Jorge Ponce

Fundamentals for the Price of Housing in Uruguay

Abstract

This paper proposes a model of fundamentals for the price of housing. The model is calibrated with data from Uruguay. The main findings are: Real housing prices fluctuate more than justified by fundamentals; the misalignment was statistically significant just before the 2002 crisis; a fall in fundamental prices anticipates the crisis; and, in the recent period fundamental prices follow a stable trend of positive growth while real housing prices fluctuate around it.

Keywords: price of housing, model of fundamentals, financial stability, Uruguay.

JEL classification: G28.

1. INTRODUCTION

Deviations in the prices of some assets, particularly those of housing, from their equilibrium path can have significant consequences for financial system stability. When real estate (housing) prices remain higher than justified by their fundamentals for prolonged periods can result

J. Ponce is an official of the Banco Central del Uruguay. The author is grateful to Fernando Borraz, Diego Gianelli, Gerardo Licandro, Adolfo Sarmiento and two anonymous referees for their comments and suggestions. The opinions expressed herein are those of the author and do not necessarily reflect the views of the Banco Central del Uruguay. For all correspondence: <jponce@bcu.gub.uy>.

in excessive indebtedness, disproportionate risk taking and overvalued guarantees, all of which make the appearance of sudden and costly corrections more likely. In a global environment characterized by loose international liquidity conditions, substantial capital flows toward emerging economies and high commodity prices, as occurred after the international financial crisis of 2008-2009, assessing the degree of misalignment of housing prices from their fundamentals became particularly important.[1]

This paper proposes a model for estimating housing prices according to their fundamentals, which exploits the fact that a home can be considered an investment as well as a good that provides services. The model is calibrated with data from Uruguay. A comparison of real prices with those justified by fundamentals provides an indicator for the direction, size and duration of possible imbalances.

The main outcomes can be summarized as follows. First, real housing prices fluctuate more than justified by fundamentals, implying that periods of undervalued or overvalued housing prices are observed across the historical series. Second, prices according to calibrated fundamentals began a downward trend four years before the emergence of the 2002 crisis. The intensity of the fall increases during the year immediately prior to the crisis, showing there is a significant misalignment from real prices, which remain relatively stable. The overvaluation of real prices as compared to fundamental prices becomes statistically significant during that period. This fact, although derived from just one crisis event, argues in favor of using fundamental housing prices as a forward-looking financial fragility indicator. Third, in the most recent period, fundamental prices follow a stable trend of positive growth, while real housing prices in Uruguay fluctuate around it without exhibiting any statistically significant changes. Thus, there are no signs

[1] The following section presents a review of the literature analyzing the links between the international environment and domestic asset prices.

of imbalances between real housing prices and those justified by fundamentals. Nevertheless, it is important to make the following observations. The fact that real housing prices are aligned with fundamentals does not mean the former cannot fall in the future. As mentioned above, real prices fluctuate more than fundamental prices. In addition, prevailing international economic conditions lend weight to the hypothesis that fundamentals for housing prices (particularly income variables) might be overvalued. This point should be the subject of further study. Fourth, housing supply and construction series, as well as estimates for other important variables such as the deprecation rate, maintenance costs and risk premium, have been generated as a byproduct of the calibration exercise.

The rest of the paper is structured as follows. The next section briefly describes the related literature. Section 3, provides a summary of Uruguay's real estate sector. Section 4, shows the model of fundamentals for the price of housing. Section 5 calibrates the model with data for Uruguay. Section 6 offers some concluding remarks.

2. LITERATURE REVIEW

A set of recent contributions have addressed the links between global imbalances, capital flows, international liquidity conditions and asset prices. Hirata et al. (2012) show that housing prices in developed countries tend to move together (they are synchronized), and how this synchronization has increased over time. Among the determinants of global house price fluctuations, the authors find that innovations to the global interest rate (or loose monetary policy) have a significant impact on housing prices. Aizenman and Jinjarak (2009) also found evidence of an increase in the synchronization of prices in world real estate markets. Their paper also shows there is a robust and strong positive association between current account deficits and the real appreciation of housing. This association is stronger in deeper financial markets. Taguchi (2011) studied the response of asset prices to capital flows in East Asian

countries. In every case they found a positive response of share prices to portfolio flows. Moreover, this effect is magnified by the indirect impact of monetary policy in countries with a fixed exchange rate regime. Vásquez-Ruiz (2012) studied a panel of 46 countries and found a strong positive association between housing prices and portfolio flows. The exchange rate regime also affects the strength of this relation. Kim and Yang (2011) found that capital flows to Asian countries have contributed to the appreciation of equities and land. Meanwhile, Favilukis et al. (2012) found that capital flows only have a limited effect on housing prices when the endogenous effects on risk premia and the expected supply of housing are considered. On the other hand, changes that modify access to mortgage credit have a large impact on prices.

The literature mentioned in the preceding paragraph does not study the direction of causality between current account deficits and asset prices. Laibson and Mollerstrom (2010) found evidence suggesting that causation runs from asset price bubbles to current account deficits. In particular, movements in asset prices explain more than 50% of the current account deficits in OECD countries. Gete (2010) formally showed how an increase in the demand for housing can generate a current account deficit. Jinjarak and Sheffrin (2011) analyzed the causal relations between the current account deficit and real estate prices. They found little evidence that the former cause the latter.

