TITLE: DEMAND FOR HOUSING AND URBAN SERVICES IN BRAZIL: A HEDONIC APPROACH[**]

AUTHORS: BRUNO DE OLIVEIRA CRUZ AND MARIA DA PIEDADE MORAIS

INSTITUTIONAL AFFILIATION: Researchers at the Regional and Urban Studies Department/DIRUR of the Institute of Applied Economic Research/IPEA of Brazil

CONTACT PERSON: MARIA DA PIEDADE MORAIS

E-MAILS: piedade@ipea.gov.br and bruno.oliveira@saude.gov.br

PHONES: (5561) 315.50.33/52.99/2605

FAX: (5561) 322.36.41

ADDRESS: SQS Quadra I Ed. BNDES 3º andar

Brasilia- DF Brazil

CEP 70076-900

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ABSTRACT

This paper aims to estimate the demand for housing and urban services in the main Brazilian metropolitan areas (RMs), as a contribution for the formulation of public policies in urban development. The theoretical approach used is the hedonic prices model (Rosen,1974), which relates price with the property characteristics. The data comes from the National Household Survey (PNAD)/97 of the Brazilian Institute of Geography and Statistics/IBGE, encompassing 10 RMs. We have verified that the provision of proper housing and urban infrastructure services can increase significantly the property prices in the metropolitan areas, implying that such policies can have strong distributive impacts and can be used to fight urban poverty in Brazil.

Among the RMs studied São Paulo presented the highest average rent, independently of the characteristics of the properties. In Salvador, Recife e Fortaleza rents are half the rents in São Paulo, while Brasília and Rio present rents around 75% of São Paulo rents.

The importance of the present study resides in trying to evaluate the impact of the governmental urban policies through regression analysis, what would allow policy makers to obtain more detailed information on the nature of housing demand – regarding the consumers' preferences for the different attributes of the house and levels of provision of urban services - as well as on the capacity of cost-recovery and the social impacts of the different housing, sanitation and urban development programs.

KEY WORDS: Housing Demand, Hedonic Prices and Urban Economics

JEL CLASSIFICATION: R21, R31

1. INTRODUCTION

The construction sector participates with approximately 68% the Brazilian Gross Fixed Capital Formation (IBGE, 1997) and is also responsible for employing a large amount of non-qualified labor. The housing sector in particular, has a strong impact on the reduction of poverty[1] and housing deficit[2] in Brazil, with important implications to policy decisions.

Despite the importance of the housing sector to the Brazilian economy, studies with theoretical and empirical fundaments are still restricted in the country. This paper is an attempt to aid policy makers to obtain estimates on the nature of the demand for housing attributes, including the levels of provision of urban infrastructure services, as well as on the capacity of cost-recovery of the governmental housing and sanitation programs and to identify the way in which such programs affect the welfare and the patrimony of their target population.

Given that different levels of access to urban infrastructure affect significantly the property values, the use of hedonic regressions can provide, furthermore, the bases for the calculation of a specific tribute, the *"contribuição de melhoria"*,[3] that is hard to implement in practice because of the difficulties to evaluate in what extent the provision of urban infrastructure contributes to a change in property values.

This paper is divided into 5 parts, besides the introduction. Section 2 describes theoretical model. Section 3 presents a review of the empirical works that have used hedonic price models with emphasis on studies carried out in Brazil concerning the Housing Market and articles that have applied this concept to the formulation of housing and sanitation

[1] Rocha (1998) estimates that the brazilian poor are around 30 million people (30% living in metropolitan areas).

[2] The official figures for the Brazilian housing deficit are 5,6 million of units, caused mostly by cohabitation (63%) and concentrated in the population that earns up to 5 brazilian minimum wages (85%) and in the northeast region of the country (44,7%), according to BRASIL/SEPURB/Fundação João Pinheiro (1995). However, a recent study of DIPOCS/IPEA (Medeiros et al, 2000) suggests that 99% of the cohabitation in Brazil is among relatives, what is not necessarilly bad and doesn't configurate a housing deficit in every case. These findings show the need for further research on this area.

policies. Sections 4 and 5 describe the data, the methodology and the empirical results. The last section presents the conclusions and suggests new themes for the research agenda on Housing in Brazil.

2. THEORETICAL FRAMEWORK: THE HEDONIC PRICES MODEL

In economic theory, housing has frequently been regarded as a durable good, characterized by its various attributes, that can be independently analyzed.

Hence, housing can be classified as a heterogeneous good with peculiar characteristics such as location, size, and quality of construction, among others. Housing demand can, therefore, be thought as a function of the various attributes or characteristics of the property. This approach became known in the literature as the hedonic or implicit prices models, where hedonic prices can be interpreted as shadow-prices, reflecting the flow of return of certain property attributes.

One of the first works on the demand for the attributes of heterogeneous goods, was developed by Waugh (1928), that estimated the variation of vegetal prices in Boston. Griliches (1961) applied the regression analysis to analyze the effects of quality changes in the price of cars, as did Fisher et al. (1962), Cagan (1965), Triplett (1966) and Dhrymes (1971). Chow (1967) studied the demand for computer services in United States from 1955-65. Recently, hedonic prices models had been applied to evaluate environmental services, by comparing the prices of properties with the same attributes located in neighborhoods of different environmental qualities (Mieszkowski & Saper, 1978; Nelson, 1978; Graves et al., 1988 and Smith, 1978). Concerning the Real Estate market, we can point out Bailey et al. (1963), Musgrave (1969), Goodman (1978), Bartick (1983), Cobb (1984), Anas & Eum (1984), Epple (1987) and Wallace (1996), among others.

