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Research Article

ENVIRONMENTAL ECONOMIC VALUATION OF PROTECTED AREA IN BRAZIL: APPLICATION OF THE HEDONIC PRICING MODEL

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ABSTRACT

Protected areas are an important means for the conservation of environmental systems. They have been used for this purpose since the nineteenth century, but it was only in the twentieth century that they became famous, mainly due to the influence of international organizations such as the International Union for Conservation of Nature (IUCN), which to this day presents itself as one of the main organizations in defense of environmental protection. In Brazil, conservation units became popular after the creation of the National System of Conservation Units (SNUC), with an exponential increase in the creation of these areas. However, the increase in the creation of these areas did not guarantee that the ecological systems were effectively protected, much due to the difficulties of financial resources for this purpose. In this sense, the object of study in question, the Parque do Poeta, fits into this discussion. Starting from an economic theoretical contribution for the interpretation of this phenomenon, the work proposed to answer the following question: what is the benefit of the conservation of the protected area, known as Parque do Poeta, seized by the real estate market in Campina Grande, Brazil? The results of the research show that this effect happens in the real estate market of Campina Grande, it is observed in the parameter value calculated from the statistical model through the hedonic price methodology. The environmental economic value of the protected aream, was understood as the first derivative of the hedonic price function with respect to the proximity of apartments in the city with the protected area, and from it can be seen that the variation of willingness to pay for a natural environment in Campina Grande is greater when the property is closer to the Parque do Poeta.

Keywords: environmental economics; hedonic pricing; real estate market.

INTRODUCTION

Protected areas are capable of generating value in multiple ways for individuals and institutions. However, some research on the subject has concluded that protected areas are still undervalued around the world. With this, some authors argue that discovering, investing in and communicating this "hidden" value that resides in many protected areas can promote greater public support for the management of these areas and generate new sources of income for their protection. The underestimation of the benefits of protected areas can occur due to the difficulty of determining monetary values and conventional market mechanisms are not effective in providing the socially optimal amount of protected area, thus measures that commonly require government intervention are necessary (Costa et al., 2019).In view of this complexity of factors in the implementation of an environmental policy, the study observed the externality process generated by the creation of a protected area, which until the year 2020 was known as Parque do Poetal. The former Parque Estadual do Poeta e Repentista Juvenal de Oliveira (Parque do Poeta), an area of 267 hectares inserted in the caatinga biome, which is located in the urban perimeter of the municipality of Campina Grande in Brazil was recently disaffectionated by the state government (Law No. 11,797/2020). The area, however, has many natural riches typical of the Caatinga biome and is rapidly expanding its tourism potential, especially for ecotourism activities. The vegetation in the park is typical of a transition zone consisting of a preponderant tropophyte region that mixes with xerophytes. For the purposes of this research, the externality is measured in monetary units using a technique for valuation of environmental goods and services, which is inserted between the economic and ecological objectives of sustainable development. Environmental valuation techniques are methodological tools that have been gaining space in the environmental sciences scenario. The attitude of attributing value to things is considered an intrinsically human characteristic and practiced by people in various societies in history, however, the use of scientific methods for this purpose is something recent and involves a multidisciplinary knowledge. As with any research in environmental sciences, the methodological difficulties involved in a work of this nature are present and the work sought to contribute to the advancement of this scientific field (Frör, 2007). Within this perspective, the benefits of conserving the natural environment of the protected area are perceived implicitly by the hedonic pricing model. Thus, the assumption is that the market can signal the economic value of a protected natural environment. Thus, the problem of this work is inserted into the question about the benefits that society has with the conservation areas and how economic theory can offer answers in favor of improving the implementation of environmental public policies in Brazil. From this, the research seeks to answer the following question: what is the conservation benefit of the protected area, known as Parque do Poeta, seized by the real estate market in Campina Grande - PB? In order to take any position on these questions, the general objective is to analyze the benefits, in marginal terms, provided by the environmental quality offered by the Parque do Poeta, and the specific objectives are: to estimate the hedonic price model of the real estate market in Campina Grande - PB; to measure the effect that the environmental quality produced by the Parque do Poeta has on the real estate market and to analyze the policies for the protection of protected areas in the light of the environmental economic theory.