From a financial stability perspective, it is necessary to be able to identify when a series of asset prices is misaligned from their fundamentals or equilibrium path. Garriga et al. (2012) found that the behavior of housing prices can be correctly described by using standard asset pricing formulas. However, the pricing model required is highly nonlinear. Hott (2009) provided a nonlinear model for calibrating housing prices according to their fundamentals. Both papers conclude that observed prices vary more than that predicted by their fundamentals. Borraz et al. (2012) estimated a dynamic panel data model for 32 countries between 1990 and 2011, studying the relation between housing prices and global variables. The methodology allows periods

of overvaluation to be identified for each country when using the estimated relation as a fundamental for housing prices. The results are in line with those found by Jara and Olaberría (2012), who used the methodology of Olaberría (2011).

Olaberría (2011) studied the link between capital flows and financial asset price booms measured as a deviation of current prices from a Hodrick-Prescott trend, finding a strong and significant association between these variables for emerging countries. The author also found no evidence to support that capital controls reduce such association. Hott and Jokipii (2012) used the fundamentals model of Hott (2009) for identifying misalignments in housing prices, finding a significant and positive link between low interest rates and house price bubbles. In addition, the empirical evidence supports the hypothesis that interest rates that have remained low for long periods magnify the impact. Cubeddu et al. (2012) studied a sample of Latin American countries and analyzed whether housing prices were aligned with their fundamentals and up to which point the growth of mortgage credit was excessive with respect to long-term trends. The authors concluded that there were no significant misalignments of housing prices from their fundamentals (estimated through a Hodrick-Prescott trend), but these could materialize if current trends persist.

Price indexes are elaborated by different methodologies, according to the literature. Several methods are also employed for estimating the part of observed prices that can be explained by the evolution of fundamentals in order to identify potential misalignments. The intended goal, the relative complexity of the methodologies and the availability of data determine the choice of one over another. Ponce and Tubio (2013) systematized the methodologies for elaborating housing price indexes and evaluated their applicability to the case of Uruguay. On the one hand, simple methodologies such as that of *repeat sales* do not appear to be applicable given low housing rotation in the Uruguayan market. On the other, highly complex methodologies such as *hedonic models* would not be applicable either, at least for obtaining a relatively long series, due to the lack of

disaggregated data.[2] Thus, data availability determines the use in this paper of a mix-adjusted price index (see section 4.2.1). Meanwhile, the methodology proposed for identifying periods of overvalued housing prices is based on microeconomic fundamentals (see section 4). It therefore contributes with an estimation that is complementary to those carried out using Hodrick-Prescott filters (e.g., Jara and Olaberría, 2012) or dynamic panel models (see Borraz et al., 2012, who include the case of Uruguay).

3. THE RESIDENTIAL REAL ESTATE SECTOR IN URUGUAY

The Uruguayan economy has exhibited significant strength in recent years. The average annual growth rate of Uruguay's gross domestic product (GDP) was almost 6% during the last decade. In this context of strong economic growth and loose international financing conditions, real estate sector activity expanded considerably. In fact, the greater income and improved financing possibilities that characterize positive economic cycles also benefit activity in the real estate sector. In particular, construction has exhibited significant strength since 2003, doubling levels of activity as compared to those prevailing in the recession of 2002-2003. In recent years, the sector has shown considerable dynamism mainly driven by housing construction in Punta del Este and the Montevideo coastal zone. According to data from the National Institute of Statistics, the constructed surface area in Montevideo totaled 240,000 square meters in 2012, as compared to around 60,000 square meters in 2002. For several years, the sector's activity was concentrated in building tower blocks and apartments on the coastal zone, but this segment has exhibited some signs of saturation over the last few years.

[2] Landaberry and Tubio (2015) recently elaborated a hedonic price index for housing in Uruguay for the period 2009-2013 by compiling a new database that incorporates data from different sources.

The growth in housing construction and supply was accompanied by a significant expansion in investment. It is estimated that in 2011 and 2012 investment in housing construction amounted to around 1.6 billion USD per year. This represented an important increase from the figures recorded in 2008 and 2009, when investment in housing was a little under 900 million USD. Meanwhile, investment in construction has captured over a quarter of the foreign investment received by the country. As mentioned previously, the luxury segment of Montevideo and Punta del Este has been the main focus for such investments, especially by Argentine investors.

On the demand side, figures from the National Institute of Statistic's Continuous Household Survey show that around 60% of Uruguayan households own their own home. Furthermore, if household income levels are included in said analysis, it can be seen how the percentage difference of households with own homes among the lowest and highest quintile is 20%, meaning on average 50% of lower income households own the homes they live in. Slightly over 80% of total households with homes have already paid for them. Thus, housing represents the most important asset of the average Uruguayan household.

With respect to financing for home purchases, Uruguay is characterized by low mortgage credit penetration. Although in nominal terms mortgage credit in Uruguay has registered significant growth in recent years and constitutes the average household's main liability, in terms of gross domestic product it has remained relatively stable at around 4%, which is a rather low level compared to international values.

Rental agreements are freely negotiated in Uruguay, meaning the parties are who decide on the term, currency and payment readjustment system. This flexibility has allowed market prices to respond to fundamentals, which function as appropriate signals for agents in the sector to make decisions. Under the context of the significant economic growth registered during the last few years, the rental market has exhibited substantial strength, above all in Montevideo, where there has been a continuous increase in the number of contracts signed.

4. THE MODEL

This section describes the model of domestic fundamentals for housing prices. It is inspired by Hott (2009) and exploits the fact that a home can be considered as an investment asset as well as a good that serves utility. The price of a home can therefore be considered in two complimentary ways: as an outcome of the market for housing services or the equilibrium in an asset market.