[3] "Contribuição de melhoria" is a kind of impact fee or development charge

However, the classic work that formalized the hedonic prices theory was Rosen (1974), which will be described here.

Suppose that the price of the house is given by the following function:

$P = f(C)$,

Where P is the price of the house and C are its attributes, which determine such prices. The hedonic price of a given component (i) of C is defined as $\partial P/\partial Ci$.

Rosen (1974) has shown that the characteristics presented in the hedonic prices function result from the maximization of both consumers and producers.

Assume for simplicity that there is only one heterogeneous good, housing. The household utility function is, then, given by:

$Q = Q(q(x), c)$

Where Q is the utility function, $q(.)$ a function of the property characteristics and c represents all other homogeneous goods, which could also be seen as money.

The housing production function can be represented as the result of the combination of a bundle of property characteristics. Hence,

$t(x, K, L) = 0$

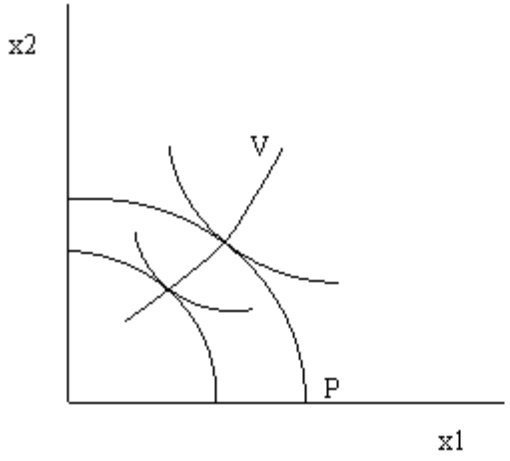
Where $t(.)$ represents the production function and K and L correspond to capital and labor.

Notice that the hedonic price equations are not a reduced form of supply and demand, but an optimum solution (binding constraint) for both consumers and producers.

As long as there are increasing marginal costs for the attributes of the house and restrictions for the composition of the "basket" of characteristics, the hedonic prices function is likely to be nonlinear, implying that the attributes relative prices are not fixed, being determined by buyers and sellers at each point of the hedonic surface.

In figure 1 we can observe two attributes of housing x1 and x2- its size in m^2 and the number of rooms - and the producer's restriction *(P)*, whose inclination represents the marginal costs of production. *V* represents the expansion path, i.e., the optimum equilibrium for both producers and consumers while the other curves correspond to the consumer indifference curves.

Figure 1 – Equilibrium in the Hedonic Prices Model



Rosen (1974) has shown that, with a large number of consumers and producers, the hedonic prices function will represent all the optimum points, the expansion path, like in the envelope theory. Only under restricted hypotheses, this function would be linear, what implies that hedonic prices models should allow the use of nonlinear specifications in its estimate. However, such model doesn't define *a priori* an optimum functional form for the hedonic equation and, therefore, it common to use Box-Cox transformation (1964) in

empirical estimating, in order to determine the best specification for the hedonic regression, although linear and log-linear forms are more used in the literature.

Some authors describe the coefficients of the property attributes, derived from the hedonic regressions, as the families' willingness to pay for those characteristics. However, Follain & Jimenez (1985a) affirm that this approach can lead to simultaneity bias because implicitly there would be a market for each individual attribute. For example, for the size of the property there would be an implicit supply and demand in the acquisition by a particular family that should not necessarily be the same to another family. Thus, the authors suggest a two stages technique as a more robust methodology to estimate the household's willingness to pay for housing and urban services. Nevertheless, they affirm that the coefficients of the hedonic regressions can be used to infer the effect of the characteristics in the property's final price, although one should not interpret these coefficients as estimates of the willingness to pay for the attributes.

3. THE EMPIRICAL STUDIES: A BRIEF SURVEY OF THE LITERATURE

In Brazil, there are some studies that have applied hedonic models to the Housing Market. However, most of these studies despite having used robust econometric techniques, were restricted to a particular market, and have emphasized the middle and high-income market segments, showing almost no concern for policy making.

Corneiro & Dantas (1988), used data on prices and location of plots, supplied by the National Bank of Housing (BNH), to estimate a hedonic prices function for 3 neighborhoods of Recife (Pernambuco), using Generalized Least Squares (GLS) and Box-Cox transformation. Barbosa & Bidurin (1991) have also used hedonic models for estimating land prices in Recife, using data on the physical, economic and location characteristics of urban plots. Besides the Box-Cox method (with Maximum Likelihood) and GLS models, the authors proposed the use of cross-validation techniques to obtain an optimum specification for the regression, where the distribution function could be

Gamma or Lognormal. They also discussed the possibility of including subjective information supplied by property brokers, using a Baysean approach.

González & Formoso (1994) have applied the hedonic model to study the rental market in Porto Alegre (Rio Grande do Sul), using a sample of flats available for renting during July 1992, taking into account the various segments of the formal rental market, excluding those properties rented for holiday season. They have used factorial analysis for selecting the variables of the model and the household monthly rent as a proxy for the property value, instead of its selling price in the market.

