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Expropriation risk and housing prices: Evidence from an emerging market

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ABSTRACT

This paper examines the microeconomic determinants of residential real estate prices in Caracas, Venezuela, using a private database containing 17,526 transactions from 2008 to 2009. The particular institutional characteristics of many countries in Latin America, and Venezuela in particular, where land invasions and expropriations (with only partial compensation) have been common threats to property owners, provide us with an opportunity to test the effects of these risks on housing prices using a unique database. The effect of these risks on property prices is negative and significant. To our knowledge, this is the first attempt to quantify these impacts in the Hedonic pricing literature applied to real estate. Size, the number of parking spaces, the age of the property, the incidence of crime, and the average income in the neighborhood are significant determinants of prices. Finally, this paper analyzes the microeconomic determinants of housing prices at the municipal level.

1. Introduction

This article examines the microeconomic determinants of the price (per square meter) of housing in Caracas, Venezuela. By doing so, it builds a framework of reference for investors who can use it to determine the price of a property based on its attributes; for owners, who may apply it to determine the value of their properties and the characteristics that drive their values; to developers, as they can estimate the optimal combination of attributes a property should have in order to maximize their benefits; to banks, who will have an objective methodology of valuation of assets that will serve as a guarantee for the delivery of a possible credit; and, finally, to policy makers, who can gauge, among other findings, the negative impact that invasions and expropriations may have on property prices. This is the first study of this type performed in Caracas, the largest real estate market in Venezuela and the fourth largest economy in Latin America. It is also the first article that measures the effect of expropriations and invasions on the prices of (neighboring) houses.

The authors analyze the microeconomic determinants of the price of housing in the metropolitan area of Caracas and the magnitude of their effects from 2008 to 2009. The article is divided into four sections. The first section develops a conceptual framework concerning the valuation of real estate assets using a Hedonic pricing model and provides the background, functional forms, and the most important conclusions found in the literature. The next section describes the main components of the data, as well as the descriptive statistical indicators. The authors present their adaptation of the model to the analysis of this particular data set and present the results for the metropolitan area of Caracas and for each of the five municipalities that comprise it in the third section. Finally, the main empirical results are highlighted and the conclusions are provided in the last section.

2. Literature review concerning the Hedonic pricing model

This section develops the framework for real asset valuation using a Hedonic pricing model, its background, the different functional forms this model may take, and some of its most important contributions.

2.1. The Hedonic pricing model

The idea behind Hedonic pricing is simple. If a property is made up of a series of attributes (which may be heterogeneous), then its market price must be an aggregate of the individual prices of all of them. The Hedonic pricing model is relatively straightforward as it is based on actual market prices and, if data are readily available, it can be relatively inexpensive to apply.

Unlike the majority of economic goods, buildings are characterized as being heterogeneous goods, something that makes them virtually unique and unrepeatable. However, what is known in the market is the composite price that contains no information regarding the marginal prices of the attributes that build it up. It is necessary to determine the implicit price (i.e., the Hedonic price) or contribution

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of each of these attributes within the total price due to their high heterogeneity and ease of differentiation.

Regression analysis based on the Hedonic pricing model has been used at length in the housing economics literature to analyze the relationship between the price of a unit of real estate and its attributes. A review of the use of the Hedonic model in real estate research can be found later in this section.

2.2. Microeconomic foundations of the Hedonic pricing model

Many authors place the origin of the Hedonic pricing methodology in the work carried out by Court (1939) for the determination of prices in the automotive market (Sirmans, Macpherson, & Zietz, 2005). Others place the origin of the Hedonic pricing methodology 17 years earlier, when Hass (1922) applied it to the calculation of the prices of cropland. Wallace (1926) continued this line of research in Iowa. Three years later, an application of the Hedonic pricing model was also found in a study of the quality of vegetables by Waught (1929). The common goal of these works is to analyze the price of a good by studying variations in the quality of the product, as represented by certain characteristics or attributes.

Subsequently, Houthakker (1952) and Tinbergen (1956) sought to build a theoretical formulation to justify the relationship between price and quality, which was eventually developed by Lancaster (1966) in his new approach to the consumer theory. This laid down the theoretical foundations supporting the Hedonic price model (i.e., that consumers derive their utility from the characteristics of a property and not from the properties themselves).

Later on, in 1974, Rosen (1974) provided the microeconomic foundation to the theory of Hedonic pricing and extended the research of Lancaster (1966) to real estate, which would become the paradigm of the Hedonic approach. This work closely follows the approach proposed by Rosen (1974). The Hedonic regression allows the estimation of a set of points in the intersection of the demand curves of different consumers, with different tastes, and supply functions of different firms with (probably) different production technologies. Rosen (1974) argues that the coefficients of the Hedonic regression can be interpreted as an approximation of the demand or supply (or neither). Indeed, if consumers are identical (in terms of income and tastes), but suppliers differ between them, the resulting Hedonic regression will look similar to a demand curve. Alternatively, if the suppliers are identical in terms of their cost structure and the consumers are different, the estimated parameters will be an approximation of the structure of the supply. However, if consumers and suppliers are heterogeneous (i.e., they have different distributions), the estimated coefficients of the Hedonic regressions should be interpreted as the equilibrium prices of those attributes.