The model of fundamental prices presented here combines both interpretations. The asset view of housing is the first to be considered: the house prices are defined as the present value of future rents. In second place, future rents are calculated over a housing market equilibrium, i.e., housing is considered as a consumer good. Finally, fundamental housing prices are calculated by replacing the imputed future rent in the present value equation by its fundamental value.

4.1 Asset: Current Value of Future Imputed Rents

When considering housing as an asset, its price is defined as the present value of future rents. The arbitrage condition implies that in equilibrium any individual must remain indifferent as regards purchasing or renting a home. Calibration of the model will exploit this condition. The cost per period of renting a home is *rental*, M_t, while the cost per period when purchasing a home is the imputed rent, H_t.

To calculate imputed rent the following factors are considered:

1) Financial cost (opportunity cost): the costs of financing for purchasing a home (or the opportunity costs due to the unavailability of own money) are represented by $m_t P_t$, where m_t is the interest rate in period t and P_t is the price of housing during the same period.[3]

[3] The assumption implicit in this representation of financial costs is that the whole value of the home, the share financed with loans

2) Maintenance costs and a risk premium: Maintenance costs and a risk premium are modelled as a fixed proportion of the price of housing, ρP_t.

3) Expected net capital gains or losses: The expected capital gains or losses are given by the variation of housing prices from one period to another. This expected capital variation is modeled in net terms from the depreciation, δ the house suffers over time: $(1-\delta)E_t\left(P_{t+1}\right)-P_t$.

Imputed rent (H_t) is obtained by including these items as follows:

1 $$H_t=\left(m_t+\rho+1\right)P_t-\left(1-\delta\right)E_t\left(P_t+1\right).$$

When defining discount factor $R_t=1+\rho+m_t$, P_t is taken out of equation 1, and forward iteration then implies the following for the price of housing:[4]

2 $$P_t=E_t\left[\sum_{i=0}^{\infty}\frac{\left(1-\delta\right)^i H_{t+i}}{\prod_{j=0}^{i}R_{t+j}}\right].$$

4.2 Consumer Good: Imputed Rent

Equation 2 implies that the price of a house is equal to the current expected value of future imputed rents. The equilibrium condition in the housing market is used to calculate these rents. In particular, the sequence of imputed rents, H_t, must determine a demand for housing equal to their supply.

The supply of housing in a specified period, S_t, is determined by the supply in the preceding period net of depreciation and by the construction of new units, B_{t-1}:

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as well as that financed with own funds, is discounted at the same interest rate m_t.

[4] This is one particular solution (without rational bubbles) for the equation in finite differences where convergence is ensured by assuming that $\delta>0$.

3 $$S_t = (1-\delta)S_{t-1} + B_{t-1} = (1-\delta)^t S_0 + \sum_{j=1}^{t} (1-\delta)^{j-1} B_{t-j},$$

where S_0 is the initial supply of housing.

To determine the demand for housing, D_t, it is assumed that there is a finite number of identical individuals in the economy. Each individual has Cobb-Douglas type consumption preferences for housing and other goods in such way as the proportion of aggregate income, Y_t, allocated to consumption is represented by parameter α. The demand for housing is therefore given by:

4 $$D_t = \alpha \frac{Y_t}{H_t} \cdot$$

The supply and demand for housing are made equal and by rearranging the following equation for imputed rent is obtained:

5 $$H_t = \alpha \frac{Y_t}{(1-\delta)^t S_0 + \sum_{j=1}^{t} (1-\delta)^{j-1} B_{t-j}} \cdot$$

4.3 Fundamental House Prices

By placing the value of imputed rents from equation 5 into the price equation (equation 2), and using the supply of housing in equation 3, the following fundamental house price equation is obtained:

6 $$P_t^* = E_t \left[\sum_{i=0}^{\infty} \frac{(1-\delta)^i \alpha Y_{t+i}}{S_{t+i} \prod_{j=0}^{i} R_{t+j}} \right] \cdot$$

5. CALIBRATION

Calibration of the model's parameters is carried out in two stages. The first of these exploits the arbitrage condition according to which any individual must be indifferent between renting and purchasing a home. The parameters are chosen in a way that minimizes the square differences between actual rents, M_t, and the value of imputed rents, H_t. In the second stage the parameters are calibrated in a way that minimizes the square differences between house prices and fundamental prices. This calibration process allows for exploring the nonlinearity of the fundamental price model, which according to Garriga et al. (2012) is necessary for correctly describing housing prices.

5.1 First Stage: Rent and Imputed Rent

The parameters of equation 5 are calibrated in the first stage. The parameter of the preference for housing, α ; the depreciation rate, δ ; and the initial supply of housing units, S_0. It is also necessary to calibrate a fourth parameter, the initial construction of new housing units B_0, given the conditions of consistency demanded by the series generated for the supply of housing, S_t, and the construction of new units B_t. In particular, the series for the construction of new housing units is made to follow the evolution (variation) of the index of gross physical capital formation in residential buildings:

$$B_t = B_0 \frac{I_t}{I_0},$$

where I_k is the index of gross physical capital formation in residential buildings in period k. Meanwhile, the series for the supply of housing is forced to replicate the number of housing units reported by the relevant censuses of 1996, 2004 and 2010 with a five percent margin of error.

