International Business Management 11 (1): 78-88, 2017
ISSN: 1993-5250

Analysis of the Brazilian Residential Real Estate Price Dynamics

[1]Leandro Iantas Moralejo, [2]Pablo Rogers Silva, [1]Admir Pancote,
[1]Wilson Aparecido de Freitas, [1,2]Claudimar Pereira da Veigaand and [1]Luiz Carlos Duclos
[1]Pontifical Catholic University of Parana, PUCPR, Curitiba, Brazil
[2]Federal University of Uberlandia, UFU, Curitiba, Brazil

Abstract: The main objective of this research is to analyze the Brazilian residential real estate price dynamics in the period 2001-2013. The methodology applied was based on VECM model, Johansen cointegration and Granger Causality tests, impulse response funtion and variance decomposition of cholesky. A dummy variable was considered in order to capture the effect of "Plano Minha Casa, Minha Vida" of government plan in order to reduce the housing deficit for the low-income population from April 2009 to December 2013. As a result Granger Causality tests indicated a strong causal relationship of the model variables. Impulse response funtion and variance decomposition testing results confirmed that the demand shock encouraged by government actions through the increase in the volume of mortgage, the lengthening of loan terms and the increase in household's disposable income committed to real estate financing has not been fully propagated in housing prices. As a research contribution, we note that in the short term, a significant portion of the variance in housing prices is explained by shocks in the rent price. Impulse response function empirical results confirmed that the low unemployment rates in the construction sector is one of the factors that pressured residential real estate costs and prices.

Key words: Efficient market hypothesis, construbusiness, real estate cycles, significant, Brazil,

INTRODUCTION

In Brazil the real estate sector brought attention due to the rapid increase in house prices in main conurbations. The average price of residential real estate properties has expanded 225.79% from March 2001 to December 2013. The credit expansion was also observed in the real estate sector, after a long period of contraction caused by the collapse of residential mortgage in the 1980s, especially since 2004 (Moralejo *et al*., 2016). Besides the variety of demand and supply side factors determine housing prices, the recent performance observed in the real estate sector is linked to broader causes and many factors can be pointed to explain the accelerated growth in recent years. Institutional changes such as the institution of the property lien mechanism to facilitate credit recovery in case of default, specific government policies for the sector, especially those intended to reduce the housing deficit for the low-income population, the lengthening of loan terms up to 35 years which allowed the reduction of the monthly installments, the economic growth that increased the average real wages and consumer purchasing power are some of these factors.

Although, common in other countries, researches related to the determinants of real estate prices in the Brazilian market are very limited. One of the few empirical researches on this subject was made by Melo (2012) which measured the impact of macroeconomic variables in the real estate sector in the estate of Ceara-Brazil in order to identify most relevant shock variables in the short-term and long-term. The results demonstrated positive influence in a loan mortgage supply and interest rate variables in relation to the number of real estate units sold while consumer confidence did not affect the sector, even on a short term basis.

Studies on real estate prices are mainly focused on two areas: real estate bubbles and changes in real estate prices. The first investigates the definition and measurement of bubbles while the second studies the determinants of real estate prices. This research is focused on the second area. Variety of demand and supply side factors determine housing prices in an emerging economy. Some researchers investigated real economic factors such as income, employment rate and government economic intervention as these are the factors that play dynamic role in the real estate sector.

Corresponding Author: Leandro Iantas Moralejo, Pontifical Catholic University of Parana, Avenida Imaculada Conceicao 1155, Curitiba-PR, Brazil

Researches may differ in modeling of housing prices taking into consideration the number of variables that influences the sector and the difficulties in capture all of these factors (Moralejo *et al*., 2016; Korontai *et al*., 2016).

Chow and Han (2008) investigated the short-term and long-term determinants of property prices in Hong Kong using co-integrating analysis. The results of their research indicated that per-capita GDP, real interest rate, land supply and residential investment deflator were long-term determinants of Hong Kong property prices. In the short-term housing prices were affected by stock price. Shiratsuka analyzed the influence of the monetary policy in Japan's experience of the asset bubble price. According to the authors the phenomena was based on excessively optimistic expectations with respect to the future, leading to great fluctuations in asset price. This research stressed the policymakers responsibility in assessing financial and macroeconomic stability from the viewpoints of sustainability.

Further to the extension of the number of variables that influences the sector and the difficulties in capture all of these factors what explains at the micro level may not at the macro level due to differences in location and other specific qualitative factors. Equally, what holds in developed countries may not hold good for emerging economies. The intensity of speculation in the developed economies is so significant that could cause business cycles while this is rare instance in emerging economies (Mallick and Mahalik, 2015; Enciso *et al*., 2016; Veiga *et al*., 2014).

Based on the endogenous hypothesis of real estate cycles and the Efficient Market Hypothesis (EMH) this research attempts to explain the housing price behavior in Brazil using endogenous variables of the construbusiness system. The approach is useful when an analysis could capture a few direct and indirect important determinants of housing prices, taking into consideration the difficulties to obtain the information on all the quantitative and qualitative variables influencing housing prices. The primary objective here is to establish the dynamic casual relationships between housing prices and its determinants such as cement consumption, construction sector unemployment rate, national index of building costs, household's disposable income committed to real estate finance and rent price index in Brazil.

Theoretical framework: It is generally accepted that property markets behave cyclically in the long run, primarily due to building lags in relation to demand changes which are mainly driven by the fluctuations of business activity. Nevertheless, according to Pornchokchai (2007) because of market imperfections, especially in terms of availability, information time-lags, time delays between the development of surplus demand and the ability to satisfy it through additional supply, property and housing markets in particular are rarely in equilibrium (Pornchokchai, 2007; Kudlawicz *et al*., 2016).