THEORETICAL FRAMEWORK

Hedonic Pricing Model

The methodology used in this research is based on the modeling developed by (Rosen, 1974), known as hedonic regression, from which it is estimated the implicit value of certain attributes of a good, such as environmental amenities, through observable characteristics in the market. The model in question represents the market equilibrium for a particular good, formulated from the set of its characteristics (Seabra, 2016). (Rosen, 1974) formulated a model based on the hedonic hypothesis, in which it is assumed that goods are valued by the utility of their attributes or characteristics. A theory of hedonic prices is formulated as a problem in the economics of spatial equilibrium in which the entire set of implicit prices guides both consumer location and producer decisions. In this sense, hedonic prices are defined by Rosen (1974) as the implicit prices of the attributes of a good, these being revealed to economic agents through the observed prices of differentiated products and their quantities of specific characteristics. These characteristics constitute the empirical nature of the model's explanation. For Rosen (1974), econometrically the implicit prices are estimated by first step regression analysis (regressing product price on characteristics) in the construction of hedonic price indexes. The main purpose of the model is to exhibit a generating mechanism for the observations in competitive environment and use this structure to clarify the meaning and interpretation of the estimated implicit prices. The model suggests a method that can often identify underlying structural parameters of interest. Also, as a general methodological point, it is shown that conceptualizing the problem of product differentiation in terms of some underlying characteristics leads to a spatial equilibrium analysis (Rosen, 1974).In this sense, the hedonic pricing model is applied in the valuation of environmental goods using housing as a differentiated product. This popularity of the hedonic method may be due to the fact that the prerequisites are relatively minimal and also because it has a simplified empirical implementation. In addition, the perceptions that can be extracted in an analysis of this type are quite interesting: as for example, in the change of environmental quality felt by the population of a locality. The choice made by housing consumers for a particular locality is the key point observed by the theory. These location choices are often directly related to an environmental amenity of interest. Locations with appreciable scenic views for example have more agency value in property values (Taylor, 2008). Applied to the valuation of environmental goods, the hedonic pricing model is inserted in a perspective that considers private markets as an indicator of the willingness to pay (WTP) of individuals for environmental quality. There are thousands of applications of the method since its inception in the 1970s, and its use continues to rise in recent years due to the development of computational techniques. Basically, the model predicts that buyers choose properties based on structural characteristics (e.g., internal space, bedrooms, bathrooms, etc.) and location characteristics (e.g., air quality, distance near parks, educational institutions, or locations with lower flood risks). Assuming a competitive market, the location variation of environmental amenities is then evidenced in housing prices. The model has been improved over the years and has become one of the main techniques for valuing changes in environmental quality in academic research, litigation and public policy (Bishop *et al.,* 2020). Bishop *et al.,* (2020) notes that the starting point for the activity of hedonic price modeling is a survey that captures an exogenous variation in a specific environmental characteristic that can be enhanced by buyers (e.g., air quality). The author argues that under ideal conditions, the derivative of the hedonic price function can be interpreted as evidence of the indirect value to the environment, which can be used to calculate the so-called marginal willingness to pay for (WTPm) amenity. In the first instance, the process of estimating WTPm is apparently straightforward. However, in practice, several decisions need to be made to perform the modeling, including measures of sales prices and amenities and the choice of econometric specification (Bishop *et al.,* 2020).