The calibration of the parameters solves the following optimization problem:[5]

$$\min_{\alpha_1, \delta, S_0, B_0} = \sum_{t=0}^{T} \left[\alpha_1 \frac{Y_t}{(1-\delta)^t S_0 + \sum_{j=1}^{t} (1-\delta)^{j-1} B_{t-j}} - M_t \right]^2, \quad (7)$$

where α_1 is the parameter of the preference for housing, α, corrected by the different scales of the variables employed. Calibration takes into account the following restrictions to parameter values: $\alpha_1 > 0$, $0 < \delta \leq 0.025$, $S_0 \geq 988{,}525$ and $B_0 \geq 0$. Given that α is the parameter of preferences for housing, α_1 has to be positive. The restriction for the parameter of depreciation, δ is introduced to guarantee that the minimum lifecycle of a housing unit is ten years and the maximum is potentially unlimited (remembering that quarterly data will be used for the calibration). The restriction for initial housing levels, S_0, is given by the total supply of housing units reported in the census of 1985 (remembering that the calibration is carried out with a data set starting in the first quarter of 1988). Meanwhile, construction of new units, B_0, must necessarily be non-negative.

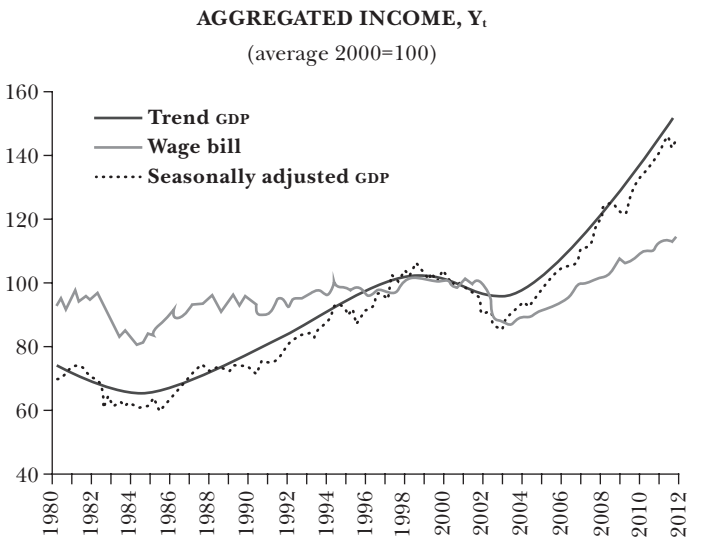
5.1.1 Data

Quarterly data for Uruguay is used for calibrating. The period of analysis runs from the first quarter of 1998 to the second quarter of 2011.

Three variants are used for aggregate income, Y_t: *i)* the index of the physical volume of seasonally adjusted gross domestic product, *ii)* the Hodrick-Prescott trend for the index of the

[5] The assumption that there are no financial market frictions is implicit in this model, meaning the arbitrage condition should always comply equally. This is particularly important in the case of Uruguay given the shallowness of the real estate market and the existence of special housing development plans throughout the last few decades. Many of these plans used development mechanisms other than interest rates (m_t) and it is therefore not possible to incorporate their impact on mortgage credit in this paper.

Figure 1



physical volume of gross domestic product, and *iii)* the wage bill calculated as real average wages multiplied by the number of workers. Figure 1 shows these variables. Rents correspond to the National Institute of Statistics' real price series for rents. A description of the series employed is provided in the annex.

5.1.2 Results

Table 1 shows the results of the calibration.[6] As can be seen, the results do not differ substantially when different variants are used for aggregate income, Y_t. In particular, the 0.66% quarterly depreciation parameter implies that, on average, a home fully depreciates in 40 years. Meanwhile, the results obtained by using gross domestic product as aggregate income imply an estimate for the initial supply of housing (for the first

[6] Calibration of parameter α is omitted given that assumptions on the factor of scale contained in calibrated parameter be made in order for it to be identified.

quarter of 1988), S_0, only slightly above the 1985 census value. Calibration of the initial supply of housing obtained by using the wage bill as the aggregate income variable is in line with the data from the 1985 census, as well as with the depreciation rate and initial construction of new units that were calibrated. Figure 2 shows the supply of housing arising as a result of the calibration exercise and compares it with census data. Figure 3 shows the series for the construction of new housing units arising from the calibration and compares it with the index of gross physical capital formation in residential buildings.

Table 1

CALIBRATED PARAMETERS

Y_t	δ	S_0	B_0
Seasonally adjusted GDP	0.0066	990,438	7,112
Trend GDP	0.0063	988,747	7,127
Wage bill	0.0066	1,017,982	6,893

Figure 4 shows the historical series for real rents, comparing it with imputed rents when the wage bill is used as the aggregate income variable. The results of the use of GDP as aggregate income variable are presented in the Annex. In all cases, real rents were higher than their fundamental values during the 1990s. The situation is reversed with the advent of the crisis in 2002. Toward the end of the series real rents have a null misalignment (when gross domestic product is used as a variable for aggregate income), or of around 10% above the fundamental value (when the wage bill is used as an aggregate income variable).

