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Housing economic valuation in the metropolitan area of Puebla, Mexico

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ABSTRACT

Objective: The purpose of this research was to identify the sale value of homes in the metropolitan area of the city of Puebla, using the hedonic price technique to determine a model that takes into consideration relevant variables that explain the housing prices.

Methodology: An overall problem is land mismanagement. The location of the homes can affect their price. A hedonic price model helps to determine the relative importance of the variables in the final price. This information provides an initial perspective to the people who are interested in acquiring a home in the study area. The model was built based on the information collected from 182 properties and it was analyzed using the SPSS software version 28.0.0.0.

Results: The most significant variables that determine housing prices, which presented a multiple valuation coefficient of 64.3%. The effect of the variables on the housing value was determined by means of elasticities.

Study Limitations: There were no limitations for this report.

Conclusions: The following variables were significant: new home, number of bathrooms, built-up area, private security, distance to the downtown of Puebla, and distance to a park.

Keywords: Housing price, Hedonic regression model, Puebla.

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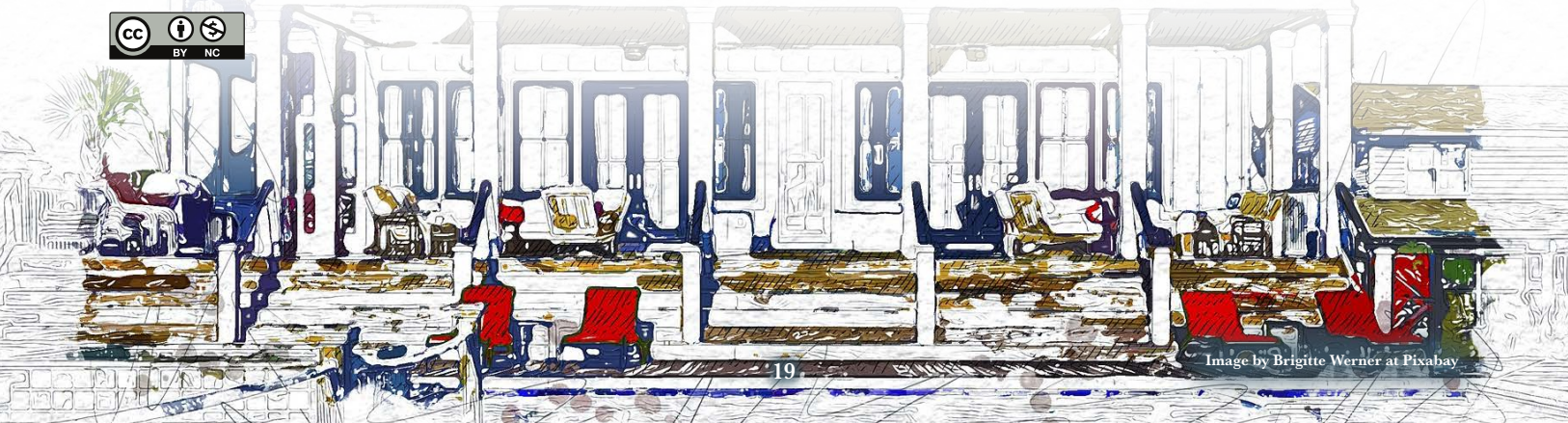
INTRODUCTION

The population has grown exponentially in the last 300 years and technological progress has modified the environment to satisfy human needs, based on the exploitation of natural resources that a large part of the population considered inexhaustible (Barbieri & Fogel, 2005; Labandeira Villot *et al.*, 2001). In recent years, the housing sector in Mexico has been boosted by lower interest rates and an increase in the credits granted by both private and government entities. However, all of the country's housing needs are yet to be met. Another important aspect is that the employment instability faced by the new generations means that they lack feasible possibilities of buying a home (Tirole, 2008).