2.3. Functional forms

Neither the model developed nor subsequent contributions to Rosen (1974) have established a criterion for selecting a functional form that provides better results. This problem, in essence, has become an empirical question. In order to assess the appropriateness of different functional forms, one would have to know the true marginal contribution of (consumer's willingness to pay for) attributes and to contrast that with the gradient of the particular Hedonic price function. The obvious difficulty in obtaining such data has led to the widespread use of goodness-of-fit. Traditionally, the most commonly used functional forms have been the linear, semi-logarithmic, and the double-logarithmic.

In 1964, Box and Cox provided a theoretical tool to determine the exact functional form from the following general expression:

$$P^{\alpha} = c + aX^{\alpha} + bY^{\alpha} + dZ \tag{1}$$

where α represents the coefficient of Box and Cox (1964) and whose determination provides the requested functional form. Eq. (1) adopts the linear form when α is one, and the logarithmic form when α is zero. Empirically, the hypothesis of a linear relationship has been ruled out, finding values of α close to zero leading to the conclusion that the functional form tends to be very approximate to the logarithmic form (Figueroa & Lever, 1992). This means that the impact of changes in the explanatory variables on the price tends to decline as the variable increases and vice versa.

From a theoretical standpoint, Cropper, Deck, and McConnell (1988), carrying a simulation where consumers bid for fixed housing stock, arrive at the conclusion that the Box and Cox (1964) transformation provides the most accurate estimates of marginal attribute prices when all attributes are observed (perfect information). When variables are not observable or are instead represented by a proxy, a simple linear Hedonic price function consistently outperforms the Box and Cox (1964) function, which provides biased estimators of hard-to-measure attributes. We have chosen a linear Hedonic price function as their interest lies in evaluating the impact on housing prices of a number of variables particular to the Venezuelan market and they are either not fully observable (expropriation and invasions risk) or do not belong to the realm of knowledge readily available to the average house buyer (homicide per 100,000 inhabitants, average income per family).

The functional form most recommended in the literature is the semi-logarithmic form as it fits particularly well to the data. Additionally, the coefficients can be interpreted as the percentage increase in the price of a good to a variation of a unit in the independent variable (Coulson, 2008; Halvorsen & Palmquist, 1980). For characteristics with binary measures, this interpretation is valid if the estimated coefficient has a small value.

2.4. Review of Hedonic applications in the housing market research

Every housing unit has a distinct price that is determined, in part, by the overall supply and demand conditions in the local housing market, but also by the different collection of attributes it embodies. Hedonic analysis does so by assuming that each attribute has its own market that is, in turn, governed by a supply and demand of its own. Therefore, each characteristic has a Hedonic price.

Numerous authors have used Hedonic applications to analyze the effects of observable attributes or macroeconomic variables on the housing market. Kim and Park (2005) study the determinants of housing prices in Seoul (South Korea) and its nearby cities, finding that the key determinants of changes in housing prices are the price index, changes in the money supply, construction area permitted, and the performance of the stock and bond markets. Wen, Jia, and Guo (2005) construct a Hedonic model of urban housing prices in the city of Hangzhou (China), dividing the characteristics of the property in three components: 1) structure, 2) neighborhood, and 3) location. Selim (2008) analyzes the determinants of the prices of homes in Turkey finding that access to water, number of rooms, size, and type of construction are the variables that most affect the price of houses. Nuñez, Ceular, and Millan (2007) confirm that the location, area, parking space, and age of a property are statistically significant determinants of the price of a house in the city of Córdoba, Spain. Finally, Keskin (2008) determines that the price of houses in Istanbul (Turkey) is determined by four types of characteristics: 1) ownership, 2) socio-economic environment, 3) quality of the neighborhood, and 4) geographic features. A number of authors have applied the Hedonic methodology to analyze the value of attributes within the housing markets of their respective country or city of location. Aguiló Safe (2002) examined the Balearic Islands (Spain), Chattopadhyay (1999) explored Chicago (U.S.), Meese and Wallace (2003) analyzed Paris (France), Figueroa and Lever (1992) examined Santiago (Chile), and Marquez (1992) used Guanare and Maracaibo (Venezuela). Additionally, Coulson (2008) presents a comprehensive

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review of the use of the Hedonic pricing model in real estate. These contributions demonstrate, despite the theoretical problems derived from estimating the model parameters and the issues inherent to most of real estate data, the efficacy of the Hedonic methodology in determining the factors that influence the price of housing real estate and the quantification of their magnitudes.

Hedonic pricing models are also used to estimate the marginal contribution to housing equilibrium prices of certain either unobservable or hard-to-measure attributes in the housing market. Ridker and Henning (1967a, 1967b) are the first to report an application of Hedonic models to estimate the effect of air pollution on the housing market of St. Louis, Missouri. The negative relationship that these authors found on a measure of sulfate in the air and housing prices motivated the development of the conceptual work of Rosen (1974) and Freeman (1974) and led the way for a larger number of contributions in this area. Most noteworthy among all of these are the three successive papers presented by Palmquist (1982, 1983, 1984), who use a linear Hedonic model and increasingly refined measures for pollution confirmed the significant and negative correlation on the housing markets of multiple cities in the U.S.