Figure 2

CALIBRATED HOUSE SUPPLY, S_t, AND CENSUS DATA

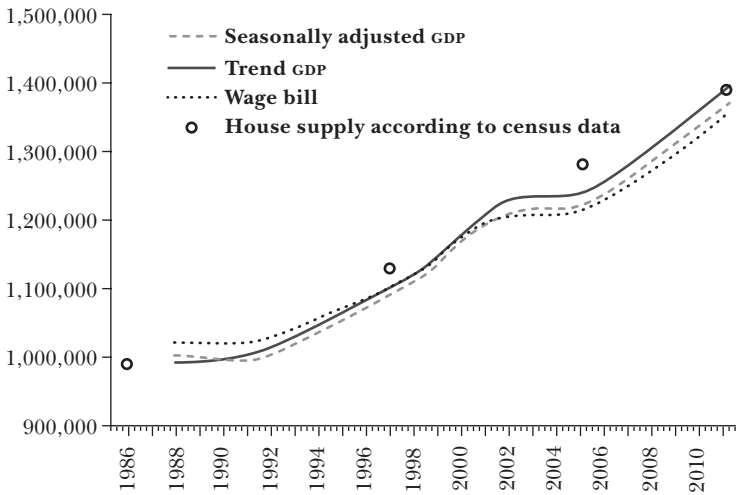


Figure 3

CALIBRATED NEW HOUSES CONSTRUCTION (B_t) AND INDEX OF PHYSICAL GROSS CAPITAL FORMATION IN RESIDENTIAL BUILDINGS (I_t)

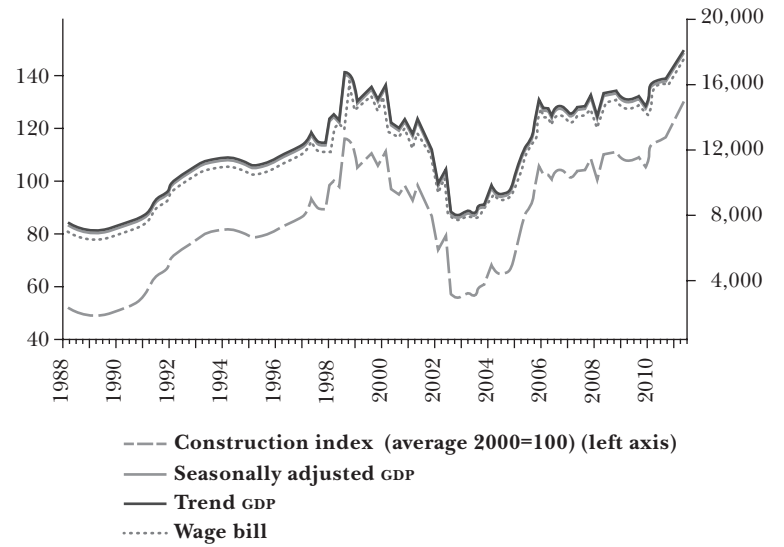
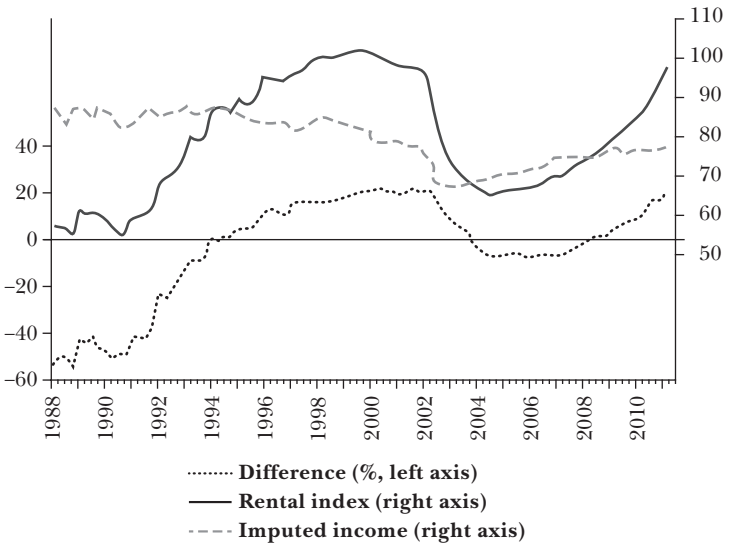


Figure 4

IMPUTED INCOME (Y_t = WAGE BILL), RENTAL INDEX AND DIFFERENCE



5.2 Second Stage: Real and Fundamental Prices

Once rents for housing have been imputed it is possible to calibrate the remaining parameters, particularly the risk premium ρ, through Equation 6 (or equivalently with Equation 2 by replacing H_t with the values calibrated in the first stage), and obtain a fundamental price series for housing. Equation 6 can be written as follows:

$$P_t^* = \sum_{t=0}^{T} \frac{H_t + \delta P_{t+1}^*}{1 + \rho + m_1} \,. \tag{8}$$

To use Equation 8 it is necessary to calibrate the future value of fundamental prices $\left(P_{T+1}^*\right)$, for which assumptions must be made on the future evolution of fundamentals. Equation 6 shows that fundamental housing prices are determined by the

ratio of aggregate income to housing supply, as well as a discount factor. For the sake of simplicity, the following assumptions are made: *1)* the ratio of aggregate income to housing supply evolves following a trend, $\frac{Y_{t+1}}{S_{t+1}} = (1+w)\frac{Y_t}{S_t}$; and *2)* the interest rate as of period $T+1$ remains constant at its average value $\bar{m}$. Hence, the future value of fundamental prices, P^*_{T+1}, can be written as:

$$P^*_{T+1} = \alpha \frac{(1+w)Y_T}{(\rho + \bar{m}\delta - w + \delta w)S_T}, \quad (9)$$

which introduces two extra parameters, w and $\bar{m}$, that must be calibrated.