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Mexico's population policy is based on the reform of the Ley General de Población of 1974. Since that time, the population has experienced major quantitative and qualitative changes (*e.g.*, the growth of urban areas in national territory). These changes have shown the need for a comprehensive understanding of urban development, based on a sustainable development approach to urban areas (CONAPO, 2014; UN-Habitat, 2018). Cities were not prepared to receive these migration flows and there was not a sufficient supply of suitable and accessible land for housing. Consequently, millions of Mexicans settled in areas that were unsuitable for housing construction. The poor location of homes can be explained by the concept of spatial capital, which allows assessing physical accessibility to goods and services (Coneval, 2018). Spatial capital is a type of urban resource internalized by the individual resulting from the combination of objective material conditions (graphics, design, infrastructure availability, accessibility, and connectivity) and subjective socio-cultural conditions (how they use and make the spaces and means of transport their own) (Apaolaza *et al.*, 2016; Coneval, 2018).

The metropolitan area of Puebla faces important challenges as a consequence of the use of high agricultural-value land and other areas adjacent to the city, resulting from land management and water demand. These problems have been caused by the absence of intermunicipal agreements on issues such as solid waste management, air pollution, transportation, and changes in land-use. The real estate market situation is influenced by several factors. The analysis of the socioeconomic, environmental, and accessibility aspects enables the identification of which of them have a greater impact on the configuration of the sale value and how it is affected by certain actions —such as urban planning, equipment, infrastructure, crime, etc.

The overall objective of this research is to analyze, through the hedonic price technique, the relationship between variables that may interfere with the property sale value in seven municipalities of Puebla's metropolitan area. Such variables include distance to the downtown, a nearby park or a hospital, and the number of crimes. The following hypotheses are formulated: a) the longer the distance from parks, the lower the sale value and b) the greater the number of crimes, the lower the sale value.

MATERIALS AND METHODS

Puebla is one of the most important states of Mexico, not only in the economic sphere —to which it contributes 3.4% of the domestic GDP—, but also in population terms —since about 4.8% of the country's inhabitants live in the state.

The accelerated urban expansion of the metropolitan area agglomeration of the city of Puebla between 1976 and 2005 —and the resulting transformation of agricultural and forest land into urban land— has contributed to the deterioration of the environment and natural resources (Hernández-Flores *et al.*, 2009).

Puebla, as well as its metropolitan area, has undergone a continuous growth and it concentrates the largest population in the state. The study focused on 7 municipalities that have a population of approximately 2.15 million inhabitants (INEGI, 2010). These municipalities are: Amozoc, Coronango, Cuautlancingo, Ocoyucan, San Andrés Cholula, San Pedro Cholula, and the city of Puebla itself.

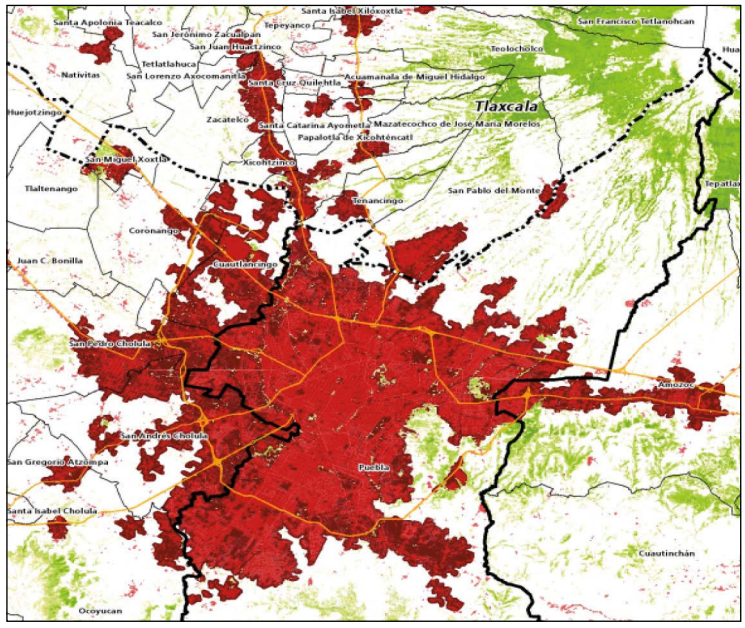

Figure 1. Puebla metropolitan area (ONU-Habitat, 2018).

Table 1. General characteristics of some municipalities of Puebla's Metropolitan Area.