Jim and Chen (2009) use a linear Hedonic pricing model to estimate the value of scenic views in the housing market in Hong Kong. Benson, Hansen, Schwartz, and Smersh (1998) employ a similar work for multiple cities in the U.S. estimating the positive impact of scenic views, with sea views carrying the highest positive impact (60%). Alternatively, Lake, Lovett, Bateman, and Day (2000) report the significant negative impact of industrial views on home values.

Sander and Polaski (2009), with identical modeling, reported a significant positive impact of open space on the housing market of Ramsey County, Minnesota. Using linear Hedonic pricing, a number of authors also report a significant positive impact on housing prices of open space and protected areas (Bolitzer & Netusel, 2000; Hobden, Laughton, & Morgan, 2004; Lutzenhiser & Netusil, 2001).

A significantly lower number of works focus on the negative impact of crime on property values. This literature focuses on metropolitan areas, and relies on cross-sectional variations in crime rates and property values to draw estimates from the marginal impact of crime (Burnell, 1988; Gibbons, 2004; Lynch & Rasmussen, 2001; Thaler, 1978). Taking advantage of a ten-year database and exploiting the contrast brought about by sharp drops in crime rates in the U.S. during the 1990's, Pope and Pope (2012) depart from the standard linear Hedonic model and adopt a panel perspective in their assessment of crime rates on property values. Within a fixed effects framework eased by the panel structure of their data, the authors conclude that decreasing crime leads to higher property values, which accelerate as you move along the income dimension of the municipalities (i.e., wealthier neighborhoods experience a greater increase in property value in response to a drop in crime rates).

The effects of expropriations and illegal occupation on the value of property have not been addressed in the literature. This may be due two factors. First, there are relatively few countries around the world where such events (expropriations and illegal occupations) are so widespread as to allow a systematic study and, in those cases where they exist, the information required is not available. Additionally, there are difficulties associated with gathering data concerning expropriations on a localized basis. The authors take advantage of a cross-sectional data set of 17,526 housing transactions in a violent and institutionally weak country to exploit cross-municipality differences in a quest to determine the impact of crime, expropriation, and illegal occupations on housing prices.

Table 1 summarizes the major findings of the research reviewed here and Table 2 includes a summary table from Sirmans et al. (2005) and Zietz, Zietz, and Sirmans (2007) providing the variables typically included in studies of this type specifying the result of the signs and the number of times that these variables were not significant.

3. Geographical area of study and data

3.1. Geographical area of study

The Metropolitan District of Caracas (MDC) is where most of the administrative, financial, and educational activities of Venezuela are located. It includes the capital and the surrounding area and is the headquarters of many federal authorities. The MDC represents the largest concentration of population in Venezuela and, in itself, comprises the following five municipalities: 1) Baruta, 2) Chacao, 3) El Hatillo, 4) Libertador, and 5) Sucre. Unofficial estimates often place the total population of MDC above the four million mark.

3.2. The data

This study uses data provided by one of the most important banking institutions in the country, which includes 17,526 recorded prices of transactions of purchase and sale of residential real estate located in the MDC, as well as its most important features. These transactions occurred between January 2008 and August 2009. The quality of the data is somewhat guaranteed by the fact that these operations were carried through a mortgage requiring the bank to objectively assess the value of the property (to issue a loan in accordance to it and the credit capacity of the buyer) and the operations to be registered before official authorities.

Of these 17,526 transactions recorded from 2008 to 2009 by this bank, 6967 (39.75%) were carried out in the Libertador municipality, 3991 (22.77%) in Sucre, 3469 (19.79%) in Baruta, 1786 (10.19%) in Chacao, and the remaining 1313 (7.49%) in El Hatillo. It is important to note that there may be a possible underestimation of the actual number of transactions in some parishes and municipalities due to the informality that characterizes the real estate market in some of these areas, particularly in the poorest neighborhoods.

The inherent characteristics of each of the 17,526 transactions are divided into the following four sections: 1) structural, 2) location, 3) neighborhood, and 4) other. The structural characteristics are defined as those implicit in the transaction or that are of direct measurement. The authors consider the price per square meter, the area of construction in square meters (Mt^2), the number of parking spaces, the age of the building, and the market hosting the operation (i.e., primary or secondary). All of this information is available in the database provided by the bank. Unfortunately, the database did not contain other potentially useful information, such as the number of bedrooms or the number of bathrooms per house/apartment.

The other three sections (location, neighborhood, and other) are included to try to capture all the factors that may significantly affect the amount of the asset, but that may not be attributable to the property per se or are not included directly in the contract of sale. 64.6% of transactions were carried out for amounts of less than 4700 Bolivars/Mt^2 (or US $2186 at the official exchange rate of 2.15 Bs/US$ in force at the time) and only in 15.10% of the cases, the amount of the transaction exceeded the 6.246 Bs/mt^2 mark (or US $2905). Regarding the size of the housing property (square meters), 74.7% of the transactions belong to residences of less than 116 m^2 and 62.55% of the transactions were concentrated in the 58 m^2 and 116 m^2 range. 61.79% of the properties in the database had one or more parking spaces, and that in 57.04% of the cases included a range between one and two parking spaces. As to the age of the building, by the time of the transaction, in only 1.15% of the cases, the property was less than ten years old, while in more than 89% of the cases, the age of the building exceeded 20 years. Buildings more than 50 years of age exceed 25% of the sample. Finally, among the set of structural variables, 26.6% of transactions were in the primary market registering a total of 4656 transactions, while the remaining 73.43% were transactions in the secondary market with a total of 12,870 transactions.