Aguirre & Macedo (1996), have estimated a hedonic function for Belo Horizonte (Minas Gerais), using Box-Cox transformation and data from the Institute of Economic, Administrative and Accounting Researches of Minas Gerais (IPEAd). The results were obtained by Ordinary Least Square (OLS), Maximum Likelihood (ML) and non-transformed data. The sample is limited to information on flats, with an average size of 120 m^2. However, some of their findings indicate a possible bias in the sample, because the presence of a garage was not significant to increase the property price. This is probably due to the fact that flats with 120 m^2 are targeted to higher income groups, who require *a priori* the existence of a garage in the property. Perhaps the inclusion of an extra parking space would be more important to explain the variation in flat prices than the existence of a garage in the building.

Santos et. al. (1999), have applied the hedonic prices model to the RMs of Recife, Curitiba and Brasília, using data from PNAD/97. They have used a log-linear model and the OLS technique for the estimation of the regressions for each RM, separating families per income levels. The great contribution of this study was trying to explain the families willingness to pay for housing services, taking into account their income level, with an emphasis on the public of governmental housing programs[4] (families with monthly

[4] The Brazilian Governmental Housing Programs can be divided in 3 categories: (i) Subsidized Funding to help state and local governments to invest in the improvement of the living conditions of families with income bellow 3 Brazilian minimun wages (HABITAR BRASIL and PRO-MORADIA); (ii) Funding to firms, cooperatives and individuals for the construction and improving of housing conditions of families

income bellow 12 brazilian minimum wages[5]). However, their results can be biased, once the data was censured *a priori*, because of the partition of the sample by income strata.

Figueroa (1993) has estimated a hedonic prices function for Paraguay, by Iterative Least Squares. The advantage of this method is that it avoids the use of ML to estimate an optimum functional form, so that the Box-Cox transformation could be derived by OLS. To find the optimum λ, several values were imputed, and equations were estimated by OLS for each specification, choosing those with the smallest Sum of Squared Errors (SSE). Such methodology permits to obtain the optimum functional form, without the need of using non-linear methods like ML. The data come from a survey carried out especially for this study in housing programs implemented by the Paraguayan government. After estimating the equations, the author analysis the social impact of housing programs for low-income populations. The property price was obtained by questioning the owner directly, in order for him to evaluate his house. According to the author, this would allow to capture how much people are willing to pay for their properties. Figueroa has demonstrated how urban infrastructure policies affect the property selling price, consequently, the families' patrimony. He has also showed how hedonic models can be used to estimate some of the positive externalities[6] of urban infrastructure policies, such as the increase in families' wealth and living conditions.

Another study that used hedonic models to aid public policies is Follain & Jimenez (1985b). The authors have used data from a household survey similar to PNAD for five cities of Colombia, Korea and Philippines. They have used rent as a proxy for property value. From the estimates of the household willingness to pay for the property attributes, the authors estimated the optimum size and characteristics of the properties addressed to low income population, that would maximize the producers' profit and the consumers'

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with income less than 12 brazilian minimum wages (Carta de Credito and Programa de Apoio à Produção); (iii) Enabling Market Programs: Programa Brasileiro da Qualidade e Produtividade na Construção Habitacional (PBQP-H) and Programa de Arrendamento Residencial (PAR).

[5] The Brazilian minimum wage corresponded to R$120,00 in September 1997.

[6] Some externalities of urban policies are not captured by the hedonic model like the decrease in contagious disease caused by sanitation policies, for instance. Nevertheless, the hedonic approach offers a first approximation to the benefits generated by these policies. In the example used, one could say that the families are internalizing the risk of contagious diseases in the house price.

utility. In this way, it could be possible to estimate which housing program would be most suitable for the low income population, at the minimum cost to the government and still respecting the consumers preferences for the various attributes of the property. Hence, such methodology could permit to answer the following question: given a certain cost and a target group previously defined for an urban policy, what would be the best project, in the sense of maximizing the social welfare derived from that policy?

Knowing that housing has a strong impact on poverty, once it represents a great part of the patrimonial wealth of the families, Smeending et. alli (1993) analyzed the impact of governmental policies addressed to low income population on poverty and income inequality reduction in 7 developed countries, through non-pecuniary subsidies in the housing, health and education. The researchers captured the impact of housing on poverty just for some countries, due to lack of data. Nevertheless, in countries where this inference was viable, they verified that the benefits on the lower quartis of income were quite significant. Analyzing poverty alleviation policies in Brazil, Neri et alli (2000), showed the relationships between poverty, resources distribution and financial market operation in the country. The authors demonstrated that the income poor have lower rates of access to public services like water, sewage, telephone and garbage collection and that the percentage of already paid own houses is larger among the poor (71%) than non-poor (68%). However, one should notice that 15% of the poorest population doesn't own their house land, what seems to support the hypothesis that great part of the low income population had access to housing through self-construction in irregular settlements (IPEA, 1998). The quality of the housing structure and the living conditions are also more precarious among the poor. Furthermore, using a logistic regression, they showed that having access to a given resource, like housing, implies in lower probabilities of being poor. Liu (1999) also showed that the brazilian poor have lower access to adequate housing and urban services, and that the proportion of poor is larger in the periphery of urban areas, where the basic services are more scarce. He stressed that under land tenure security, improvements in housing and urban services will rise the values of the houses occupied by the poor, and thus, reduce urban poverty. These 3 papers above show a strong research agenda, which is the relationship between poverty, housing and urban

services. Unfortunately, the studies that deal with poverty alleviation in Brazil have emphasized exhaustively the returns of educational policies in poverty and income inequality reduction. However, we think that poverty reduction strategies should include a mix of policies and not rely exclusively on a single instrument. Therefore, the formulation of consistent housing and urban services policies can have a strong impact in urban poverty reduction in Brazil.