Methodological Description

The hedonic pricing model was used for the environmental economic valuation of the protected area located in the municipality of Campina Grande, known as Parque do Poeta. For the application of the method, the housing asset was used as the complementary asset to the environmental quality offered by the protection of the natural area. In this sense, the environmental quality is interpreted as an environmental characteristic of the dwelling good, traded in a market, and represented by the function z = (z1, z2, ..., zn). Where according to Rosen (1974), the components of z, (z1, z2, ...,zn), can be measured objectively and represent in these values the perceptions of housing consumers regarding the quantities of the incorporated characteristics, such as environmental quality. In this case, Rosen (1974) points out that the assumption contained in this model is that a large amount of the characteristics of the housing good are available for choice among various possible combinations of the components zi of good z. That is, there is a hypothetical "basket of products" between the characteristics of housing and all other possible consumer products, x, in which choices can be made. Obviously, this assumption is not always valid, being in some situations better in some markets than in others. In the case of the research conducted, the characteristics z of the housing property were separated into three major groups of attributes, as stated in NBR 14653-6/2008. The structural characteristics (Ri), environmental characteristics (Ai) and socioeconomic characteristics of the region (SEi). According to that standard, the hedonic price function that will be measured for the environmental good will use "quantifiable characteristics that indirectly express the willingness to pay or receive for the environmental resource and its specific influence on the price of the good (Pi). The good referred to will be the housing good and the general expression of the function that relates the price of the good (Pi) to its characteristics, will be expressed by:

$$P_i = P(R_i, A_i, SE_i) \quad (1)$$

These characteristics were further divided into several other attributes for the specific type of housing adopted as the research cut, the multifamily residential units with elevator (apartments with elevator). The choice of this typology was due to the very structure of this dwelling, which makes it easier for the inhabitant to observe the natural environment, so that he/she can enjoy a more appreciable scenic view. Also, the external effects caused by urban violence are attenuated, not causing much influence on the individual's locational choice. For the structural characteristics were then initially considered the variables: floor, building area, building pattern and number of suites. For environmental characteristics it was considered: distance to the protected area and for socioeconomic variables it was used only the variable of average income of heads of household per neighborhood. According to Taylor (2008), one of the common characteristics that will happen with the housing consumer is that he will seek to obtain the maximum possible satisfaction with the consumed good. In economic theory, this appears as a problem of consumer utility maximization. In maximizing the utility of the housing consumer, some assumptions are made, such as that the differentiated good, that is, the good represented by the function z = (z1, z2, ..., zn), is sold in a perfectly competitive market and the interactions between producers and consumers will lead to a situation called optimal equilibrium price point. With this, the utility of the housing consumer is defined on two goods: z, the differentiated good that includes her environmental characteristics, and x, a composite good that represents all other goods (i.e., the income remaining after buying z). Consumer j, with demographic characteristics αj , then has his utility defined as:

$$U^j(x, z_1, z_{2,\ \dots\ ,} z_n\ ;\ \alpha^j) \quad (2)$$

Taylor (2008) demonstrates that the hypothetical consumer j will seek to maximize utility, choosing the differentiated good, z, and the quantity of units of x, subject to a budget constraint yj = x + P(z). Where y will be his income, x the quantity consumed of all other goods and P(Z) the differentiated good considered, the housing good that includes all its characteristics. In this case, the consumer will choose the basket of good (z; x) where the following situation is satisfied for each attributezi:

$$\frac{\partial P}{\partial z_i} = \frac{\partial U/\partial z_i}{\partial U/\partial x} \quad (3)$$

which tells us the marginal rate of substitution (MSR) between any characteristic, zi, and the composite good, x. For the characteristic of interest, the environmental quality of Poet's Park, we chose to measure its quantity through the distance to the park. In this, it is assumed that it is included all the perception that people have regarding the environmental goods and services offered by the protected area of study. This assumption may seem fragile on the surface, but it is implied that most individuals making housing choices do not take into account detailed aspects of all possible ecosystem services. However, they may take into consideration more general aspects of the environment, including for example in their decision making an idea about the improvement of air in a forested region or an increase in quality of life when it is possible to enjoy green spaces for recreation and contact with nature. All these aspects can be classified as air regulation services, climate regulation services and cultural services and were generalized in this research as a characteristic of environmental quality, which increases as the dwelling gets closer to the protected area. According to NBR 14653-6/2008, this measurement of the economic value of environmental goods and services by the hedonic price method can only capture the use values (VUD, VUI and VO) of these goods, this is done from Equation 4. In this research , this implicit value of the environmental quality of the protected area was measured by the following function:

$$MWTP = \frac{\partial P}{\partial Dist} \quad (4)$$

where MWTP is the marginal willingness to pay for the attribute of distance to the protected area and is measured by calculating the first partial derivative of the hedonic price function of apartments with elevator in Campina Grande by the variable distance to the protected area. The interpretation of this relation is given in the same way as the marginal rate of substitution, which will inform how much the consumer of apartments in Campina Grande - BR is willing to exchange monetary units for the proximity to a green area, that is, for the increase in environmental quality. The simplest formulation of the hedonic pricing equation, related to housing market behavior, is represented by:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik} + \varepsilon_i\ , \ \ i = 1, \ldots, m. \quad (5)$$

where: Y_1 ,...,Y_m - is called dependent variable, represented by the housing price; X_{i1},...,X_{ik} - are called independent variables, corresponding to the already mentioned structural characteristics, environmental and socioeconomic aspects. β_0,...,β_k are called parameters of the model and ε_1,...,ε_m are the random errors, which cannot be explained by explicit characteristics, reflecting the random dynamics of human behavior. The estimation of the population parameters (β) will be calculated through statistical inference, from a sample of real estate data of sale and supply of the market in Campina Grande - BR. The estimation will be calculated by the Ordinary Least Squares (OLS) method, which consists in minimizing the sum of squares of the distances, measured vertically, between the prices observed in the market and those adjusted by the adopted model (Dantas, 2003).

DATA

The data used in the research were obtained in partnership with the appraisal and engineering expertise company Proxy EngenhariaLtda, which operates in Campina Grande - BR and region since 2011. The sample obtained was 240 supply and sales data for properties of the apartment type with elevator, in twenty neighborhoods of the city between the years 2015 and 2020. The Figure 1 shows the geolocalized properties within the urban fabric of Campina Grande. The differences in the types of hatching indicate the average income of the neighborhoods (IBGE, 2010).The variables used were divided into two types: endogenous and exogenous variables. The endogenous variables are related to the structural characteristics of the properties, whereas the exogenous variables are related to the environmental and socioeconomic characteristics. The endogenous variables were collected by information transmitted by real estate brokers and the exogenous variables were obtained by measurement via GIS (Geographic Information System). The green star on the map represents the location point of the protected area of the study, other points with locations of environmental amenities in the city were also shown (yellow and blue star). The R language was used in the statistical calculations and in the construction of the graphs.

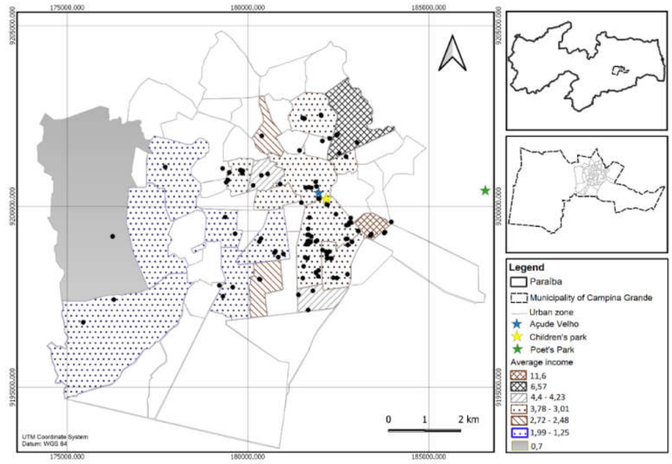

Figure 1- Data from geolocated apartments in the city of Campina Grande. Source: Elaborated by the authors.

Exploratory Data Analysis

The correlation matrix was used as a criterion for choosing explanatory variables and identifying multicollinearity problems. A correlation can be positive (r > 0), which means that when one variable is increasing the other is also increasing, or negative (r < 0), which means that when one is increasing the other is decreasing. The correlation can also be null or zero, which means that the variables are not related. Table 1 indicates the levels of correlation between the variables, ranging from null, weak, medium, strong, very strong to perfect.

Table 1- Correlation levels among the variables. Source: Dantas (2003).

