 8,4 | 116.875 | 651.942 | 1.524.860 | 189.178 |
| South | 734.115 | 7 | 120.748 | 176.424 | 424.000 | 12.943 |
| Midwest | 521.381 | 10 | 49.579 | 14.543 | 301.854 | 29.405 |
| Brazil | 6.355.743 | 9,3 | 942.631 | 1.902.490 | 3.177.772 | 332.850 |

Source: João Pinheiro Foundation (FJP), PNAD (2015).

The Northeast region has the highest number of precarious housing and family cohabitation among the regions, with 498,379 and 662,863, in that order. In the case of family cohabitation, the Southeast region numbers are similar to the Northeast with 651,942. The Southeast also has a more significant number of excessive charges with rent (1,524,860) and excessive densities (number of residents in rented properties larger than three people per dorm) with 189,178.

In order to contain the housing deficit, the number of public policies that encourage real estate financing has increased in recent years. With the Minha Casa Minha Vida (MCMV) program, the number of financing contracts has increased. This information is shown in Figure 2.

Figure 2 – Evolution of the total of housing financing contracts and the annual average of Selic rate from 2007 to 2017.

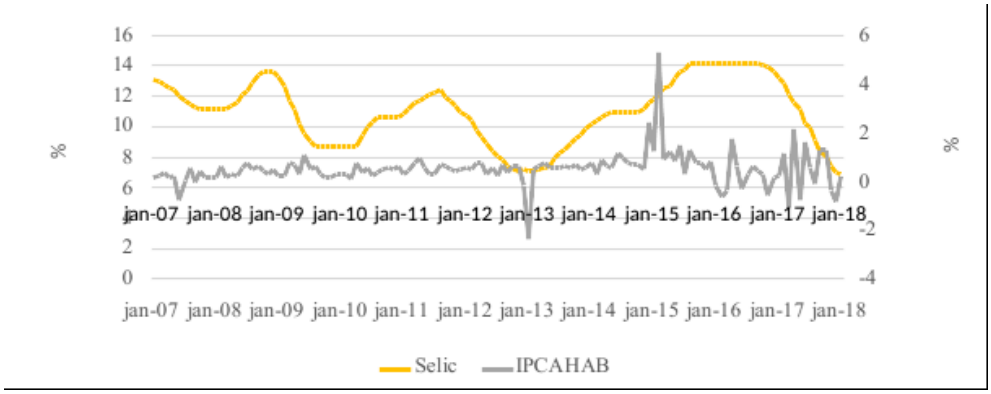



Source: CBIC-Database - data collected in January of each year.

The total number of real estate financing contracts during 2007 and 2017 shows that since the creation of the MVMC in 2009, the number of financings has increased considerably. In 2007, the number of contracts was 395,405. In 2017, this number increased to 1,903,860 contracts, a 381.5% growth over ten years. It can also be seen in Figure 3 that despite the upward movements in the interest rate (Selic), housing financing contracts continued to expand, mainly from 2013.

When observing the trajectory of the housing IPCA and Selic rate series (Figure 3), apparently, housing prices remain constant throughout almost the entire period, with the interest rate not affecting price fluctuations or price declines.

Figure 3 – Trajectories of the housing IPCA and the Selic rate.




Source: Prepared by the authors based on data from IBGE and the Central Bank.

This problem can be related to the influence of the prices administered by the IPCA and to housing incentive policies, such as the MCMV. According to Aidar (2006), this is due to the memory component of the IPCA caused by regulated prices. Consequently, variations in the Selic rate do not generate the expected effects on housing prices.

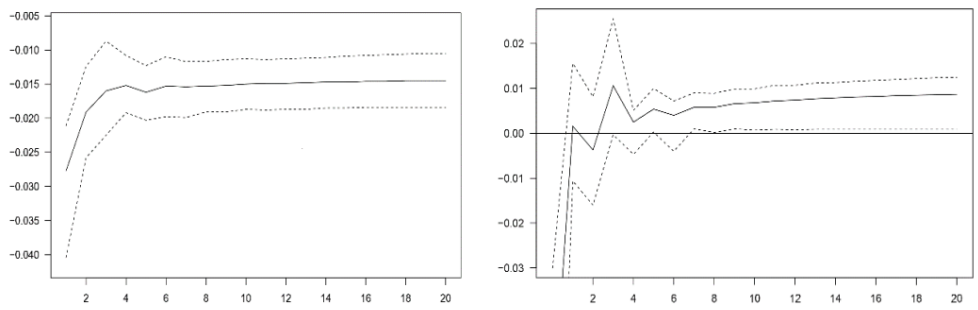
### 4.2 Evaluation of the Impact and Sensitivity of Exchange rate, Output Gap, Housing IPCA, and Selic rate

In order to analyze the stationarity of endogenous variables (Exchange rate, Output Gap, housing IPCA, and Selic rate) and exogenous variables (Risk Premium, Real Interest, International Interest, Deviations in housing prices, and PPI), were carried out the unit root tests of DF-GLS, KPSS, and Phillips-Perron. When analyzed, it was found that the variables are stationary in the first difference in at least two of the tests. Therefore, they are integrated into the order one (I (1)).