The hedonic prices models supply a theoretical framework that allows us to measure the social costs and benefits of housing and urban policies. Construction costs are relatively easy to obtain, while property market values depend on their attributes. Thus, with estimates derived from hedonic equations, one can infer the social impacts of the governmental policies in urban development, like the improvement of urban infrastructure in poor neighborhoods, for example. The coefficient of each characteristic of the residence, derived from the hedonic model reflects that attribute shadow-price, and its contribution to the house's final price. Such methodology also permits to obtain estimates of the willingness to pay for the attributes of the house, through the construction of the household's utility function. The existence of estimates of the willingness to pay for housing services can induce cost recovery practices and thus reduce the need for public subsidies, as well as increase local government revenues by means of development charges collection and increased property taxes.

4. THE DATA AND METHODOLOGY

The data used in this study comes from PNAD[7] of IBGE, for 1997, including 10 Brazilian RMs: Recife, Rio de Janeiro, Fortaleza, São Paulo, Curitiba, Belém, Belo Horizonte, Porto Alegre, Salvador and Brasília[8]. We have just considered data on the rented permanent private homes, located in urban areas. PNAD was not originally designed as a research on housing, but rather as a survey on employment and income, what limits the amount and the quality of the available information on residences. Although PNAD

[7] PNAD is an annual survey that contains data on randomly selected households of the RMs.
[8] PNAD's data refers to Federal District only, although the RM of Brasília is larger.

contains information on some of the house attributes like the number of inhabitants, number of rooms, level of urban services, it lacks important information like age, size (m^2) and property price. Despite these limitations, PNAD is representative at the national level and permits a comparison between several metropolitan housing markets, allowing us to draw important conclusions for the formulation of public policies in urban development.

Following other empirical studies, we have used the rent paid in the month of reference of PNAD[9] as a proxy for the property value, in the absence of information on the its market price. Since housing is a durable good rent can be seen as the payment for the residence services or, alternatively, as the present value of the flow of income derived from the ownership of the house. In principle, rent should maintain a direct relationship with property value, justifying its use in the hedonic regressions replacing its price. However, such methodology is not problems free, once the rental market in Brazil presents serious imperfections, being highly regulated, and relatively small in international terms, representing just 13,7% of the Brazilian private housing stock in 1997, as one can see in the table below.

Table1 – Metropolitan Brazil: Housing Tenure Types -1997

Property Rights	**Number of Units**	**(%)**
Own Already Paid	27.484.799	67,6
Own still paying	2484.240	6,1
Rented	5.561.748	13,7
Ceded by entrepreneur	1.790.088	4,4
Ceded by other means	3.138.918	7,7
Other condition	184.264	0,5
Not informed	566	0,0
Total	40.644.623	100,00

Source: IPEA/DIRUR from PNAD/97 micro-data.

[9] September, 1997.

To define the attributes of the house we considered the following aspects: quality of the structure (walls and roof); size of the dwelling unit (number of bedrooms and other rooms); access to public services (water, sewerage, garbage collection, phone connection and electricity); quality of the neighborhood (household per capita income); living conditions (density per bedroom and exclusive bathroom) and characteristics of the local housing markets (RM where the property is located).

The household per capita income was included in the regression to capture the quality of the neighborhood, because one expects that people with lower per capita income live in poor neighborhoods and vice-versa. In the same sense, high densities per bedroom and absence of exclusive bathroom, reduce the rent one is willing to pay for the house, due to the worsening in the living conditions. We also included dummies for each RM, trying to capture specific characteristics of the local housing markets.

One of the main problems of this study is the absence of a measure of accessibility of the residence in the model, despite it's importance in explaining urban land prices, and consequently, house values. The omission of a location variable was due to difficulties with the database. Although PNAD has a variable that could serve as proxy for property accessibility, such as commuting time to work, we opted for not to include it in the model, once the location decision is taken by the household's head and this information is missing in many cases, what would have caused an excessive reduction in the sample size.

After having eliminated the missings, the outliers and restricted the sample to the private rented homes located in urban areas of the RM studied, we have obtained a total sample of 5.284 observations.

Considering the adequacy of the housing structure and levels of urban services we first used IBGE criteria. According to this methodology, houses possess proper sewerage when they are connected to public sewerage network or have septic tanks (dummy=1). For walls IBGE arbitrates that masonry (brick, cement and concrete) and processed wood

are adequate (dummy=1), while other materials are inadequate. For the roof, concrete or cement, tile and processed wood are considered durable (dummy = 1), while other materials are inadequate. In a second regression we have considered the qualitative differences among the variables "quality of construction" and "public services" classified as adequate by IBGE criteria. As one can see in the next sections, these 2 models can have quite different outcomes.