Real estate cycles are dependent on economic cycles, in other words, the evolution of the main macroeconomic fundamentals. However, it is considered that there is a standalone component which gives to the real estate industry specific dynamics at certain times and spaces, explaining the speculative changes in asset prices in relation to their fundamental values as well as its consequences such as speculative bubbles. This stand-alone component in the real estate market is associated with psychological behavior of agencies speculation involved in the real estate process; information asymmetries on markets and real estate values and the free-rider behavior of some economic agents and the management of liquidity preference. The resumption of economic studies brought a relevant theoretical debate between two academic schools in relation to the relevance of real estate cycles.

Efficient market hypothesis: The first one used as argument for the non-relevance of real estate cycles the EMH. Competition among the many intelligent participants leads to a situation where at any point in time, actual prices already reflect the effects of information based both on events that have already occurred and on events which, as of now, the market expects to take place in the future. According to the author, in an efficient market at any point in time the actual price will be a good estimate of its intrinsic value (Fama, 1970). The first one used as argument for the non-relevance of real estate cycles the EMH. The price of a financial asset should always reflect all available information, hence indicating that the market price should always be consistent with the fundamentals and therefore agents should not expect the return of this asset to be higher than the normal return According to Fama (1970). However, as stated by Shleifer and Summers (2000), the EMH foundations are depend on three considerations.

Investors' rationality: This infers that all information regarding fundamentals is instantly assessed and reflected to market prices. Hence, asset price is always expected to reflect all available information. However, individuals diverge on the significance of 'all available information', leading to three different forms of EMH: weak form, semi-strong form and strong form.

Collective rationality: Trades carried out by non-rational investors are assumed to be random and canceled out in the market. Hence, this requires these trades should have no net effect on market prices. This assumption implies that such trades are not correlated with each other or at least are only weakly correlated.

Arbitrage: To the extent that there are non-rational investors, according to Shleifer and Summers (1990) there must be rational arbitrageurs who act to eliminate the price effects of non-rational traders. There is a vast literature on anomalies and how they relate to the above three considerations and to the three forms of EMH.

The main documented anomalies in connection with the assumptions of the EMH include the following: investor rationality: full rationality alone is a very strong assumption. As argued by Doukas (2001) in the context of economic models that incorporate rational expectations, this implies that the agents handle all information perfectly. But a decrease in rationality does not prove that markets are not efficient. A market can be efficient even if the participants commit random errors and errors are not systematic. According to Shiller and Arijon (2003), it is not necessary that all market participants to be rational in a market that incorporates rational expectations, if there are sufficient arbitrageurs to take immediate advantage of any unexploited profit opportunities. Asset prices fully reflect all available information on fundamentals. According to EMH, prices should adjust immediately to new information. According to Fama (1991), the price of an asset adjusts quickly and efficiently to all relevant firm-specific information that is available. On the other hand, Campbell and Shiller estimated that 27% of the annual return volatility of the US stock market is explained by information about future dividends. Thus, prices clearly seem to react not only to information concerning changes in fundamentals but also to other arriving information. Therefore, prices seem to react not only to information concerning changes in fundamentals but also to other arriving information. EMH assumption related to uncorrelated trades: according to Shleifer and Summers (1990) investors are divided into two groups: arbitrageurs whose expectations of equity returns are rationally developed and noise or liquidity traders whose opinions and trading are systematically biased. In fact, if every investor were rational and perfectly understood the information, there would be a very low trading volume. Thus, the noise traders are proving the market with the necessary liquidity.

The problem related to irrational investors is that their trades tend to be correlated rather than uncorrelated. One reason for the herd behavior among individual investors is related to the way they make decisions (Hirshleifer and Teoh, 2003). Shleifer and Summers (1990) suggested that individual investors may herd because they respond to the same market signals.

Regarding HME validity, it is crucial to understand if the herd behavior is constant or occur randomly in the market. Constant presence would seriously violate HME. Another factor is crucial is whether there are enough rational arbitrageurs in the market to eliminate the possible effects of irrational investors on prices. The crucial question about the EMH validity is whether arbitrageurs might not act rationally. If not, EMH is clearly established on a precarious base. Many of the results from studies conflict with the basic assumptions of market efficiency (Veiga *et al*., 2010). The main question is whether the arguments against market efficiency are so strong that EMH should be rejected at all times or deviations should be occasionally accepted (Taipalus, 2012).

Real estate cycles endogenous hypotesis: The second one indicated that investors should use the theory of cycles to determine the impacts on the assets return and the risks of investing in certain assets. Thus, the understanding of the real estate cycles becomes strategic to maximize the returns on investments. Based on an extensive economic literature (Pyhrr *et al*., 2009) demonstrated with theoretical arguments and empirical evidence, the existence of cyclical movements in the real estate market, rejecting the conclusions proposed by EMH theorists of and simultaneously recognizing the importance of understanding the real estate cycles. Rottke *et al*. (2003) stated that real estate cycles may be caused by endogenous market imperfections. The real estate cycles rest on the lag in construction, planning and entitlement. Real estate cycles may partially be caused by endogenous market imperfections. The most important of these imperfections is the existence of the time lags which would be classified into three types: the price-mechanism lag, decision lag and the construction lag (Rottke *et al*., 2003; Nobre *et al*., 2016).

The price-mechanism lag occurs when there is a mismatch between supply and demand due to rapid and unexpected increase in demand. Consequently, in an environment where supply is greater than demand, the market reactions towards a temporary equilibrium take place in form of price or quantity adjustments. Therefore, rents go up while vacancy goes down. As soon as the vacancy is absorbed below the natural level, the short run market reaction can only occur in form of price movements. Because of the internal decision processes of large companies, investors also react with a lag to rising

prices (decision lag). When they finally decide to invest, new construction has to be planned and construction companies have to be contracted. The time that passes until a project has been built is called construction lag.