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Table 1
Summary of selected research on the determinants of housing prices.

Author	Year	Title	Econometric model	Conclusions
Ridker and Henning	1967	Hedonic models and air pollution: Twenty-five years and counting	Probit	Environmental pollution significantly affects the price of homes
Thaler	1978	A note on the value of crime control: Evidence from the property market	Linear–semi-logarithmic	Significant evidence on higher willingness to pay for houses in neighborhoods with lower crime rates
Palmquist	1982, 1983, 1984	Estimating the demand for air quality from property values	Linear–semi-logarithmic	Pollution, as measured by increasingly refined indicators established a significant price premium associated with lower pollution in the housing market of multiple cities in the U.S.
Meese an Wallace	1986–1992	House price dynamics and market fundamentals: The Parisian housing market	Ordinary least squares (OLS) in two stages	Long-term economic fundamentals affect housing prices.
Burnell	1988	Crime and racial composition in contiguous communities as negative externalities	Linear–semi-logarithmic	Prejudiced household's evaluation of crime rate and segregation nearby reduces housing values and tax revenues.
Benson et al.	1998	Pricing residential amenities: The value of a view	Linear–semi-logarithmic	A positive impact of scenic views, with sea views carrying the highest positive impact (60%).
Chattopadhyay	1999	Estimating the demand for air quality: New evidence based on Chicago housing market	OLS in two stages	The provision is estimated to pay for a less polluted air measured in terms of SO2 and PM-10. There is a higher price in the case of PM-10 than in the case of SO2 implying that the people dislike WP-10 more than the SO2.
Lake et al.	2000	Improving land compensation procedures via GIS and Hedonic pricing	Linear–semi-logarithmic	Significant negative impacts of industrial views on home values.
Bolitzer and Netusil	2000	The impact of open spaces on property values in Portland, Oregon	Linear–semi-logarithmic	A significant positive impact on housing prices of open spaces and protected areas.
Lynch and Rasmussen	2001	Measuring the impact of crime on house prices.	Linear–semi-logarithmic	A significant negative impact of crime rates on housing prices.
Gibbons	2004	The cost of urban property crime	Linear–semi-logarithmic	One-tenth standard deviation decrease in the local density of criminal damage ads 1% value on an Inner London housing property.
Hobden et al.	2004	Green space borders: A tangible benefit? Evidence from four neighborhoods in Surrey, British Columbia 1980–2001	Linear–semi-logarithmic	A significant positive impact on housing prices of open spaces and protected areas
Lutzinger and Netusil	2001	The effect of open spaces on a home's sale price.	Linear–semi-logarithmic	A significant positive impact on housing prices of open spaces and protected areas
Selim	2008	Determinants of house prices in Turkey: A Hedonic regression model	Linear–semi-logarithmic	The system of water, swimming pool, type of home, number of rooms, meters of construction, features of the neighborhood, and the type of construction are the variables that affect the price of houses.
Jym and Chen	2009	Value of scenic views: Hedonic assessment of private housing in Hong-Kong	Linear–semi-logarithmic	A broad harbor view may increase the value of an apartment by 2.97%, equivalent to US$ 15,173. Even a confined harbor view may lift the price by 2.18% or US$ 11,137.
Sander and Polaski	2009	The value of views and open space: Estimates from a Hedonic pricing model for Ramset County, Minnesota	Linear–semi-logarithmic	A significant positive impact of open spaces on the housing market of Ramsey County, Minnesota.
Pope and Pope	2012	Crime and property values: Evidence from the 1990s crime drop	Hedonic model with fixed effects	A large and statistically significant negative association between crime rates and property value.

Table 2
Variables used in similar studies and results obtained.

Variables with predominantly inconsistent results				
Variable	Appearances	Number of times with positive sign	Number of times with negative sign	Number of times non-significant
Size of field	52	45	0	7
Square meters	69	62	4	3
Done using bricks	13	9	0	4
Number of bathrooms (3/4 or 1/2)	40	34	1	5
Number of rooms	14	10	1	3
Bathrooms	37	31	1	5
Fireplace	57	43	3	11
Air conditioning	37	34	1	2
Basement	21	15	1	5
Garage	61	48	0	13
Swimming pool	31	27	0	4
Age	78	7	63	8
Rooms	40	21	9	10
Distance	15	5	5	5
Time in market	18	1	8	9

Note: The results are Sirmans et al. (2005) and they were taken from Zietz et al. (2007).