5. MAIN RESULTS

The independent variable of the model was the value of the monthly rent, which served as proxy for the property price. The explanatory variables were the following :

RENT = *f* (Number of bedrooms, number of other rooms, quality of the walls, quality of the roof, household per capita income, density per bedroom, exclusive bathroom, piped water, sewerage system, garbage collection, electricity, phone connection and local characteristics of each RM).

The variables telephone and electricity were later removed from the model, because phone presented missing correlations with rent and electricity is present in all sample units.

Table A.3 in Annex I shows the descriptive statistics of the main variables used in both models.

One possible problem of the study is the fact that it can see that it can exist a bias in the sample selection, once rented homes present, in general, better quality of the structure and access to urban services (see tables A.2 and A.3). However, such bias is due to the limitations of the informations captured by PNAD. One possible sequence of this study could be working with other databases like IBGE's Survey on Patterns of Life (PPV) and SEADE's Survey on Living Conditions (PCV). Although these databases possess more

information on the quality of housing and urban services, they don't have PNAD's spatial scale, being available just for a few years and restricted to a few or even a single RM.

Despite the limitations described above and the preliminary nature of this research, the hedonic regressions and estimates presented here are innovative because they compare the Housing markets the main Brazilian RMs simultaneously. We have made 2 regressions, joining data from the 10 RMs, pondered the households by its weight in PNAD, through the weighted least squares method (WLS), and included a dummy for each RMs, taking São Paulo for comparison.

We have tested several specifications for the hedonic regressions, like linear, semi-log and double log. The semi-log regressions resemble to have adjusted better to the data, presenting a smaller SSE than the linear, as well as coefficients with the expected signs according to economic theory and statistically significant at a 95% confidence level. The R^2 adjusted was 0,585, what represents a good explanatory power of the model, considering we were using cross-section micro-data. From the analysis of the correlogram we can infer that the residuals were normal and independent, and showed no sign of heteroscedasticity. The linear regression, didn't respect the hypothesis of normality of the residuals, among others, while the double-log specification, in spite of having the highest R^2 adjusted, presented some coefficients with the wrong signs, as well as a certain tendency in the graph of the residuals. The results of the hedonic regression with semi-logarithmic specification and IBGE criteria for housing adequacy can be seen in the table below.

Table 2 - WLS Regression with semi-log specification and IBGE adequacy criteria
Dependent variable: ln rent

Attributes	Parameter Estimate	Standard Error	t – test
Intercept	3,042	0,143	21,318
Bedrooms	0,256	0,010	25,443
Other Rooms	0,156	0,005	32,029
Solid Walls	0,337	0,106	3,177
Solid Roof	0,258	0,090	2,875
Piped Water	0,310	0,040	7,680
Exclusive Bathroom	0,134	0,036	3,738
Proper Sewerage	0,315	0,026	12,253
Proper Garbage Collection	0,442	0,047	9,340
Density per Bedroom	-0,016086	0,007	-2,374
Household per Capita Income	0,000234	0,000	23,992
Dummy Belém	-0,470	0,059	-7,916
Dummy Fortaleza	-0,754	0,036	-21,206
Dummy Recife	-0,707	0,035	-19,988
Dummy Salvador	-0,655	0,033	-19,802
Dummy Belo Horizonte	-0,450	0,026	-17,043
Dummy Rio de Janeiro	-0,311	0,017	-17,880
Dummy Curitiba	-0,486	0,033	-14,615
Dummy Porto Alegre	-0,460	0,029	-15,635
Dummy Brasília	-0,305	0,033	-9,301
R^2 Adjusted	0,585		

Source: DIRUR/IPEA from PNAD/97 micro-data.

All the RMs dummies were statistically significants and had negative signs, indicating that rent in São Paulo is higher than in other RMs, independently of the characteristics of the properties, what implies that the inhabitants of São Paulo should pay more for houses of similar quality and level of urban services. Brasília, Rio de Janeiro and Belo Horizonte were the RMs that approached more the value of the rent in São Paulo, corresponding to 73,7%, 73,3% and 63,8% of that value, respectively.

For the urban infrastructure services analyzed (water, sewage and garbage collection) the coefficients of the regression are positive and significant indicating that each public service separately would rise rent by 36,3%, 37,0% and 55,6% respectively, what demonstrates that such policies can have strong redistributive impacts. Permanent walls can increase rent by 40,1% while a proper roof rises rent by 29,4%.

Concerning the number of rooms in the house, an additional bedroom can increase rent by 29,2%, while an increase in other rooms would rise rent by 16,9%.

The coefficient associated with the household income per capita presented a positive sign, showing that leaving in a neighborhood with high average income is valued positively by the families, contributing to an increase in rent. Inversely, a high density per bedroom, typical of poor neighborhoods, worsens the living conditions, causing a decrease in rents. Finally, the presence of an exclusive bathroom increases rent by 14,3%, due to better living conditions.