Based on the conception that there is a relevant time lag between the increase in demand and the delivery of new properties, the logic of the cyclical movements in the real estate market and the effects of price transmission to the economy became consistent. In this sense, a deficit resulting from delay in meeting demand is directly reflected in rents and real estate prices, generating a heating phase (hot real estate) and real estate euphoria. The expectations of real estate valuation become elevated, encouraging industry entrepreneurs to start an excessive volume of new constructions which tends to drive the market to overbuilding. However, when these additional real estate stocks are delivered, there is an oversupply of new built-up areas, impacting rents and real estate prices and the growth dynamics of the real estate sector which tends to go recessive for a long period.

Analyses of endogenous real estate cycles suggest that recurring imbalances in the real estate market mainly reflect problems arising from delays in the production of new units. In admitting the truth of this conclusion, a behavioral analysis of economic agents and their influence on market structure would become necessary. However, given the multiplicity of relationships and real estate agents working in the production chain, the key players could be grouped and classified into four broad groups: builders, investors, users and public authorities.

The initial causes of endogenous movements are exogenous influences the real estate market and occur in the form of demand shocks of different sizes and depending on the situation can speed up or slow down the process of real estate valuation.

These exogenous factors can be categorized as medium and long-term influences. Medium-term influences are based on the economic development of a country, its domestic market and consist of movements in key economic variables such as inflation, interest rates and GDP growth. Long-term influences are based on structural changes such as changes in economic structures, policies, new technologies and information and communication. Taking as a starting point the existence of a time lag in the real estate market, price corrections are consistent, however the possibility that a cycle starts from an initial deficit of residential properties, leading to an increase in real estate prices with direct reflection on agents' expectations encouraging new enterprises and therefore new properties can lead to an oversupply situation, reverting the cycle (Rottke *et al*., 2003; Harzer *et al*., 2016).

MATERIALS AND METHODS

To understand the factors determining housing price behaviour in Brazil, this research used monthly data. Data was collected from Brazilian Central Bank, Brazilian Institute of Geography and Statistics (IBGE), Federation of Trade in Goods, Services and Tourism of the State of São Paulo (FECOMERCIO), National Confederation of Industry (CNI) and Getulio Vargas Foundation. The choice of the data period for the empirical analysis was based on the availability of data series. The monthly data set used spans from March, 2001 to December, 2013.

The data on variables included housing priceindex and variables from the construbusiness sector. The housing price index is a based on monthly residential real estate collateral value index (IVGR) estimated by the Central Bank of Brazil. It is a general measure of housing price in Brazil. Seven independent variables from construbusiness sector were used in order to understand housing price behavior in Brazil:

- CONCIMENTO (annual cement consumption per capita)
- TXDESOCON (construction sector unemployment rate 12 months average)
- INCCMO (national index of building costs working force)
- ENDFAMINO (household's disposable income committed to real estate finance)
- FINIMOB (volume of mortgage)
- PMF (average mortgage term)
- INPCALU (rent price index)

This search focused in the analysis of construbusiness variables (endogenous to the system) and housing prices since the effects of a sharp movement in housing prices may not be relevant for the economy as a whole but may be for the Construbusiness sector. This initial perception is mainly driven by the low mortgage to GDP ratio in Brazil when compared to other countries that suffered the effects of the housing bubble crisis in the United States and Europe; default crises in sectors with similar GDP importance, for example, vehicle financing in Brazil in 2012 had effects limited to the automobile sector and the stress testing exercise conducted by the Brazilian Central Bank confirmed no severe impact in the financial system even in cases of extreme devaluation in housing prices.

These eight variables were considered endogenous to the system and an exogenous dummy variable, MCMV was included in order to capture the effect of "Plano Minha Casa, Minha Vida" plan government plan in order

to reduce the housing deficit for the low-income population from April, 2009 to December, 2013. In order to understand housing price behavior in Brazil time series techniques were employed. These procedures assumes in the long-run, housing price adapt to economic fundamentals. However, in short-run, the housing price may deviate from long-run equilibrium but continually readjust to the deviations through an error correction mechanism. Therefore, Johansen cointegration-vector error correction model was used as a suitable strategy to examine the co-movement between housing price and economic fundamentals and their dynamic relationship both in the long and short-run.

As suggested by Sims (1980), this research utilized impulse response function and variance decomposition of Vector Autoregressive (VAR) modelas a check for robustness of results. To test for cointegration in housing price equation it is necessary to ensure that the variables are integrated of same order. Thus, unit root test for each variables in the model were conducted. In addition to Augmented Dickey Fuller test for stationarity due to its limitations in correcting for heteroscedasticity, anon-parametric test formulated by Phillips-Perron (Perron, 1989) was performed for verifying ADF results.

The choice of the lag length is quite sensitive to the result of the Multiple Cointegration test. This research selected the appropriate lag length according to Akaike Information Criterion (AIC). According to Mallick and Mahalik (2015) AIC usually prefers the latter as it selects longer lags. According to the authors, the logic of preferring a longer lag is that it can show the effects of housing price determinants in the current period, over a longer time. There may persist lagged effects of determinants of housing price besides their immediate impacts.

The aim was to analyze housing price dynamics. Therefore as a check for robustness, the study applies VAR model. However, one area of controversy for estimating in VAR models is whether the variables included in the model should be stationary or not. Someargue that if the time series is non-stationary, regression of one time series variable onone or more variables can often give rise to spurious results due to the effect of acommon trend. Sims (1980) and others, though, recommend against differencing even if the variables have a unit root. The main argument against differencing is that "it throws away" information concerning the co-movement in the data which in general, leads to poor forecasting. However, econometricians use stationary variables for stability and robustness in VAR results.