Calibration in this second stage is made by solving the following optimization problem:

$$\min_{\alpha_2, \delta, w, \bar{m}} \sum_{t=0}^{T} \left[\frac{\alpha_2 H_t + \delta P^*_{t+1}}{1+\rho+m_t} - P_t \right]^2, \quad (10)$$

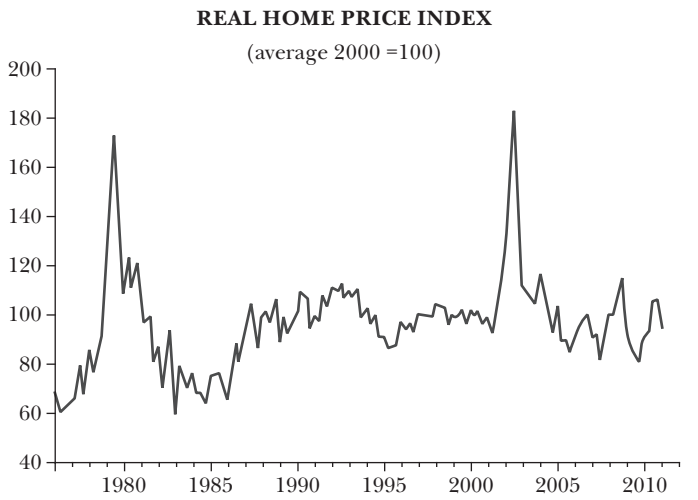
where α_2 is a parameter of scale. Calibration is made taking into account the following restrictions on parameter values: $\alpha_2 > 0$, $0 < \rho \leq 0.03$ and $0 < \bar{m} \leq 0.025$. The restriction to the parameter of maintenance costs and risk premium, ρ, is the same as that used in Hott (2009). Meanwhile, the restriction to the real average interest rate implies a maximum in annualized terms of approximately 10 percent.

5.2.1 Data

Quarterly data is used for calibrating. The period of analysis runs from the first quarter of 1988 to the second quarter of 2011.

In addition to the imputed rents calculated in the previous stage, a real housing price index is employed (see Figure 5). The latter arises from linking the National Institute of Statistics's housing price index with the pre-1999 data calculated

Figure 5



by Carlomagno and Fernández (2007), following the methodology proposed by Grau et al.,1987.[7] Finally, the real interest rate series was generated from the banking system's active rate series for the non-financial sector by removing the inflationary component.

5.2.2 Results

Table 2 shows the calibration results. As can be seen, the inclusion of different aggregate income indicators does not substantially affect the results of the calibration. Moreover, only the restriction to the risk premium operates when gross domestic product is considered as an aggregate income variable.

[7] It is important to point out that the linked series offer different coverages. The series taken from the National Institute of Statistics is compiled based on the transactions that were actually made. The other series are based on press releases on the prices demanded by those offering houses for sale. None of the series are adjusted for housing quality or characteristics.

Table 2

CALIBRATED PARAMETERS

Y_t	ρ	$\bar{m}$
Seasonally adjusted GDP	0.030	0.020
Trend GDP	0.030	0.021
Wage bill	0.029	0.018

Figure 6

PRICE ACCORDING ITS FUNDAMENTALS (Y_t = WAGE BILL), REAL PRICE AND DIFFERENCE
(in gray: interval of confidence at 95%)

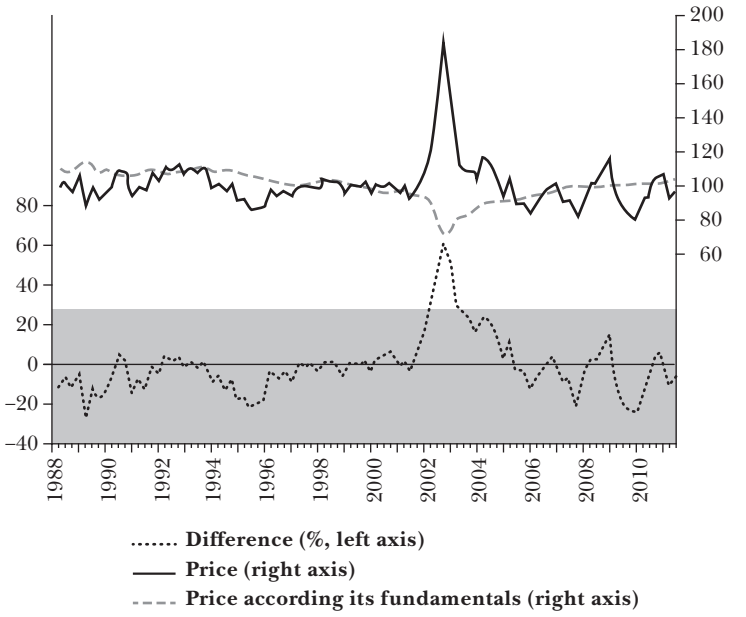
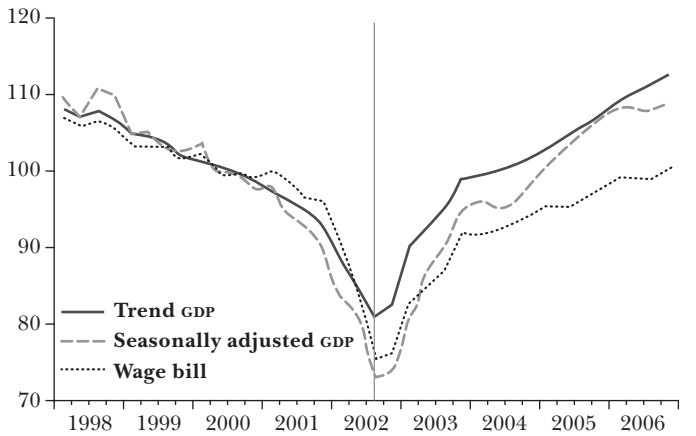