Taking into account that housing prices represent several times the household's annual income and that housing corresponds, most of the times, to their most valuable asset, and that exists an important relationship between housing conditions and poverty, the great social benefits derived from appropriate housing and urban development policies become evident. As some of the positive externalities associated with proper housing and sanitation provision are not reflected in the hedonic model, one can infer that the gains in social welfare derived from such policies are even higher. It should be stressed, however, that it can exist a location bias in these results, once the coefficients of the regression can be reflecting other attributes associated with properties located in higher income neighborhoods, that are not being captured by the model, because these neighborhoods present a larger probability of possessing higher levels of urban equipments and other amenities.

When we considered the different qualities for proper structure and public services as they appear in PNAD, the results become more impressive and the R^2 adjusted increases to 0,614. All the parameter estimates were significant at a 95% confidence level and presented the expected signs.

In this model São Paulo still presents the highest rent, followed by Belém (79,5%), Porto Alegre (76,6%), Brasília (76.0%), Curitiba (74,8%), Rio (73,9%) and Belo Horizonte

(62,0%). These surprising results indicate that the local markets characteristics have a great importance in explaining rents and property prices. The rents in the northeast are almost half of the rents in São Paulo, ranging from 54,3% in Salvador to 52,4% in Fortaleza. Although the results seem quite unexpected they are consistent with IBGE data on Construction Cost per m^2 for September 1997 as we can see in table A.1. The ranking of the RMs obtained in this second model is almost the same as the one from IBGE , where São Paulo state presented the highest average Cost per m^2 (R$381,74), with Pará coming in second position (R$377,78), followed by Rio Grande do Sul (R$362,43) and Federal Disctrict (R$356,01). Among the RMs studied Belém presents the highest housing deficit to total stock ratio (22%), as well as one of the largest population's average annual growth rate (2,23%) and the highest growth rate within the peripherical areas (6,35%). One possible explanation could be the fact that Belém is almost totally compound of marine areas, a protected area with special land use regulations, what can be causing land scarcity in the core municipality and making the city grow in the periphery at vertiginous rates.

From this model we can also infer that families pay higher rents for houses with masonry walls (44,9%), concrete roof (41,5%), connection to sewerage network (43,6%), direct garbage collection (47,9%), piped water (29,6%), exclusive bathroom (10,7%) and located in higher income neighborhoods, while an increase in the density per bedroom causes a decrease in rent. Taking into account the qualitative differences houses connected to sewerage network presented rent 29,7% higher than houses with septic tank without connection and 11,5% higher than houses with septic tanks connect to the sewerage network. For roof materials, concrete increases rent by 19,6% and by 28,6% comparing to tile and processed wood, respectively. For walls, masonry increases rent by 34,9% in relation to processed wood.

The results of this model could help policy makers to design housing and sanitation programs that match the consumers' preferences for the different housing attributes, as well as perceive the potential for cost recovery of the different policies and in what extent governmental interventions affect the properties rents and values, what could help

the local governments in development charges and property taxes collection. This results are even more important once they can increase local and state governments autonomy in obtaining funds for investments in urban development, considering that Brazilian is passing trough a fiscal crises in the context of macro adjustment policies and many local and state governments show little debt capacity to candidate to federal government funds. The study also stresses the need of more detailed research on the Real State Markets at the local level, like the nature of urban land regulations and tributary systems, supply and demand for housing, among others.

Table 3 - WLS Regression with semi-log specification and different qualitative for proper housing and services

Dependent variable: ln rent

Attributes	**Parameter Estimate**	**Standard Error**	**t – test**
Intercept	3,138	0,007	447,895
Bedrooms	0,263	0,000	532,310
Other Rooms	0,145	0,000	601,561
Masonry Walls	0,371	0,005	71,352
Processed Wood Walls	0,0742	0,005	13,636
Tile Roof	0,168	0,004	38,187
Concrete Roof	0,347	0,004	78,434
Processed Wood Roof	0,09541	0,007	13,707
Piped Water	0,259	0,002	130,441
Exclusive Bathroom	0,102	0,002	57,606
Sewerage Network	0,362	0,001	273,617
Septic Tank connected to Network	0,253	0,001	171,243
Septic Tank not connected	0,102	0,002	57,640
Direct Garbage Collection	0,391	0,002	167,387
Indirect Garbage Collection	0,371	0,003	142,968
Density per Bedroom	-0,009518	0,000	-28,578
Household per Capita Income	0,0002077	0,000	427,579
Dummy Belém	-0,230	0,003	-75,084
Dummy Fortaleza	-0,646	0,002	-358,603
Dummy Recife	-0,629	0,002	-354,893
Dummy Salvador	-0,611	0,002	-352,978
Dummy Belo Horizonte	-0,478	0,001	-368,449
Dummy Rio de Janeiro	-0,302	0,001	-342,221
Dummy Curitiba	-0,291	0,002	-163,350
Dummy Porto Alegre	-0,266	0,002	-154,085
Dummy Brasília	-0,274	0,002	-169,546
R^2 Adjusted	0,614		

Source: DIRUR/IPEA from PNAD/97 micro-data.

6. CONCLUSIONS

This paper intended to estimate hedonic prices regressions in order to infer the impacts of the provision of housing and urban services on property values in 10 Brazilian RMs, as a mean to subsidizing public policies in urban development. The results point that the supply of proper housing and urban infrastructure services like water, sewage and garbage collection can increase significantly the rents and prices of the properties in these areas, what demonstrates that such policies can contribute to urban poverty reduction in Brazil.