Dynamic analysis of VAR model is routinely carried out using ''orthogonalized'' impulse responses where the underlying shocks to VAR model are orthogonalized using Cholesky decomposition method. This methodology assumes that the system is recursive and all the determinants are influencing housing prices simultaneously and the estimations of impulse response and variance decomposition are orthogonalized so that the covariance matrix of the resulting innovations is a lower triangular matrix (Sims, 1980).

RESULTS AND DISCUSSION

The reaseach was based on a two-stage estimation. In the first one, cointegration analysis was used to identify cointegrating relationship among the variables. This was important because if two non-stationary variables are cointegrated, a VAR model in the first difference is misspecified. If cointegration relationship is identified, the model should include residuals from the vectors (lagged one period) in the dynamic Vector Error Correction Model (VECM).

It was necessary to check the order of integration of the level variables for an appropriate econometrics method. Unit root tests of each variable at their levels as well as first difference of non-stationary level variables were conducted. The result from Table 1-3 shows that all the variables are non-stationary at their levels. All the non-stationary variables are found to be stationary at their first differences and therefore are integrated of order one except by ENDFAMIMO and LFINIMOB variables which need to be differenced twice due to problems with multiple unit roots in the VAR models when the variables were differenced only once. As recommended by Agung (2009), the analysis was performed using logarithmic transformation for the time series.

The cointegration model used nine variables. Eight variables have been assumed to be endogenous in the cointegration framework and one exogenous, MCMV was included in order to capture the effect of "Plano Minha Casa, Minha Vida" plan government plan in order to reduce the housing deficit for the low-income population from April 2009 to December 2013.

Unrestricted VAR model: The VAR model involves selection of appropriate lag length. An inappropriate lag selection may give rise to problems of incorrect parameterization. The objective of estimation was to ensure that there was no serial correlation in the residuals. Akaike Information Criterion (AIC) was used to select optimal lag lengths. The resulting lag structure is reported in Table 4. The thirteen period was considered to be the optimal lag according to AIC.

Table 1: Estimated Augmented Dickey-Fuller (ADF) unit-root test results

	Intercept		1 differentiation	
ADF test	With no trend	With trend	With no trend	With trend
IVGR	-1.0690 (0.7269) (13)	-2.5000 (0.3278) (13)	-1.9565 (0.3058) (12)	-1.3833 (0.8618) (12)
CONCIMENTO	-0.4930 (0.8880) (13)	-3.0574 (0.1208) (13)	-1.9539 (0.3070) (12)	-2.0105 (0.5902) (12)
TXDESOCON	-1.0797 (0.7228) (13)	-1.8958 (0.6514) (13)	-3.1584 (0.0247) (12)	-3.1419 (0.1008) (12)
INCCMO	0.5325 (0.9873) (13)	-3.1282 (0.1039) (13)	-3.0469 (0.0331) (12)	-3.7286 (0.0236) (13)
ENDFAMIMO	0.4649 (0.9850) (12)	0.1428 (0.9974) (12)	1.0127 (0.9966) (11)	-1.7021 (0.7455) (11)
FINIMOB	-1.5507 (0.5051) (12)	-3.7621 (0.0215) (12)	-1.2404 (0.6558) (11)	-0.5345 (0.9809) (11)
PMF	-0.0691 (0.9496) (6)	-2.2179 (0.4758) (6)	-3.4348 (0.0113) (5)	-3.4915 (0.0440) (5)
INPCALU	-2.4808 (0.1222) (1)	-1.9961 (0.5985) (1)	-4.7015 (0.0001) (0)	-6.2279 (0.0000) (0)

Table 2: Estimated Phillips-Perron unit-root test results

	Intercept		1 differentiation	
Phillips-Perron test	With no trend	With trend	With no trend	With trend
IVGR	1.1137 (0.9975)	-3.5467 (0.0380)	-3.0457 (0.0330)	-3.0195 (0.1304)
CONCIMENTO	0.8232 (0.9942)	-2.6641 (0.2531)	-6.9267 (0.0000)	-8.0786 (0.0000)
TXDESOCON	-0.7814 (0.8212)	-1.9112 (0.6439)	-5.3416 (0.0000)	-5.3160 (0.0001)
INCCMO	-0.0916 (0.9473)	-2.6195 (0.2724)	-8.5374 (0.0000)	-8.5096 (0.0000)
ENDFAMIMO	10.2875 (1.0000)	3.0903 (1.0000)	-3.4933 (0.0094)	-10.8832 (0.0000)
FINIMOB	3.0581 (1.0000)	-2.9636 (0.1460)	-4.2011 (0.0009)	-7.6237 (0.0000)
PMF	0.6755 (0.9913)	-3.0097 (0.1330)	-9.7408 (0.0000)	-10.0905 (0.0000)
INPCALU	-2.9964 (0.0375)	-2.0853 (0.5495)	-4.6542 (0.0002)	-6.2449 (0.0000)

Table 3: Unit-root hypothesis tests conclusion

Variabl*	Conclusion
Livgr	Data needs to be differenced once to make it stationary
Lconcimento	Data needs to be differenced once to make it stationary
Txdesocon	Data needs to be differenced once to make it stationary
Linccmo	Data needs to be differenced once to make it stationary
Endfamimo	The testing results were not conclusive: the variable follows a I(1) or I(2) process, however the variable was differentiated twice since by differentiating the variable only once, problems with multiple unit roots in the VAR models were identified
Lfinimob	The testing results were not conclusive: the variable follows a I(1) or I(2) process, however the variable was differentiated twice since by differentiating the variable only once, problems with multiple unit roots in the VAR models were identified
Lpmf	Data needs to be differenced once to make it stationary
Linpcalu	Data needs to be differenced once to make it stationary