Based on the model suggested by Bogdanski et al. (2000), presented in the methodology, a VEC model with two cointegration vectors was estimated, with exogenous variables in the first difference. With this estimation, it was possible to analyze how these variables interact from their shocks and the other variables' shocks with the impulse response function and the variance decomposition analysis.

To analyze the behavior of the IPCA considering the shock of the other endogenous variables, the following impulse response functions described in Figure 4 were estimated.

Figure 4 – Impulse response of the housing IPCA considering a shock from the Output Gap and the Selic.




Source: Authors.

There is a positive shock from the output gap and the Selic on the housing IPCA in both cases. In the first case, the reaction is understood, since a more massive output gap indicates heating up in the economy and pressures the inflation rate to rise. The Selic's positive shock is not in line with the macroeconomic theory, as one of the functions of the interest rate is to contain inflation. As shown by the work of Costa, Campos, and Castro Júnior (2015), it is possible to observe that the housing IPCA is not very sensitive to changes in interest rates and responds with a movement contrary to expectations.

This problem in the inflation targeting regime can be seen in the decomposition of the housing IPCA variance described in Table 3.

Table 3 – Decomposition of the variance of the Housing IPCA

| Period | Exchange | Output Gap | Housing IPCA | Selic rate |
|---|---|---|---|---|
| 1 | 0 | 0,22 | 0,58 | 0,20 |
| 2 | 0 | 0,22 | 0,58 | 0,20 |
| 3 | 0 | 0,22 | 0,58 | 0,20 |
| 4 | 0 | 0,21 | 0,59 | 0,20 |
| 5 | 0 | 0,21 | 0,59 | 0,20 |
| 6 | 0 | 0,21 | 0,59 | 0,20 |
| 7 | 0 | 0,22 | 0,58 | 0,20 |
| 8 | 0 | 0,22 | 0,58 | 0,20 |
| 9 | 0 | 0,22 | 0,58 | 0,20 |
| 10 | 0 | 0,22 | 0,58 | 0,20 |
| 11 | 0 | 0,22 | 0,58 | 0,20 |
| 12 | 0 | 0,22 | 0,57 | 0,20 |
| 13 | 0 | 0,23 | 0,57 | 0,20 |
| 14 | 0 | 0,23 | 0,57 | 0,20 |
| 15 | 0 | 0,23 | 0,57 | 0,20 |
| 16 | 0 | 0,23 | 0,56 | 0,20 |
| 17 | 0 | 0,24 | 0,56 | 0,20 |
| 18 | 0 | 0,24 | 0,56 | 0,20 |
| 19 | 0 | 0,24 | 0,56 | 0,20 |
| 20 | 0 | 0,24 | 0,55 | 0,20 |

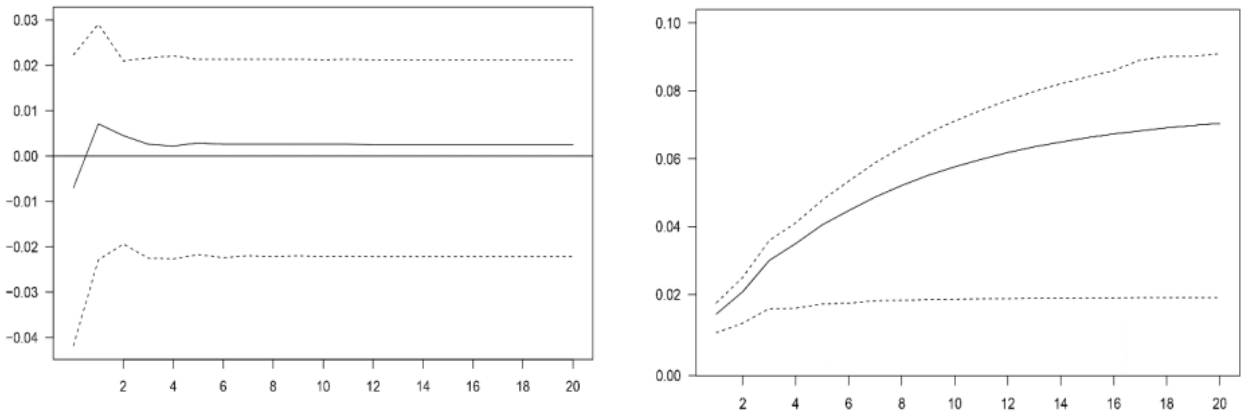
Source: Authors.