Another interesting result is that t São Paulo has presented the highest rent among the 10 RMs studied, followed by Rio de Janeiro, Brasília and Belo Horizonte, that presented rents about 30% to 36% lower than the rent in São Paulo, for houses of the same attributes, when we consider the IBGE criteria of adequacy . When we consider the qualitative differences among the quality of walls and roof and type of sanitation system São Paulo still presents the highest rent, followed by Belém , Porto Alegre and Brasília. These unexpected results show the importance of local markets characteristics to determinate property rents and prices, and the need of further research at the local level.

Despite its preliminary nature, this work represents an innovation in relation to the studies that have been produced in Brazil, by trying to evaluate the impact of urban development policies through hedonic prices regressions, demonstrating the existence of a fertile research agenda in Brazil in Housing and Urban Economics, practically still unexplored. One possible sequence of this study could be the application of Blinder (1973) and Oaxaca (1973) model of salary discrimination to the Real State Market what could allow us to visualize that a house with the same physical can have differentiated rents and prices depending on local characteristics such as a more rigid urban regulation, for example. Another interesting use for hedonic regressions is the estimation of the household's willingness to pay for housing and urban services. Thus, one could supply an estimate of how different levels of land use regulations and housing and urban service

provision could explain differences in the property prices, as well as estimate the costs and benefits and the potential for cost-recovery of different urban development policies.

This study aimed to contribute for the formulation of public policies in urban development, allowing to obtain important results like the strong redistributive impact derived from the provision of proper housing and urban infrastructure services and its crucial character to urban poverty reduction in Brazil. However, there is still a lot to be done in this area, and one of the first tasks could be to improve the available data on the Brazilian housing sector.

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ANNEX I

Table A.1: Characteristics of the RMs Studied

Metropolitan Area	State	% of Urbanization in the State	Distance to São Paulo (km)	Share in State' Population	Population Average annual growth rate (91/96)	Number of Municipalities	Population (1996)	Area (km^2)	Demographic Density (hab/km^2)	Demographic Density at the core municipality	Construction cost per m^2 (R$) September 1997	Housing Deficit 1991	Housing deficit/ total Urban Housing Stock (%)
BELEM	Parä	53,51	2.452,5	28,57	2,23	5	1.574.487	1.936,50	813,1	1.050,8	377,78	67.042	20,45
FORTALEZA	Ceará	69,21	2.360,5	37,93	2,32	9	2.582.820	3.388,20	762,3	6.259,6	320,59	93.522	16,02
RECIFE	Pernambuco	74,02	2.124,5	41,73	1,14	14	3.987.967	3.121,40	989,3	6.146,3	280,74	130.483	17,35
SALVADOR	Bahia	62,41	1.451,1	21,6	1,68	10	2.708.818	3.068,50	882,8	3.114,8	309,72	89.427	12,76
BELO HORIZONTE	Minas Gerais	78,42	489,1	22,87	2,09	26	3.812.888	6.464,40	589,8	6.299,5	279,78	83.511	8,78
RIO DE JANEIRO	Rio de Janeiro	95,53	358,1	76,02	0,77	19	10.192.097	6.143,20	1659,1	4.392,0	354,24	297.992	9,49
SÃO PAULO	São Paulo	93,11	0	48,54	1,46	39	16.561.333	7.963,70	2079,6	6435,2	381,74	371.422	8,37
CURITIBA	Paraná	77,88	338,8	26,94	3,4	24	2.425.361	13.309,30	182,2	3.425,2	342,90	34.448	5,94
PORTO ALEGRE	Rio Grande do Sul	78,67	851,2	33,68	1,42	23	3.245.306	6.152,80	527,5	2.562,4	362,43	75.468	7,88
BRASÏLIA	Distrito Federa/Goiás/ Minas Gerais	92,88*	870,5	-	2,66	22	2.561.123	59.584,50	43,0	312,9	356,01	63.542	15,00
BRAZIL		78,36	-	31,04	1,38	4.074	157.070.163	8.547.403,5	18,38	-	339,67	4.988.371	15,8