Table 4: AIC defining optimal lag lengthto be considered in VAR model

Lag	AIC
0	-63.315890
1	-65.779550
2	-65.927630
3	-65.921640
4	-65.779370
5	-65.814560
6	-65.644790
7	-65.588540
8	-65.712840
9	-65.850060
10	-66.006270
11	-66.690670
12	-68.498360
13	-69.95167*

As recommended by Agung (2011), after running Wald testing in order to analyze the non-significant lags, it was decided to exclude lags 7, 8 and 13 so that the remaining lags were statistically significant. Lagrange Multiplier method (LM) applied for the degenerated VAR(12) confirmed the absence of series autocorrelation up to order 24 and the VAR model stability testing demonstrated that all unit roots were on the unit circle (Fig. 1). Cointegrating relationship is estimated by Johansen (1988) multivariate cointegration test.

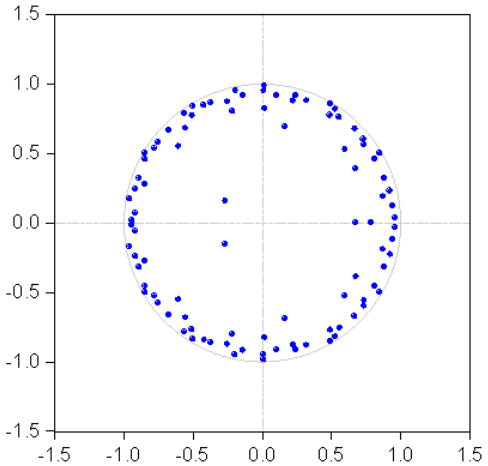

Fig. 1: Inverse roots of AR characteristic polynomial; reach data

Whereas the time series can be cointegrated, estimate an unrestricted VAR would be a specification error (Bueno, 2011), thus it was necessary to know whether the series were cointegrated. Based on Johansen

cointegration test, it was concluded that the time series were cointegrated and there were several cointegration vectors between them. A Vector Error Correction Model (VECM) was estimated for impulse response function and variance decomposition analysis due to evidence of long-term relationships between the system variables.

Vector Error Correction Model (VECM): According to Bueno (2011), there are five possible VECM models: no intercept and trends in both cointegration vector and the level of the variables; there is only intercept in the cointegration vector; there is intercept in the cointegrating vector and linear trend in the series level; there is intercept in the cointegrating vector and linear trend in the cointegration vector and in the level and there is intercept and linear trend in the cointegration vector and quadratic trend in the level.

In this research the model a constant in the cointegration vector and no trend in the data since was chose as according Morettin, this is the most common model for economic series. Additionally, with the inclusion of the dummy MCMV the trend is already in the data (Bueno, 2011). The LM testing to detect the presence of autocorrelation of the residuals and the stability of the estimated VECM corroborate the adequacy of the model. The dummy MCMV was statistically significant in all system equations; the variable with worse explanation (adjusted R^2) by other system variables was PMF followed by IVGR. The best explained variable by the other system variables was INPCALU followed by CONCIMENTO.

Granger Causality test: The Granger Causality test was intended to understand the variable order of importance for the system explanation, so this order is considered in the impulse response function and decomposition of variance. The individual significance test of each variable (and their lags) and the test to explain the variable Ivgr brought some preliminary conclusions: only Endfamimo variable was not explained by other system variables; probably because this variable is determined exogenously; in general, the system was well adjusted in special most variables were explained by other system variables (except in case of Endfamimo), thus presenting the effect of Granger Causality; the variables Concimento, Inccmo and Inpcalu were statistically significant in causing Granger on Ivgr variable.

The variables sequence considered in the Cholesky decomposition was: Txdesocon→Inpcalu→Ivgr→Concimento→pmf→Inccmo→Finimob→Endfamimo. This order was originated by analyzing the magnitude of the Chi-square statistic in Granger Causality test.

Impulse response function and variance decomposition: Impulse response function accumulated in 24 months was used to assess the impacts of model variables on housing prices (Ivgr). The magnitude of the shocks of these variables was one standard deviation. To ratify the results of the impulse response function testing, variance decomposition analysis was used. In general, it is possible analyze this contribution in the short term (up to 6 months) and medium/long term (24 months). The results of the variance decomposition are shown in Table 5 and 6, respectively.

According to the results of the Impulse Response Function and Variance Decomposition, the following considerations can be made: effect of increasing the volume of mortgage (Finimob) by also lengthening the average mortgage term (PMF) with a consequent increase in household's disposable income committed to residential real estate finance (Endfamimo) in residential real estate price (Ivgr).

Among the main direct effects of "Minha Casa, Minha Vida" plan in housing prices, the lengthening of the average mortgage term (PMF) seems to produce more impact on a long term basis than the increase in mortgage volume (Finimob). However, impulse response function testing results partially met the expectations of a positive long-term influence of the variables in house prices. While Endfamino and Finimob variables had positive long-term influence in house prices, PMF variable had negative influence.

One of the hypothesis for the PMF variable having a negative influence on the housing prices along the time could be a more than proportional increase in outstanding debt vis a vis the reduction in the amount of the installments. As can be seen in Table 7, each increase of 12 months in average mortgage term represented an increase of 3.66% in total debt. This was linear along the time. On the other hand, the increase in mortgage term represented an initial reduction of 46.46% in value of the installment in 24 months, reducing additional 15.49% in 36 months, 7.74% in 48 months, 4.65 % in 60 months and so on. The reduction in the amount of the installments became proportionately less than the increase in the debt after 7 years and represented additional reduction of <1% after 10 years. While the increase in debt was linear along the time, the reduction in the value of the installments was decreasing.