The inherent characteristics of the neighborhood are divided into two areas. The first is related to the crime rate in the municipality where the property is located. This area included variables such as homicides, injuries, and robberies per 100,000 inhabitants calculated based on the work of Acero Velásquez (2006). The Chacao municipality is leading among theft indicators with an incidence of 1153 for every 100,000 inhabitants and also in injuries with 309 per 100,000 inhabitants. The problem with the indicators of theft and injuries is that, in many cases, the victim does not inform the police regarding these incidences (out of distrust or the perceived uselessness of filing a complaint) and, as such, these indicators may severely underreport the exact figures. Meanwhile, Libertador is leading in homicides with an incidence of 69 per 100,000 inhabitants. The homicide rate is a more reliable indicator of violence and crime as it would be difficult to underreport these incidences.

The second neighborhood-specific characteristic is the level of per capita income of the municipality hosting the transaction (taken from http://www.bcv.org.ve). This indicator is used as a proxy for the level of education and standard of living of the neighbors of the property, an attribute that plays an important role in the price of properties. Chacao is the municipality with the highest levels of average per capita income (Bs. 1321 per month or around US $614, calculated at the fixed official exchange rate of 2.15 Bs/$ in force at the time),

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while Sucre has the lowest average (Bs. 649 per month or around US $302). It is noteworthy as an indicator of the income inequality that characterizes the Metropolitan Area of Caracas that 79.6% of the transactions in the data set involve neighborhoods with an average income lower than the overall average of Bs. 945 per month (or around US $440).

The proximity of the transaction, measured in months, is another variable included in the study. The premise for inclusion of this variable is to account for the effects of inflation in Venezuela and also to consider the possible effects of changes in the economic and real estate business cycle. This variable takes a value of one if the operation was conducted in January of 2008, two if it occurred in February of 2008, three if it was conducted in March of 2008, and so on. In Figure 8, 83.9% (14,711 transactions) of the transactions were carried out in 2008, while the average transaction occurred around the months of July and August of 2008 (7.6 months).

The authors tried to incorporate a proxy for the risk of expropriation as a variable that has become increasingly important in Venezuela, a country where, for example, in March 2006, two years before the beginning of the sample period, President Hugo Chávez had already announced that it would expropriate the properties of those owners unwilling to sell at regulated prices (taken from http://www.globalpropertyguide.com/investment-analysis/Rise-of-the-left-the-fall-of-real-estate, where it was translated from Spanish to English). For instance, "If someone in Caracas has five apartments and refuses to sell at the right price, we will implement a decree of expropriation for public good and will pay the owner what the property is really worth."

Additionally, as published by the newspaper El Universal (2010, October 19) (the translation to English is ours): "Between 2005 and 2009, the Venezuelan Government has executed 762 forced expropriations of land and businesses, with an upward trend in the last year, when 374 cases have been recorded."

These announcements have been followed by an increasing number of land invasions throughout the country. Expropriated properties are usually paid by the government at below market prices and it may take years for the owner of an expropriated property to collect any payment. In many cases, the police do not act upon property invaders. Based on figures for expropriations and invasions provided by the Civil Association for Leadership and Vision (Liderazgo y Visión) for the period 2008–2009, the authors built an index in an attempt to measure the effect of perceived expropriation and invasions risks on the prices of residential real estate. The index was calculated as the total number of these incidents that occurred in a certain municipality divided by the number of transactions recorded in the bank's database for that municipality.

4. Results

4.1. Metropolitan area of Caracas

Using a semi-logarithmic specification, the authors applied the following model:

$$\text{Log}(PMT2) = \alpha + \beta_1 MTS2 + \beta_2 PEST + \beta_3 EEDI + \beta_4 MERC + \beta_5 HOMI + \beta_6 INGV + \beta_7 PTRA + \beta_8 INE3 + \varepsilon$$

where *PMT2* represents the price per square meter, *MTS2* is the area of the property (measured in square meters), *PEST* is the number of parking spaces the property has, *EEDI* is the age of the building, *MERC* is a dummy variable that takes a value of zero if it was traded in the primary market and one if the transaction took place in the secondary market, *HOMI* is the number of homicides per 100,000 inhabitants and per parish, *INGV* is an average income of the municipality hosting the transaction expressed in VEB (Venezuelan Bolivars), *PTRA* represents the proximity of the transaction, and *INE3* is an index representing the risk of invasions and expropriations, measured as the number of these incidents occurring in a certain municipality divided by the number of transactions in that municipality.

A summary of the most important descriptive statistics of the variables used in the model can be found in Table 3.

The regression is performed using an estimation of the variance of White under the assumption of heteroskedasticity, so that the results obtained are more conservative than those obtained under the traditional methodology of Ordinary Least Squares (OLS). The results of the regression can be found in Table 4 where the signs obtained were as expected. Additionally, the variables for the number of parking spaces and invasions and expropriations as a portion of the transactions are the most significant judging by the magnitude of the respective t-statistics.

The variable of expropriation and invasion risks yield a fairly high ratio indicating that the value of a property is sensitive to the perceived risk of being expropriated or invaded. This variable is robust to using, as a quotient of the invasions and expropriations, the population of the municipality involved (in the original case, it was the number of transactions in the analyzed municipality) or using the number of such events by municipality.

The variable square meters (Mt^2) indicates the appropriate sign and is statistically significant. Its shape is concave with respect to the origin implying that if the size of a property increases by 1 m^2, its price per square meter is reduced by 0.17%. This result is consistent with the evidence reported in other studies at the international level.