Municipality	Urban area (Km^2)	Population	Density	
			Inhab/km^2	Homes/km^2
Amozoc	12.6	138,214	84	2151
Coronango	3.1	40,949	1049	2942
Cuautlancingo	33.2	112,235	2647	929
Ocoyucan		25,720	214	
Puebla	168.6	1,576,259	3025	2554
San Andrés Cholula	21.9	137,290	1849	1723
San Pedro Cholula	12.2	128,032	1684	2517

Source: developed by the authors based on data from ONU-Habitat (2018).

Model and variables

Hedonic prices

The hedonic price technique is based on the fact that the merchandise offered in a given market has homogeneous characteristics and that each merchandise is either made up of a series of components that determine its value or is based on the relationship that exists between the consumer preferences and the characteristics of real estate (Lancaster, 1966).

People buy homes from the market with the intention of increasing their well-being, because they consider that these goods have a set of characteristics that satisfy some of their needs, as a consequence of their use value. Many goods do not have a single use value, given that they satisfy several needs at the same time and can be classified according to their physical characteristics. In the case of housing, some characteristics may be: social and spatial environment or its environmental and geographical location.

Their combination determines the amount that the user is willing to pay for the property (Fitch Osuna *et al.*, 2013).

Variables

We seek to develop a model that can test the hypotheses regarding the sale value of homes in the metropolitan area of Puebla, taking into consideration that the combination of variables determines the value. The economic valuation method used is the hedonic price technique. In this case, the method breaks down the value of a property based on its characteristics and development aspects. The standard specifications of this model are based on Sobrino-Figueroa (2014).

$$P_1 = \alpha + X_1\beta + \varepsilon_1$$

Where P_1 represents the value of the house, α is the coefficient, X_1 represents a vector of attributes or physical and spatial characteristics of N houses in Puebla's Metropolitan Area, β is the vector associated with each characteristic, and ε is a vector of errors, independently and identically distributed for all N houses. The proposed model is based on the fact that user preferences regarding the attributes or characteristics in question are identical for all individuals (Brueckner & Colwell, 1983).

The data used belongs to 61 neighborhoods distributed in 7 municipalities of the metropolitan area of the city of Puebla (Table 1). The sale value and the average size, as well as the physical characteristics of the housing, were obtained from a real estate company that operates in Puebla's metropolitan area, as well as from Propiedades.com, tuhogarmexico.com, Inmuebles24, and Lamudi (2020).

Vector is made up of other characteristics of the homes that are taken into consideration to explain the value (Table 2). One of Google Maps[5] tools was used to determine the distance (km) from each neighborhood to a hospital, to Puebla's downtown, to parks, and to a shopping center. Another important aspect that is taken into account is the number of crimes per 100 thousand inhabitants, based solely on data provided by the Fiscalía General del Estado de Puebla (2020) —therefore the actual data may have been underestimated (although determining the appropriate number is not the objective of this research). The effects that this variable would produce are reverse, regardless of the type of crime that is committed (whether it impacts life, well-being, personal freedom, sexual freedom and safety, property, family, society, etc.).

RESULTS AND DISCUSSION

The ordinary least squares (OLS) method was applied to estimate the best model. This method has been used by Jansson and Axel (2000) and Nuñez C. and Schovelin S. (2002) for functional relationships that have proven to be appropriate for these kinds of problems.

[5] The Google Maps tool is used to determine the distance in kilometers from each home to the point of interest (DZP, DP, DH, DCC).

Table 2. Variables used in the model.

Variable	Denomination
New house	Cnu
Number of bathrooms	Bañ
Number of bedrooms	Recam
Parking lot	Est
Built-up area (m^2)	Cons
Private security	SP
Distance to Puebla's downtown (km)	DZP
Distance to a park (km)	DP
Distance to a hospital (km)	DH
Distance to a shopping center (km)	DCC
Population density (inhab/km^2)	DenP
Homicides per 100,000 population	Hom
Crimes per 100,000 population	Del
Criminal events (Hom + Crim)	EveDel

Source: developed by the authors based on the variables used.

The coefficients of the variables are obtained through the OLS which, in their turn, are used to carry out the significance tests. The available information is used to develop the best model.