The outcome of impulse response function and variance decomposition tests corroborate the preliminary analyzes that IVGR variable did not demonstrate the same performance as the other variables. Government

Table 5: Variance decomposition of IVGR degenerated VECM (12) (24 periods)

		Impact (%) (months)					
Variable choque	Variable impacto	1	3	6	12	18	24
Endfamino	Ivgr	0.00	1.86	6.28	5.14	6.70	5.47
Finimob	Ivgr	0.00	0.02	0.07	3.78	5.33	5.43
PMF	Ivgr	0.00	5.51	8.37	19.20	17.83	16.94
Inpcaalu	Ivgr	45.54	36.38	29.00	25.16	22.00	17.84
Txdesocon	Ivgr	4.57	4.02	4.65	10.01	11.53	13.42
Inccmo	Ivgr	0.00	1.93	3.48	6.78	6.69	6.05
Concimento	Ivgr	0.00	6.95	9.59	7.10	11.36	13.62

Table 6: Variance decomposition of endogenous variables of the system degenerated VECM (12) (24 periods)

		Impact (%) (months)					
Variable choque	Variable impacto	1	3	6	12	18	24
Ivgr	Endfamino	1.16	1.24	4.70	6.56	8.67	8.67
Ivgr	Finimob	8.36	11.20	8.82	7.77	8.20	11.77
Ivgr	PMF	1.11	1.07	2.75	16.18	23.07	24.21
Ivgr	Inpcaalu	0.00	0.96	1.03	3.03	15.44	18.07
Ivgr	Txdesocon	0.00	1.22	3.59	12.78	21.33	22.47
Ivgr	Inccmo	12.42	11.64	11.85	10.48	6.00	6.99
Ivgr	Concimento	6.91	12.40	12.55	18.92	22.44	22.75

Table 7: Mortgage simulation CAS (Constant Amortization System)

					Increase in interest rate		Reduction in installment		Annual variation	
Years	Principal (total)	Interest (total)	Principal+ interest	Initial (months) (installment)	%	R$	%	R$	Interrest	Installment
1	100.000.00	4.131.62	104.131.62	8.968.97						
2	100.000.00	7.945.43	107.945.43	4.802.30	3.66	3.813.80	-46.46	-4.166.67		
3	100.000.00	11.759.23	111.759.23	3.413.41	7.32	7.627.61	-61.94	-5.555.56	3.66	-15.49%
4	100.000.00	15.573.03	115.573.03	2.718.97	10.99	11.441.41	-69.68	-6.250.00	3.66	-7.74%
5	100.000.00	19.386.84	119.386.84	2.302.30	14.65	15.255.22	-74.33	-6.666.67	3.66	-4.65%
6	100.000.00	23.200.64	123.200.64	2.024.52	18.31	19.069.02	-77.43	-6.944.44	3.66	-3.10%
7	100.000.00	27.014.45	127.014.45	1.826.11	21.97	22.882.82	-79.64	-7.142.86	3.66	-2.21%
8	100.000.00	30.828.25	130.828.25	1.677.30	25.64	26.696.63	-81.30	-7.291.67	3.66	-1.66%
9	100.000.00	34.642.05	134.642.05	1.561.56	29.30	30.510.43	-82.59	-7.407.41	3.66	-1.29%
10	100.000.00	38.455.86	138.455.86	1.468.97	32.96	34.324.24	-83.62	-7.500.00	3.66	-1.03%
15	100.000.00	57.524.88	157.524.88	1.191.19	51.27	53.393.26	-86.72	-7.777.78	3.66	-0.62%
20	100.000.00	76.593.90	176.593.90	1.052.30	69.59	72.462.28	-88.27	-7.916.67	3.66	-0.31%
25	100.000.00	95.662.92	195.662.92	968.97	87.90	91.531.30	-89.20	-8.000.00	3.66	-0.19%
30	100.000.00	114.731.94	214.731.94	913.41	106.21	110.600.32	-89.82	-8.055.56	3.66	-0.12%
35	100.000.00	133.800.96	233.800.96	873.73	124.52	129.669.34	-90.26	-8.095.24	3.66	-0.09%

intervention (from 2009) to increase the volume of mortgage (Finimob) by also lengthening the average mortgage term (PMF) with a consequent increase in household's disposable income committed to real estate finance (Endfamimo) has not been fully propagated into house prices (Ivgr).

The Variance Decomposition testing results demonstrated that the contribution of Finimob, PMF and Endfamino variables to explain Ivgr variation increases in long-term reaching 27.84% two years after the shock. In the short term, these three variables cause an effect of 7.39% three months after the shock.

Academic researches were not conclusive on this subject. Lastrapes (1998) notes that in response to a shock in money supply, the price of residential properties in the US market up just 0.1% in the short term and then reach a peak of 0.7% only 18 months after the shock, confirming long-term relationship. On the other hand, Melo (2013), using VAR and VECM models, found a short-term response to shocks in economic variables. Shocks in mortgage loans supply and interest rates variables were reflected from one to three months on the quantity of residential properties sold in the state of the Ceara, Brazil.

The reason why there was no common pattern may be connected to particular characteristics of each country or market. The slower response of the potential housing buyer to changes in credit supply and mortgage term could be related to consumer conservatism in decision making, preferring to wait a longer period to ensure that financing conditions will remain the same along the time. An additional factor to explain the non-contamination of increases in Finimob, PMF and Endfamino variables into house prices could be attributed to more than proportional increase of house prices relatively to disposable income which would limit the effect of the expanding government policies in the sector.