Source: IBGE- Statistical Yearbook - 1997
**Refers to Federal District only

Table A.2 - Housing Indicators : Average Values for Brazil and Main RMs, 1997

Attribute	Brazil	Metropolitan Area									Federal District
		Belém	Fortaleza	Recife	Salvador	Belo Horizonte	Rio	São Paulo	Curitiba	Porto Alegre	
Number of Rooms	5,63	5,05	5,61	5,64	5,41	5,99	5,29	5,14	6,05	5,54	6,00
Number of Bedrooms	1,98	2,10	2,13	2,05	1,97	2,04	1,78	1,81	2,01	1,86	2,11
Density per Bedroom	2,05	2,36	2,09	2,06	2,06	2,03	1,98	2,25	1,93	1,88	2,01
Density per Room	0,60	0,66	0,63	0,62	0,61	0,59	0,59	0,64	0,57	0,56	0,60
Household Monthly Income (R$)	928,69	1.101,78	837,35	771,63	1.028,83	1.206,95	1.201,12	1.531,84	1.388,80	1.225,25	1.825,76
Household Per Capita Income (R$)	301,66	304,98	246,15	244,57	334,56	380,54	451,53	505,49	444,93	456,59	580,82
Monthly Rent (R$)	229,19	277,48	176,33	191,81	212,49	270,76	327,38	356,94	265,77	287,25	318,00
Rent to Income Ratio(%)	28,37	29,47	29,38	31,70	30,66	31,26	32,49	33,58	28,00	29,52	31,24
Solid Walls (%)	96,10	98,40	99,30	97,50	99,10	99,90	99,90	99,00	99,5	98,70	97,50
Solid Roof(%)	96,70	99,60	99,90	99,70	99,60	99,40	99,20	99,30	97,60	98,40	99,70
Piped Water(%)	83,30	85,30	80,50	90,60	94,10	97,80	96,30	99,00	97,20	98,20	96,40
Exclusive Bathroom(%)	97,40	89,10	97,90	96,10	97,10	97,60	98,90	98,20	96,80	95,60	94,50
Proper Sewage(%)	69,50	80,30	52,50	54,30	74,80	80,70	91,10	91,20	71,00	94,70	96,10
Proper Garbage Collection(%)	76,30	89,80	90,70	88,80	90,90	87,90	91,60	98,50	96,50	97,70	95,80
Eletricity (%)	93,40	99,90	99,20	99,90	99,90	99,90	99,80	100,00	99,90	99,70	99,80
Phone Connection(%)	27,90	38,90	37,80	25,70	44,00	45,40	30,70	43,30	41,40	33,60	65,50

Source: IPEA/DIRUR from PNAD/1997 microdata
* All values refer to September 1997.
** average exchange rate in September 1997 : R$/US$ = 1,0936

Table A. 3 - Housing Indicators: Average Values for the Rented Properties Attributes Used in the Model – 1997

Attribute	Brazil	Metropolitan Area									Federal District
		Belém	Fortaleza	Recife	Salvador	Belo Horizonte	Rio	São Paulo	Curitiba	Porto Alegre	
Number of Bedrooms	1,62	1,80	1,90	1,87	1,66	1,70	1,57	1,52	1,88	1,65	1,71
Number of other Rooms	3,05	2,96	3,31	3,51	3,13	3,42	3,19	2,70	3,66	3,38	2,93
Density per Bedroom	2,21	2,11	2,06	1,98	2,04	2,10	2,02	2,51	1,97	1,82	2,11
Density per Room	0,83	0,97	0,84	0,75	0,80	0,77	0,71	0,95	0,71	0,63	0,89
Household Monthly Rent (R$)	311,96	272,13	179,65	199,23	215,36	275,60	327,00	355,21	269,29	288,02	323,15
Rent to Income Ratio	0,32	0,29	0,30	0,32	0,31	0,31	0,33	0,34	0,28	0,29	0,31
Household Monthly Income (R$)	1314,43	1347,63	981,83	938,89	1135,25	1200,98	1266,16	1425,22	1377,41	1345,07	1524,25
Hosehold per capita Income (R$)	496,84	479,05	321,07	330,39	419,73	468,35	537,73	506,48	455,56	593,32	566,35
Solid Walls (%)	99,60	98,30	99,80	98,30	99,80	100,00	100,00	99,70	99,10	99,50	98,10
• Masonry	95,40	69,80	99,80	97,60	97,90	99,80	99,50	99,30	63,10	71,90	92,90
• Processed wood	4,20	28,50	0,00	0,70	1,90	0,20	0,50	0,40	36,00	27,60	5,20
Solid Roof (%)	99,40	99,50	100,00	99,70	99,80	99,70	98,90	99,70	98,60	99,40	99,70
• Tile	53,40	69,30	80,90	68,10	41,30	42,10	42,30	54,80	73,40	54,00	65,60
• Concret or cement	45,70	26,30	18,90	31,40	58,00	57,40	56,30	44,80	22,60	45,20	34,10
• Processed Wood	0,30	3,90	0,20	0,20	0,50	0,20	0,30	0,10	2,60	0,20	0,00
Piped Water (%)	96,70	91,60	80,50	92,50	95,00	98,20	95,70	99,20	98,60	98,50	95,70
Exclusive Bathroom (%)	95,80	86,00	96,30	93,90	90,90	95,60	96,90	96,90	96,30	94,00	90,50
Proper Sewage (%)	90,70	91,70	52,20	58,60	80,90	93,60	94,60	95,80	77,70	99,30	99,80
• Sewerage Network	67,40	19,00	24,10	35,50	40,90	92,60	63,70	85,60	49,70	5,60	94,80
• Septic Tank conected to Network	17,80	36,90	6,00	8,00	26,50	0,30	27,40	8,30	18,60	83,30	1,20
• Septic Tank not conected	5,50	35,80	22,10	15,10	13,50	0,70	3,50	1,90	9,40	10,40	3,80
Proper Garbage Collection (%)	97,90	96,70	96,30	94,60	96,60	96,10	95,50	99,70	100,00	99,80	99,70
• Collected directly	90,50	59,80	83,40	76,40	53,00	91,50	92,00	94,50	98,90	98,80	92,40
• Collected indirectly	7,40	36,90	12,90	18,20	43,60	4,60	3,50	5,20	1,10	1,00	7,30

Source: IPEA/DIRUR from PNAD/97 microdata

Annex I

Map I **BRAZIL: Main Metropolitan Areas**