With Table 3, it is possible to observe how much each endogenous variable in the model explains the housing IPCA. With the results presented, the variation of the housing IPCA is almost entirely explained by itself, since in the first ten months, the index is explained by more than 59% by itself, it corresponds to the issue of administered prices, such as Garrido ( 2016), whose work argued that the indexation of the price makes the struggle against inflation inefficient, since the readjustments in regulated prices have repercussions on the subsequent readjustments, creating an inertial component in inflation.

The output gap explains up to 24%, this influence is expected, as economic growth generates a positive impact on inflation. The Selic rate has an influence of 20%, it shows that the interest rate is able to act on the inflation rate, as expected in the RMI, but due to the high influence value of the housing IPCA on itself, the rate does not act efficiently, this can disagree with the work of Vilaça (2015), showing that some sub-items, mostly monitored prices, are not affected by the interest rate.

The resulting impulse response functions were generated to observe the effect of the housing IPCA on the other endogenous variables, as shown in Figure 5.

Figure 5 – Impulse response of the Output Gap and Selic considering a shock from the housing IPCA.




Source: Authors.

In both cases, a positive impact of the shock on the variable housing IPCA can be observed in both variables. As for the impact on the Output Gap, we notice that a positive shock in the housing IPCA does not cause a significant increase in the gap. The Selic rate, on the other hand, responds significantly to positive inflation shocks. This confirms the macroeconomic theory since the interest rate channel is used by the Central Bank to contain inflation using the short-term interest rate (Selic).

Table 4 shows the decomposition of the Selic rate variance, and it is observed that a large part of its variations is explained by the Output Gap, with an explanatory power of up to 63% over the periods. The housing IPCA has high explanatory power in the first two periods of Selic variation. This situation can be seen in the impulse response function, which is expected in the RMI.

Table 4 – Decomposition of Selic rate variance.

| Period | Exchange | Output Gap | Housing IPCA | Selic rate |
|---|---|---|---|---|
| 1 | 0,00 | 0,10 | 0,86 | 0,04 |
| 2 | 0,00 | 0,31 | 0,50 | 0,18 |
| 3 | 0,00 | 0,44 | 0,37 | 0,19 |
| 4 | 0,00 | 0,51 | 0,28 | 0,21 |
| 5 | 0,00 | 0,54 | 0,24 | 0,21 |
| 6 | 0,00 | 0,57 | 0,22 | 0,22 |
| 7 | 0,00 | 0,58 | 0,21 | 0,22 |
| 8 | 0,00 | 0,59 | 0,19 | 0,22 |
| 9 | 0,00 | 0,60 | 0,19 | 0,22 |
| 10 | 0,00 | 0,60 | 0,18 | 0,22 |
| 11 | 0,00 | 0,61 | 0,18 | 0,22 |
| 12 | 0,00 | 0,61 | 0,17 | 0,22 |
| 13 | 0,00 | 0,62 | 0,17 | 0,22 |
| 14 | 0,00 | 0,62 | 0,16 | 0,22 |
| 15 | 0,00 | 0,62 | 0,16 | 0,22 |
| 16 | 0,00 | 0,62 | 0,16 | 0,21 |
| 17 | 0,00 | 0,63 | 0,16 | 0,21 |
| 18 | 0,00 | 0,63 | 0,16 | 0,21 |
| 19 | 0,00 | 0,63 | 0,16 | 0,21 |
| 20 | 0,00 | 0,63 | 0,15 | 0,21 |

Source: Authors.

Therefore, it is possible to observe that prices have a relative influence, despite not being very significant over the periods (shock dissipates) in the composition of the Selic rate, even though housing prices, which is an indication that there is a relationship between housing prices and interest rates in Brazil. In addition, the use of the Selic is confirmed as an instrument of monetary policy, given the notable influence of the economy's product in the decomposition of its variance.

## 5. FINAL CONSIDERATIONS

This study aimed to identify the impact of housing prices on economic growth and the basic interest rate and to analyze what would be the influence of these variables on housing prices. For this purpose, we used the model proposed by Bogdanski et al. (2000) and the Vector Error Correction (VEC) econometric method.

The results estimated from the impulse response function and the variance decomposition show that the housing IPCA responds little to changes in the Selic rate, which corroborates with the works already presented on the topic. These results show a deficiency in the RMI, since the main monetary policy instrument to contain inflation is the interest rate, but due to administered prices, the Selic shocks observed in the impulse response function do not generate the expected effects on the housing IPCA.

Another relevant result observed was the opposite effect: the impact of the housing IPCA on the Selic rate. With the estimates found, we note that housing prices have a significant percentage in interest rate variations. However, it shows the inefficiency of the targeting regime, since the Selic responds to the shocks of the housing IPCA, but does not respond to Selic, which leads to the idea that there is an inertial component in Brazilian inflation and this corroborated for the maintenance of high interest rates in the analyzed period.

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