Effect of increasing the unemployment rate of the construction sector (TXDESOCON) in the national index of building costs working force (INCCMO) and the residential real estate price (IVGR): One standard deviation shock in TXDESOCON variable explained the variation in the variable IVGR in 4.02% three months after the shock, reaching 13.42% two years after. Impulse response function testing results demonstrated that an increase in unemployment rates in the real estate sector had a negative effect on the house prices which confirmed the initial expectations that low unemployment rates in labor market was one of the factors that put pressure in the cost of properties.

According Castelo, excluding land acquisition cost, 50% of housing prices are composed by building costs related to labour force. Also according to the researcher, the pressures on labour costs due to the lower unemployment rates in the sector are not only reflected in house prices but spreads throughout the sector production chain. Impulse response function testing results also confirm the initial expectations that an increase in house construction costs has a positive effect on the house prices. Decomposition variance tests demonstrated that one standard deviation shock in TXDESOCON variable could explain the variation in INCCMO variable 13.77% one month after the shock. After 2 years the explanatory power keeps on 11.52%, demonstrating strong relationship.

Effect of a shock in the price of residential rents (INPCALU) in the residential real estate price (IVGR): One standard deviation shock in INPCAALU variable explained the variation in IVGR variable in 45.53% one month after the shock reducing to 17.83% 2 years after the shock. In the short term a significant portion of the house prices variance was explained by shocks in rental prices but this proportion declines along the time. Even declining along the period, INPCAALU variable was the one that had greater explanatory power in house prices dynamics two years after the shock.

Under investors' perspective, this result supports the theoretical foundation of the research that the higher rental prices are, the greater the number of people who would prefer to buy properties and rent them to others instead of invest in government bonds. On the other hand, if rental prices are lower, people would prefer to sell their properties and invest in government bonds. However, from an empirical point of view, investors' movement can be only partially used to explain this movement. According to Araujo, 95% of the residential properties are acquired for living. Only 5% of the properties are purchased by investors for income generation and investment. The preference to acquire housing properties for living can also be supported by the still high housing deficit.

The effect of a shock in rental prices in housing prices should then be explained by the higher number of tenants looking for their own property, pressured by higher rental costs. The results of Johansen cointegration and Granger Causality tests with the three variables considered as fundamental value for residential property rent-price ratio (IGP-M, INPCALU and INPCHAB), supports this assertion.

Effect of a shock in annual cement consumption per capita (CONCIMENTO) in the residential real estate price (IVGR): One standard deviation shock in CONCIMENTO variable explained 13.62% of the variation in IVGR two years after the shock. Variance Decomposition testing results confirmed impulse response function results, showing that CONCIMENTO variable has a positive long-term influence in house price. From an economic point of view this influence is explained by the effect that the increase in demand brings to the price of building material and consequently in house prices.

Effect of a shock in residential real estate price (IVGR) in the construbusiness sector: Impulse response function testing results confirmed the initial perception that IVGR variable appears to impact more the other variables of the system than being impact by these variables. This result confirmed the initial perception that the effects of a sudden movement in residential real estate price would not be relevant for the economy as a whole, mainly due to low mortgage to GDP ratio in Brazil when compared to other countries that have suffered the effects the housing bubble crisis in the United States and Europe but it would be for Constru business sector.

CONCLUSION

The main objective of this research was to analyze the Brazilian Real Estate price dynamics in the period 2001-2013. The analysis of the Brazilian Real Estate price dynamics based on VECM model, Johansen Cointegration and Granger Causality tests, impulse response function and variance decomposition of Cholesky demonstrated that the effect of the government policy in increasing the volume of mortgage by also extending average mortgage portfolio term with a consequent increase in household's disposable income committed to real estate finance has not been fully propagated in house prices.

Testing results confirmed the initial expectations that the low unemployment rates in the sector is one of the factors that put pressure on cost of properties and is consequently reflected in house prices. Rental price demonstrated the highest significance in the short term in relation to house prices and even declining over the time it is the variable that has greater explanatory power in the dynamics of house prices after 2 years. Testing results also confirmed the initial perception that IVGR appears to impact more of the other variables of the system than being impact by these variables.

Although, housing prices growth has been significant in recent years, some aspects of the Brazilian market corroborate the testing results: credit expansion in Brazil is not high by international standards: increased from 28.3% of GDP in March 2001 to 56.1% by December 2013 even with the rapid growth in recent years, the credit-to-GPD ratio in Brazil is reduced when compared to other Latin American countries, China and the G7. Similar behavior is observed in relation to mortgage. Housing prices have been rising strongly over the last years in most relevant metropolitan regions of Brazil. However, there are several factors suggesting the rise in housing prices was consistent with the overall economic growth in past years, combined with a demand shock encouraged by government actions through the increase in the volume of mortgage, the lengthening of loan terms and the sharp fall in interest rates. In 2013, the household's disposable income committed to debt service exceeded the unprecedented proportion of 45%. But in relation to mature economies such level is still low and the household debt has been changing the profile since 2010. According to the Central Bank data while the consumer finance remained stable, growth in household debt was motivated by the mortgage which rose from 7-15% of the household's disposable income. The change in debt profile is healthy since it is occurring with a long-term and low interest rate loans.