In the case of parking spaces, if parking space is increased by one, on average, the price of a property (per square meter) would be increased by 21.1%. This high percentage is not surprising as automobiles are the main form of transportation employed by middle class inhabitants in Caracas.

The coefficient of the age of the building is negative and significantly different from zero, but only if a significance level of 10% is used. An increase of one year in the age of a property results in a reduction in the price per square meter of only 0.01%. While this variable should have had a larger impact, it can attributed to the short supply of new homes, emphasizing the fact that more than 89% of the transactions in the database correspond to houses that are more than 20 years old. As in the previous cases, this result is consistent with Table 2 (i.e., the age of the building is negative in 63 of the 78 cases analyzed by Zietz et al., 2007).

Table 3
Descriptive statistics.

	Arithmetic mean	Standard deviation	Minimum	Maximum
LOG(PMT2)	6.54	0.26	5.70	9.02
MTS2	103.57	63.36	22.65	832.47
PEST	0.94	0.95	–	11.00
EEDI	37.30	14.32	1.00	60.00
MERC	0.73	0.44	–	1.00
HOMI	51.9	36.50	26.88	574.37
INGV	835.22	245.89	431.18	1612.60
PTRA	7.59	4.46	1.00	20.00
INE3	0.00177	0.00161	–	0.00373

Source: Own calculations based on data provided by one of the largest financial institutions in Venezuela. Note: LOG(PMT2) is the logarithm of the price per square meter, MTS2 is the property size measured in square meters, PEST is the number of parking spaces per property, EEDI is the age of the building, MERC is a dummy variable that takes the value of 1 if the transaction is in the secondary market, and 0 if it is a primary market transaction, HOMI is the number of homicides per 100,000 inhabitants and per parish, INGV is the level of per capital income in Bolivars of the municipality hosting the transaction, PTRA is a variable that measures the proximity of a transaction measured in months (January 2008 takes the value of 1, February 2008 takes the value of 2, and so on), and INE3 is an index representing the risk of invasions and expropriations, measured as the number of these incidents occurring in a certain municipality divided by the number of transactions in that municipality. Data is based on 17,526 transactions recorded between January 2008 and August 2009.

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Table 4
The model results.

Variable	Coefficient	Std. error	t-Statistic	Probability
C	14.60268	0.024024	607.8297	0.0000
MTS2	−0.001652	9.89E−05	−16.69776	0.0000
PEST	0.210998	0.006184	34.11874	0.0000
EEDI	−0.000121	7.29E−05	−1.659251	0.0971
MERC	0.143604	0.009469	15.16646	0.0000
HOMI	−0.000297	0.000123	−2.411074	0.0159
INGV	0.000426	0.000019	22.28097	0.0000
PTRA	0.021676	0.000922	23.51328	0.0000
INE3	−0.094362	0.003165	−29.80905	0.0000
R-squared	0.307117	Mean dependent variable		15.06901
Adjusted R-squared	0.306800	S. D. dependent variable		0.607442
S.E. of regression	0.505748	Akaike information criterion		1.474956
Sum squared resid	4480.256	Schwarz criterion		1.478947
Log likelihood	−12,915.30	F-statistic		970.4831
Durbin–Watson stat	1.674025	Probability (F-statistic)		0.000000

Dependent variable: LOG(PMT2).
Method: Least squares.
Sample: 1 17,526.
White heteroskedasticity-consistent standard errors & covariance.
Note: See Table 3 for a definition of each variable.

If the operation is performed on the secondary market, the price of the property will increase by 14.4%. This counter-intuitive result may be explained by the possibility that the prices paid for properties in the primary market correspond, in many cases, to pre-sale prices, which tend to be lower than the price of an already built property. This form of transaction contains an implicit financing that makes its nominal price lower.

The homicide variable is negative and statistically significant and is interpreted in the following way. As the number of homicides per 100,000 inhabitants of the neighborhood involved in the transaction increases by one unit, the price per square meter of the property falls by 0.03%. This particular variable generates robust results in those cases where similar variables, such as injuries, robbery, and rape per 100,000 inhabitants, are used. In all of these cases, the sign is correct and the variable is significant and statistically different from zero.

The neighborhood income and proximity of the transaction variables are positive and statistically significant. The first variable has a fairly low value, so when buying, while it is important, it doesn't significantly affect the price of the transaction. In the second case, the variable proximity of the transaction is positive and statistically different from zero. As the date of the transaction approaches, the price of the property increases by 2.17% for each unit or additional month. This is most likely due to inflationary issues and it is important to note that average inflation in the years 2008–2009 is 2.2% per month.

With regard to R^2 and adjusted R^2 of the regressions, note that they are 30.71% and 30.68%, respectively, two values that are similar to those obtained in previous studies throughout the world. Individually, all of the variables are statistically different from zero with an alpha of 10% (t-test). As a whole, the model is well adapted to the sample obtained (F-test). Finally, the Durbin Watson statistical test of autocorrelation yielded a value of 1.674, which is located within the prescribed limits. Therefore, the autocorrelation test is inconclusive in this case.