The model presented is the result of discarding variables that did not provide substantial information. To reach this determination, a Student's t-Test was carried out to analyze the values and to determine their significance. Subsequently, the model shown in Table 3 was chosen.

Table 3. Result of the hedonic price model for homes in the metropolitan area of Puebla with significant variables.

Variables	Coefficients	t
(Constant)	14.016	5.537
Cnu	0.123	1.699
Bañ	0.054	1.745
Cons	0.004	8.043
SP	0.174	2.622
DZP	−0.018	−2.411
DP	−0.047	−3.42

Model Summary

Model	R squared	R squared adjusted	Standard error of the estimate
1	0.643[a]	0.625	0.38549

[a] Predictors: (Constant), Del, Hom, Bañ, SP, Cnu, DP, Cons, DZP, DenP.
Source: developed by the authors based on the results of the regression model.

Based on Table 3, the functional form of the model can be developed. The model would be represented as follows:

$$P=14.016+0.123Cnu+0.054Bañ+0.004Cons+0.174P-0.02DZP-0.047DP$$

The model accounts for 64.3% of the variation in the sale value of homes, based on the independent variables included in the hedonic price model for the metropolitan area of Puebla. The variables that meet the significance criteria of the hedonic price model are analyzed next, taking the price elasticity of each variable as a reference.

Table 4 shows the price elasticities of the model. All the variables have an inelastic behavior: a 1% change in the variables will have a smaller effect in the sale price of the housing properties.

Based on the elasticity, the price for new homes (Cnu) will be 0.07% higher than for other homes with the same characteristics.

The price elasticity for the number of bathrooms (bañ) shows that increasing this variable by one unit increases the value of the house by 0.15%.

With respect to the elasticity obtained, the built-up area (Cons) points out that a one-unit increase in the built-up area increases the value of the house by 0.82%.

Meanwhile, based on the elasticity obtained, private security (SP) in the area where a property is located increase the sale value by 0.09% regarding homes that lack the service.

The effect of the distance to Puebla's downtown (DZP) means that, for each additional kilometer, the housing prices decreases by 0.21%.

Finally, the distance to a park (DP) points out that each additional kilometer decreases the value of the house by 0.19%.

Brueckner and Colwell (1983) mention that implementing this type of mathematical model to explain the value of housing is a valid measure, since it recognizes the existence of multiple attributes. Housing in the metropolitan area of Puebla has characteristics that have been used in analyses such as the one carried out by Murrieta and Lagunas (2012). They take into account the characteristics proposed in this model and also determine that users prefer housing with several bedrooms and bathrooms and that is near a park and at a certain distance from downtown, as shown by the results obtained in the previous section. The social environment is also an aspect that has a major impact on the sale value

Table 4. Price elasticities of the model.

Variable	Price elasticity
Cnu	0.07
Bañ	0.15
Cons	0.82
SP	0.09
DZP	−0.21
DPCA	−0.19

Source: developed by the authors based on the results of the regression model.

of housing properties: the variable that covers private security in the housing area is an important factor.

According to the model, the housing price depends on the distance to certain points. In other words, the distance between the home and certain points of interest for the individuals has a direct impact on the price, whether it is the downtown or new centers or poles of attraction. This aspect is also highlighted by Lara Pulido *et al*., (2016) and Murrieta and Lagunas (2012).

CONCLUSIONS

Three conclusions can be drawn from the analysis of the results. In the first place, the proximity to Puebla's downtown generates the greatest value for consumers: the greater the distance, the lower the value. In second place, the social environment is also an important aspect. The results of this model generate a negative effect, as stated in the hypothesis regarding the number of crimes. An increase in the number of crimes generates a decrease in the housing value. However, a statistical analysis reports no significant level; therefore, we decided not to use it since it does not make a significant contribution to the model. However, private security in the area where the property is located does have a positive impact on its value, which is related to the social environment. In third place, the value of housing located in the metropolitan area of Puebla has an important relationship with its surrounding environment. To have a higher value, it must be close to the downtown, not far from a park, and have an average of just over 200 square meters of built-up area.

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