Figure 6 shows historical series for real housing prices, comparing it with imputed prices when the wage bill is used as a variable for aggregate income. The results of using GDP as a

variable of aggregate income are presented in the Annex. As can be seen, real housing prices fluctuate more than those justified by their domestic fundamentals.[8] This implies that more or less prolonged periods of significant under or overvaluation are occasionally observed. The latter could indicate the existence of housing price bubbles. In fact, in the quarters leading up to the crisis of 2002, the difference between real and fundamental housing prices was statistically significant.[9] On the other hand, during the most recent period, real housing prices fluctuated around fundamental prices, or were slightly undervalued as compared to said prices arising from the model.

Figure 7

INDEX OF PRICES ACCORDING THEIR FUNDAMENTALS AROUND THE 2002 CRISIS
(average 2000 =100)



[8] See Hott (2009) for an analysis of the reasons why real housing prices fluctuate more than fundamental prices.

[9] The confidence interval of 95% was calculated under the assumption that the difference between real and fundamental prices follows a normal probability distribution. The data does not allow for rejecting this hypothesis for the series calculated using gross domestic product as a variable of aggregate income.

In every case there is a statistically significant misalignment of real prices from fundamental prices under the environment of the 2002 crisis. The fundamental prices that emerge from the model show a downward trend starting around four years prior to the outbreak of the crisis determined by a fall in aggregate income variables.[10] The speed of the decline in fundamental prices intensifies during the year immediately before the crisis due to the deepening of the recession the Uruguayan economy was undergoing (see Figure 7). Meanwhile, real prices exhibit downward rigidity. The latter could be explained by the structural characteristics of the Uruguayan economy and its real estate market. For instance, housing is offered and sold in United States dollars, which, under the framework of the fixed exchange rate regime in force at the time, might have meant that adjustments were made more by quantities than by prices.

Although these results only derive from the crisis event, they argue in favor of using fundamental prices as a forward-looking indicator of financial fragility. Moreover, measures that favor the downward flexibility of prices and the de-dollarization of real estate transactions would have to be macroprudential in nature to facilitate smoother corrections in misalignments.

6. FINAL REMARKS

A comparison of real housing prices with prices that can be explained by economic fundamentals is important from the point of view of financial system stability. Prolonged periods of housing prices that are above those justified by fundamentals can lead to over-indebtedness, excess risk taking and the overvaluing of guarantees, all of which make sudden and costly corrections more likely.

In the case of Uruguay, no statistically significant differences were found between the real price of housing and that

[10] For instance, gross domestic product fell by around 10% between 1998 and 2001.

calibrated for the recent period by the model of fundamentals. It is also important to mention that fundamental prices calibrated in this paper follow, in the recent period, a stable growth trend. The same estimated prices began to follow a downward trend four years before the outbreak of the 2002 crisis, a trend that intensified in the year preceding said crisis where the difference between real prices was statistically significant.

In general terms, this paper found evidence that housing prices in Uruguay were overvalued with respect to those justified by fundamentals immediately before the 2002 crisis. On the other hand, no significant evidence is found in the most recent period. In any case, the aforementioned does not mean housing prices cannot fall in the future or even that their fundamentals are overvalued due to the particular conditions prevailing in international markets. These matters, as well as a more detailed analysis of the exposure of financial intermediaries to housing prices, should be the subject of future study.

ANNEXES

Description of the Variables

- P_t *Real housing price index*: real housing prices compiled by Carlomagno and Fernández (2007), updated by the author to the second quarter of 2011. Up until 1998, the variable corresponds to the price per square meter obtained from real estate sales advertisments published in national newspapers. The index is compiled following the methodology proposed by Grau et al. (1987). As of 1999, the variable corresponds to the price of actually registered transactions. This is compiled by the National Institute of Statistics.

- M_t *Real rent index*: Rent component of the consumer price index compiled by the National Institute of Statistics based on surveys of real estate agents and the rental service of the General Accounting Office.

- Y_t *Aggregate income*: Uses three aggregate income variants: *1)* The physical volume of seasonally adjusted gross domestic product obtained from the Banco Central del Uruguay; *2)* the trend through Hodrick-Prescott filter of the physical volume of gross domestic product obtained from the Banco Central del Uruguay; *3)* the wage bill calculated as real average wages multiplied by the number of workers, both obtained from the National Institute of Statistics.

- m_t *Real interest rate*: The interest rate calculated by discounting the inflationary component (consumer price index calculated by the National Institute of Statistics) from a series for the average asset interest rate of the banking system calculated as the ratio between yields from interest and total loans of the system to the non-financial sector (source: Banco Central del Uruguay).

- I_t Gross physical capital formation in residential buildings compiled by the Banco Central del Uruguay.