4.2. Municipal results

In this subsection, the authors attempt to analyze whether there exists any difference in the valuation of the attributes among each of the municipalities that comprise the metropolitan area of Caracas. To do so, following regressions are run for each of the transactions in each municipality:

$$\text{Log}(PMT2) = \alpha + \beta_1 MTS2 + \beta_2 PEST + \beta_3 EEDI + \beta_4 MERC + \beta_5 PTRA + \varepsilon.$$

A summary of the averages of the variables used in the model, computed by municipality, is presented in Table 5.

Regression analysis (see Tables 6–10) indicates that, in general, all of the variables were significant and statistically different from zero at the 1% level of significance, except for the age of the building (EEDI) in the case of the El Hatillo municipality. In that case, it results in a non-significant outcome as in the eight of the 78 cases analyzed in Table 2 of Zietz et al. (2007). In all of the cases, the model is valid as a whole (F-test).

The signs of the variables, in all cases, behave as expected except for the age of the building in the municipalities of Baruta and Chacao, which have a positive sign implying that the older the property, the higher the price to be paid. This could be explained by the area where the building is located. It appears in those municipalities where urban development began in modern times in Caracas and then extended to the surrounding areas inferring that the best areas were occupied by the first buildings constructed and, therefore, they may have an important geographical value that the model collects through the age variable even though this is an attribute not measured in our model.

Next, the authors attempt to assess the differences in the valuation of attributes among the five municipalities of Caracas. For example, in the case of the variable parking spaces (PEST), a greater valuation in the Libertador municipality (−0.3451) is noted, followed by Sucre, Chacao, El Hatillo, and Baruta (0.0862). This finding can be explained by the availability of parking spaces in the municipality. It is much easier to get an apartment with a parking space in El Hatillo than it is in Libertador. As such, the value of the parking space is greater in the Libertador municipality than in El Hatillo municipality.

With regard to the age of the building, removing the cases discussed above, the loss of value as a result of the age of the building is determined by the number of new projects or ongoing projects. For instance, if Sucre (−0.0059) is compared with Libertador (−0.0034), Sucre has many new construction sites (e.g., Parish Leoncio Martínez). There is a wider range of options when purchasing a property thereby punishing the price of older structures. In the case of Liberator, this municipality offers fewer new properties limiting the options that are available. The case of El Hatillo is slightly different as properties in this municipality are largely new or relatively new.

Finally, the market where the operation is performed indicates significant differences between municipalities. This may be attributed to the coefficient capturing some of the attributes of the geographic location of housing. Aside from the differences previously mentioned, the results obtained for the general sample remain consistent with those obtained at the municipality level.

5. Conclusions

The main contribution of this article to the literature in Hedonic pricing models applied to real estate is the inclusion and quantification of

Table 5
Mean values of independent variables by municipality.

Municipal	# Transactions	LOG(PMT2)	MTS2	PEST	EEDI	MERC	PTRA
Sucre	3.991	6.52	99.92	0.89	38.96	0.48	8.00
Baruta	3.469	6.71	126.01	1.50	38.14	0.81	8.82
Chacao	1.786	6.67	123.53	1.08	37.45	0.72	5.65
El Hatillo	1.313	6.71	142.53	2.02	48.94	0.57	10.86
Libertador	6.967	6.41	82.07	0.45	42.48	0.88	6.62

Source: Data provided by one of the largest financial institutions in Venezuela. See Table 3 for a definition of each variable.

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Table 6
Results of regressions in the Chacao municipality.

Variable	Coefficient	Std. error	t-Statistic	Probability
C	15.00410	0.064958	230.9823	0.0000
MTS2	−0.001615	0.000247	−6.548321	0.0000
PEST	0.152273	0.018833	8.085324	0.0000
EEDI	0.005570	0.001085	5.131202	0.0000
MERC	0.111131	0.035027	3.172691	0.0015
PTRA	0.018780	0.005954	3.154083	0.0016
R-squared	0.140423	Mean dependent variable		15.36384
Adjusted R-squared	0.138008	S. D. dependent variable		0.648746
S.E. of regression	0.602319	Akaike information criterion		1.827294
Sum squared resid	645.7628	Schwarz criterion		1.845730
Log likelihood	−1625.774	F-statistic		58.15715
Durbin–Watson stat	1.786423	Probability (F-statistic)		0.000000

Dependent variable: LOG(PMT2) CHACAO.
Method: Least squares.
Sample: 1786.
Included observations: 1786.
White heteroskedasticity-consistent standard errors & covariance.

Table 8
Results of regression to the Libertador municipality.