Coefficient	Correlation
$\lvert r\rvert = 0$	nil
$0 < \lvert r\rvert \leq 0{,}30$	weak
$0{,}30 < \lvert r\rvert \leq 0{,}70$	average
$0{,}70 < \lvert r\rvert \leq 0{,}90$	strong
$0{,}90 < \lvert r\rvert \leq 0{,}99$	strong
$\lvert r\rvert = 1$	perfect

For the research, it was calculated the correlation matrix for the numeric variables of the chosen sample, the result is shown in

Figure 2. The choice of variables is an important process for the model construction. Thus, from the results found by the creation of the correlation matrix it was selected the variables that were used in the modeling, being the criterion for such selection, the value of the correlation coefficient Pearson with the value of the property being at the level of: medium, strong or very strong. The results show that the variables correlated with the value of the property at the strong or very strong level are: private area, construction standard and number of suites. The other variables are at an average level of correlation according to Table 1.One of the assumptions for the use of OLS to calculate the estimated parameters is that the independent variables must not have linear relationship between them. Thus, the use of correlation matrix can help in the identification of these relations.

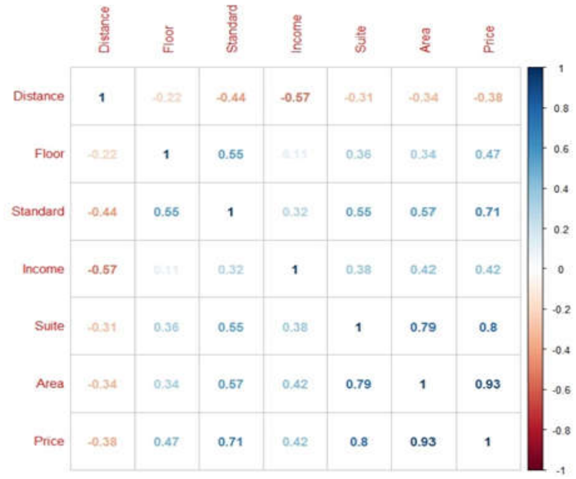

Figura 2 - Correlation Matrix. Source: Elaborated by the authors.

The scatter diagram graph is important to observe the relationship of the dependent variable with the respective independent variables in a Cartesian plane with two dimensions. Figure 3 shows the relationship of the dependent variable (Property Value) with the study variable (Distance to Protected Area). The points in the graph are separated by the building patterns existing in the sample. As expected, as we raise the constructive pattern, from normal (4) to high (6), the value of the apartments increases. When the shade decreases, the average income of the neighborhood where the property is located increases. It can be seen in Figure 2 that for normal/high standard and high standard apartments, the average rent is high when the distance to the protected area decreases. In this case, a decreasing trend with value is perceived. Contrary to the endogenous variables, the smaller the distance to the protected area, the higher the value, an inversely proportional relation. However, the dispersion is high mainly for properties closer to the protected area, which gives us an indication of a non-constant variance for the variable.

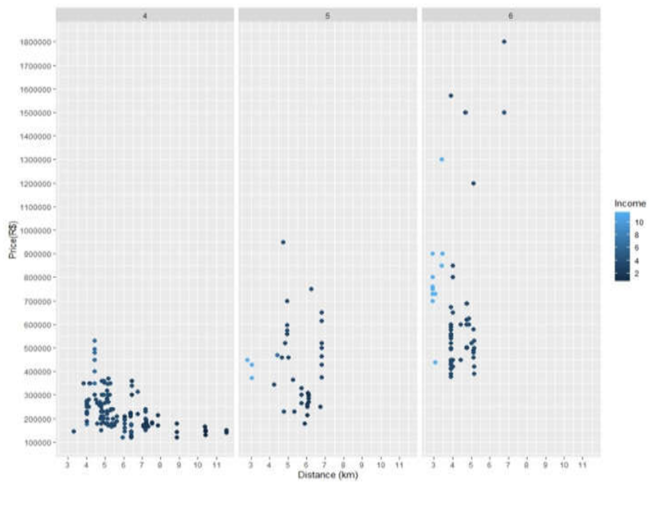

Figure2 - Scatter diagram. Source: Elaborated by the authors.