Figure 8

IMPUTED INCOME (Y_t = SEASONALLY ADJUSTED GDP), RENTAL INDEX AND DIFFERENCE

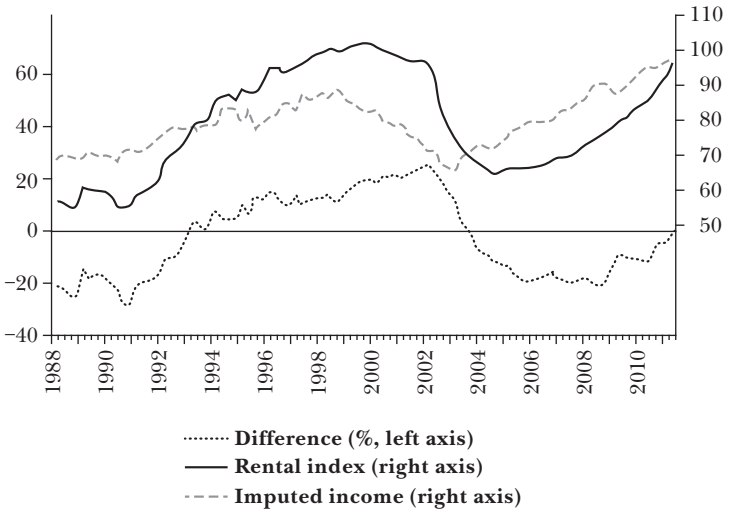


Figure 9

PRICE ACCORDING ITS FUNDAMENTALS (Y_t = SEASONALLY ADJUSTED GDP), REAL PRICE AND DIFFERENCE

(in gray: interval of confidence at 95%)

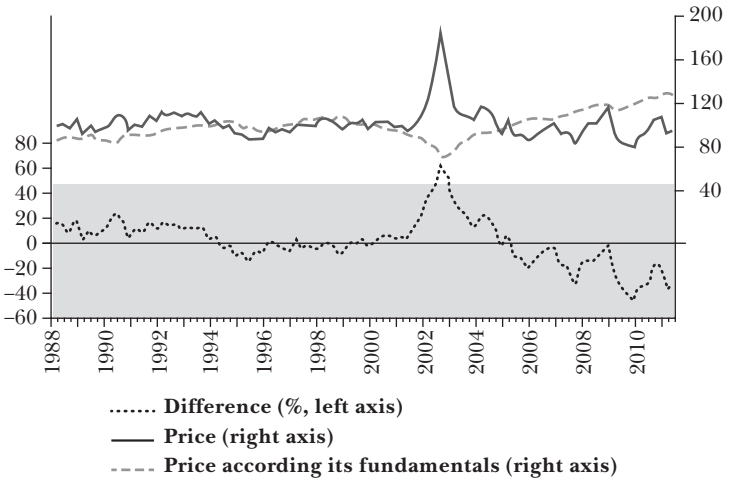


Figure 10

IMPUTED INCOME (Y_t = TREND GDP), RENTAL INDEX AND DIFFERENCE

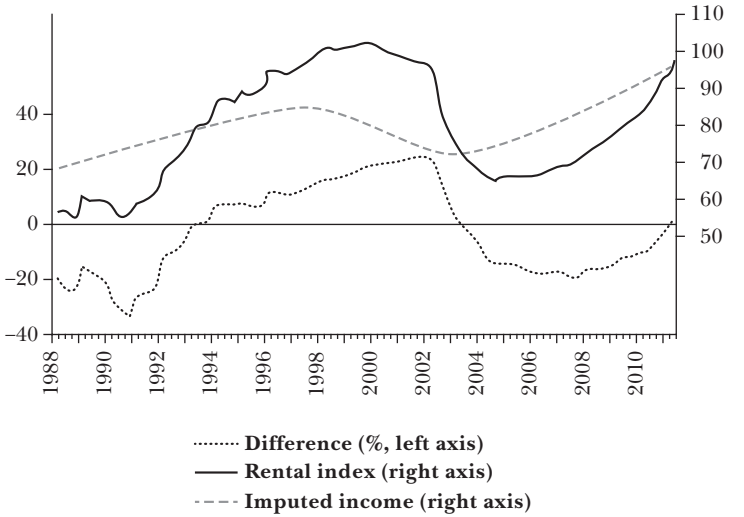
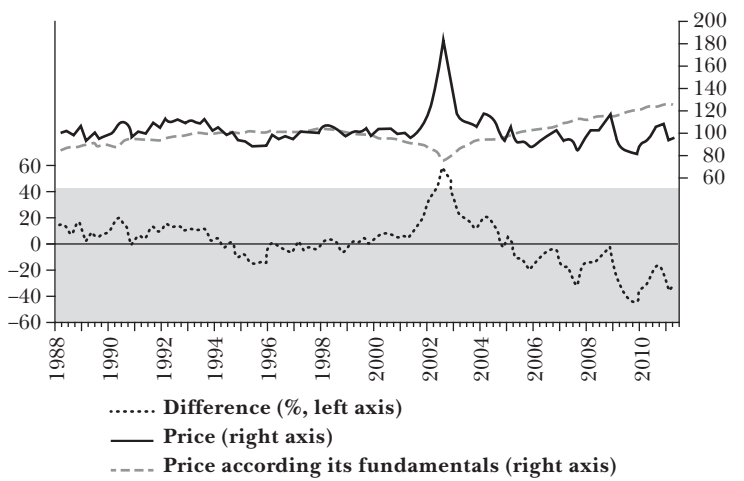


Figure 11

PRICE ACCORDING ITS FUNDAMENTALS (Y_t = SEASONALLY ADJUSTED GDP), REAL PRICE AND DIFFERENCE

(in gray: interval of confidence at 95%)



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