The reduction in house sales indicates that the purchasing power does not grow in the same pace observed in housing prices in the past years. This factor, coupled with other changes in macroeconomic variables such as unemployment and consumer delinquency rates may change the real estate price dynamics in the coming years. Limitation and search suggestions of research in conducting the analysis a number of opportunities for refining the research were identified: the analysis could be improved including a model excluding MCMV dummy variable and analyzing the differences between both models in order to find evidence of the effect of government intervention on the dynamics of housing prices. In another analysis it could be considered the differences of the time series on annual basis (12 lags), since it was difficult to eliminate the autocorrelation of order 12, demonstrating evidence of seasonal dependence in the time series. This procedure could affect the results of the unrestricted VAR models and Granger Causality tests. The sequence considered in Cholesky decomposition was originated by analyzing the magnitude of the Chi-square statistic in Granger Causality test. However, it could be used an economic justification for determining the variables order for example, considering government intervention through "Minha Casa Minha Vida" plan with a shock in average mortgage portfolio term and interest rate primarily affecting the volume of mortgage, then the prices of residential properties and then spreading the effect to the entire system, ending with the increase in household's disposable income committed to real estate finance. Some preliminary tests indicated that the dynamics of INPCALU variable was changed with this new ordinance. The other dynamics remained unaltered. For future research we suggest a more complete temporal analysis, by the year 2016 taking into consideration the current economic crisis in Brazil.

REFERENCES

Agung, I.G.N., 2011. Time Series Data Analysis using E-Views. John Wiley and Sons, Singapore, ISBN: 978-0-470-822367-5, Pages: 171.

Bueno, R.D.L.D.S., 2011. Econometric Time Series. Cengage Learning, Sao Paulo, Brazil, ISBN: 9788522106424, Pages: 299.

Doukas, J.A., 2011. European financial management association: Round table discussion-rationality of capital markets. Eur. Financial Manage., 8: 229-247.

Enciso, L.F., W.V. Silva, J.A.W. Cruz, P.G.R. Piccoli and C.P.D. Veiga, 2016. Determination of sovereign ratings in Latin American countries. WSEAS. Trans. Bus. Econ., 13: 216-228.

Fama, E.F., 1991. Efficient capital markets: II. J. Finance, 46: 1575-1617.

Harzer, J.H., A. Souza, W.V. Silva, J.A.W. Cruz and C.P.D. Veiga, 2016. Probabilistic approach to the MARR/IRR indicator to assess financial risk in investment projects. Int. Res. J. Finance Econ., 144: 131-146.

Hirshleifer, D. and T.S. Hong, 2003. Herd behaviour and cascading in capital markets: A review and synthesis. Eur. Financial Manage., 9: 25-66.

Johansen, S., 1988. Statistical analysis of cointegration vectors. J. Econ. Dyn. Control, 12: 231-254.

Korontai, J.N., G. Carpejani, A.M.M. Correia, W.A. Freitas and C.P. Veiga *et al*., 2016. Proposed performance indicators for the technology incubator at the institute of technology of Parana Brazil. Espacios, 37: 20-40.

Kudlawicz, C., T.M. Bach, C.P. Da, C.O.S. Veig and D.W.V. Silva, 2016. Cointegrations relationship and causality between exportations and economic growth from Southern Americas countries and the United States. WSEAS. Trans. Bus. Econ., 13: 162-174.

Lastrapes, W.D., 1998. International evidence on equity prices, interest rates and money. J. Int. Money Finance, 17: 377-406.

Mallick, H. and M.K. Mahalik, 2015. Factors determining regional housing prices: Evidence from major cities in India. J. Property Res., 32: 123-146.

Melo, M.M., 2013. Factors macroeconomic imobiliario market determinants of ceara state. Mag. Nexos Econ., 6: 35-59.

Moralejo, L., P. Rogers, L.C. Duclos and C.P.D. Veiga, 2016. Brazilian residential real estate bubble. WSEAS. Trans. Bus. Econ., 13: 86-93.

Nobre, L.H.N., J.E. Grable, W.V. Silva and C.P. Veiga, 2016. A cross cultural test of financial risk tolerance attitudes: Brazilian and American similarities and differences. Int. J. Econ. Financial Issues, 6: 314-322.

Perron, P., 1989. The great crash, the oil price shock and the unit root hypothesis. Econ. J. Econ. Soc., 57: 1361-1401.

Pornchokchai, S., 2007. Rethinking the real estate cycle. Government Hous. Bank J., 1: 48-59.

Pyhrr, S., S. Roulac and W. Born, 2009. Real estate cycles and their strategic implications for investors and portfolio managers in the global economy. J. Real Estate Res., 18: 7-68.

Rottke, N., M. Wernecke and J.A. Schwartz, 2003. Real estate cycles in Germany-causes, empirical analysis and recommendations for the management decision process. J. Real Estate Lit., 11: 325-346.

Shiller, R.J. and T. Arijon, 2003. Exuberancia Irracional. TBS Media Company, Sao Paulo, Brazil, ISBN: 978-84-234-2265-4, Pages: 535.

Shleifer, A. and L.H. Summers, 1990. The noise trader approach to finance. J. Econ. Perspect., 4: 19-33.

Sims, C.A., 1980. Macroeconomics and reality. Econometrica, 48: 1-48.

Taipalus, K., 2012. Detecting Asset Price Bubbles with Time-Series Methods. Bank of Finland, Finland, ISBN: 978-952-462-823-5, Pages: 208.

Veiga, D.C.P., D.C.R.P. Veiga, A. Catapan, U. Tortato and D.W.V. Silva, 2014. Demand forecasting in food retail: A comparison between the holt-winters and ARIMA models. WSEAS. Trans. Bus. Econ., 11: 608-614.

Veiga, D.C.R.P., D.C.P. Veiga and L.C. Duclos, 2010. The accuracy of demand forecasting models as critical to financial performance in the food industry. Future Stud. Res. J. Trends Strategies, 2: 83-107.