Variable	Coefficient	Std. error	t-Statistic	Probability
C	14.60384	0.036435	400.8244	0.0000
MTS2	−0.002727	0.000205	−13.29795	0.0000
PEST	0.345112	0.011942	28.89974	0.0000
EEDI	−0.003409	0.000575	−5.932567	0.0000
MERC	0.182884	0.019318	9.467159	0.0000
PTRA	0.027982	0.001467	19.06864	0.0000
R-squared	0.163106	Mean dependent variable		14.76618
Adjusted R-squared	0.162505	S. D. dependent variable		0.531498
S.E. of regression	0.486400	Akaike information criterion		1.397288
Sum squared resid	1646.629	Schwarz criterion		1.403188
Log likelihood	−4860.756	F-statistic		271.2930
Durbin–Watson stat	1.724182	Probability (F-statistic)		0.000000

Dependent variable: LOG(PMT2) LIBERTADOR.
Method: Least squares.
Sample: 6967.
White heteroskedasticity-consistent standard errors & covariance.

the effects of perceived expropriation and invasion (illegal occupation) risks at the municipality level as key determinants of housing prices. This is the first attempt to quantify these impacts in the Hedonic pricing literature applied to real estate. The particular institutional characteristics of some countries in Latin America, and of Venezuela in particular where land invasions and expropriations have been common threats to property owners, provides the authors with an opportunity to test the effects of these risks on housing prices using a unique database. There was a significant and negative effect of these risks on housing prices. The findings are robust to the different ways in which a property invasion and expropriation's risk index may be constructed. The Venezuelan economic and business environment (e.g., 762 expropriations from 2005 to 2009, a period that includes the two years of this study, 2008 and 2009, and two years prior) provides a unique setting to test these effects and specify their particular impact on housing prices.

The authors employed a reasonable Hedonic function that uses attributes as input and forms the market price of the unit as its output. The parking spaces variable and invasions and expropriations risks were the two most significant variables judging by the coefficients of the t-statistics. Furthermore, the market where the operation is performed, whether primary or secondary, the square meters of construction, the age of the building, the income level of the neighborhood, the period of the transaction, and the number of homicides per 100,000 inhabitants (a proxy for neighborhood violence), are all statistically significant variables. The whole model is reasonably adapted to the data at any level of significance (F-test).

Similar models were run for each of the municipalities to determine whether there were differences among them. It should be noted that the parking space variable is not significant in the El Hatillo municipality. Alternatively, the coefficient for the variable age of the building exhibited a negative sign in the cases of the municipalities of Baruta and Chacao, contrary to the results obtained in the general model and in the rest of the surveyed municipalities. Despite these differences, the results remained consistent with those found in the general model.

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Table 7
Results of regression in the Sucre municipality.

Variable	Coefficient	Std. error	t-Statistic	Probability
C	14.90523	0.040019	372.4576	0.0000
MTS2	−0.000661	0.000224	−2.950503	0.0032
PEST	0.177764	0.012699	13.99779	0.0000
EEDI	−0.005993	0.000612	−9.785499	0.0000
MERC	0.086747	0.019072	4.548455	0.0000
PTRA	0.026410	0.002160	12.22912	0.0000
R-squared	0.108934	Mean dependent variable		15.01663
Adjusted R-squared	0.107816	S. D. dependent variable		0.554168
S.E. of regression	0.523442	Akaike information criterion		1.544721
Sum squared resid	1091.856	Schwarz criterion		1.554180
Log likelihood	−3076.491	F-statistic		97.43471
Durbin–Watson stat	1.529291	Probability (F-statistic)		0.000000

Dependent variable: LOG(PMT2) SUCRE.
Method: Least squares.
Sample: 3991.
White heteroskedasticity-consistent standard errors & covariance.

Table 9
Results of regression to the El Hatillo municipality.

Variable	Coefficient	Std. error	t-Statistic	Probability
C	15.21883	0.051299	296.6667	0.0000
MTS2	−0.002584	0.000253	−10.19801	0.0000
PEST	0.125148	0.019714	6.348285	0.0000
EEDI	−2.97E−05	6.09E−05	−0.488105	0.6256
MERC	0.181357	0.025769	7.037702	0.0000
PTRA	0.023069	0.002813	8.201131	0.0000
R-squared	0.194850	Mean dependent variable		15.45561
Adjusted R-squared	0.191769	S. D. dependent variable		0.464898
S.E. of regression	0.417951	Akaike information criterion		1.097653
Sum squared resid	228.3105	Schwarz criterion		1.121324
Log likelihood	−714.6092	F-statistic		63.25982
Durbin–Watson stat	1.909277	Probability (F-statistic)		0.000000

Dependent variable: LOG(PMT2) HATILLO.
Method: Least squares.
Sample: 1313.
White heteroskedasticity-consistent standard errors & covariance.

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Table 10
Results of regression on the Baruta municipality.

Variable	Coefficient	Std. error	t-Statistic	Probability
C	15.12976	0.042590	355.2413	0.0000
MTS2	−0.000752	0.000141	−5.330129	0.0000
PEST	0.086249	0.013021	6.623917	0.0000
EEDI	0.003421	0.000719	4.760534	0.0000
MERC	0.118149	0.023325	5.065252	0.0000
PTRA	0.005469	0.001653	3.309625	0.0009
R-squared	0.041973	Mean dependent variable		15.43925
Adjusted R-squared	0.040590	S. D. dependent variable		0.468627
S.E. of regression	0.459018	Akaike information criterion		1.282272
Sum squared resid	729.6447	Schwarz criterion		1.292912
Log likelihood	−2218.101	F-statistic		30.34430
Durbin–Watson stat	1.814916	Probability (F-statistic)		0.000000

Dependent variable: LOG(PMT2) BARUTA.
Method: Least squares.
Sample: 3469.
White heteroskedasticity-consistent standard errors & covariance.

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