RESULTS

A linear regression model is characterized by the possibility of finding approximate linear relationships between two or more variables[1]. From it, one can make statements about factors involved in phenomena that are not directly observed in reality. In this case, the population parameters β are inferred from a given sample using the so-called method of ordinary least squares (MQO). The equation that arises represents a mirror of the phenomenon under study and with it we can find the relationships between the variables. In the study in question, the dependent variable considered was the value of the property (Y_1 ,...,Y_m) and the independent variables that were initially considered were the aforementioned endogenous and exogenous variables (X_{i1},...,X_{ik}). In order for these calculated parameters (β_k) to be non-biased, efficient and consistent, some assumptions about the independent variables (X_{i1},...,X_{ik}), the residuals and the model specification must be met. The first of these is that the independent variables must contain no random disturbance and no linear relationship between them. The second is that the residuals must satisfy the assumptions of constant variance, normality and absence of autocorrelation. And lastly, that only significant independent variables are included in the composition of the model, and that the scales of the variables are chosen so as to ensure the linearity of the model (Dantas, 2003). According to Dantas (2003) the lack of normality is common in real estate prices, because they are inserted in the field of positive reals, while the normal distribution covers all real numbers. Regarding heteroscedasticity, for the author it is natural that it occurs in real estate data, due to the variability of the budget constraint of consumers of this good, so as to produce a tendency of greater dispersion for higher prices than for lower prices. To mitigate this problem, the author suggests that the log transformation (logarithmic transformation in the Neperian base) in prices may be sufficient to stabilize the variance and normalize the residuals. Another important aspect considered by Dantas (2012) on the logarithmic transformation in the models of real estate values concerns the possibility of leaving the multiplicative, a characteristic subjected by the Brazilian technical standards that deal with the valuation of property (NBR: 14653-3/2006). The coefficients β_1 and β_5 are, in this new scenario, the price elasticities of apartments in relation to their private area and distance to the protected area respectively and the coefficients β_2, β_3 and β_4 are called semi-elasticities of the price in relation to number of suites, building pattern and floor (Wooldridge, 2016). In this case, the coefficient β_2 is the change in the log of the price when the number of suites changes by one unit, β_3 is the change in the log of the price when the building pattern changes level and β_4 is the change in the log of the price when the floor changes by one floor.

$$\text{Log(VALUE)} = 8.66 + 0.89*\text{Log(AREA)} + 0.05*\text{Nº SUITE} + 0.18*\text{STANDARD} + 0.01*\text{FLOOR} - 0.12*\text{Log(DIST. PROTECTED AREA)} \quad (6)$$

According to Wooldridge (2016) to better interpret the calculated model, it is necessary to multiply the coefficients on a linear scale by 100, and thus we will have the approximate percentage change in price when the independent variable is increased by 1 unit. The change in variables with logarithmic scale occurs in percentage form. Thus, when the distance to the protected area increases by 1%, the price of the apartments decreases by 0.12%, keeping the rest of the variables fixed.

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[1] According to Gujarati (2021) the term linear used in the expression "linear regression" means a linear characteristic of the parameters and not of the variables; the β (i.e., the parameters) are raised only to the first power. In this case the dependent variables, the X's, may or may not be linear.

Table 2- Regression results for Model 3. Source: Own elaboration.

	Coefficients	Standard Error	p-value
Intercept	8,66	0,53	<0,05
log(Area)	0,89	0,05	<0,05
Nº Suites	0,05	0,02	<0,05
Standard	0,18	0,02	<0,05
Walk	0,01	0,00	<0,05
log(Dist. Protected Area)	- 0,12	0,05	<0,05
Observations	233		
R²	0,919		
Adjusted R²	0,918		
Residual standard error	0,16		
F-statistic	434,60		
P-value	<0,05		

From Table 2, we can observe that the calculated model had a power of explanation of approximately 91.8 % (adjusted R²), slightly better than the first model calculated, which was 91.7 % (Table 2). This is mainly because it contains variables that are statistically more important to explain the value of the properties. We can then state with respect to the calculated model that 91.8% of the variation in the value of the apartments in the study can be explained by the variables present. That is, the built-up area, the number of suites, the building pattern, the floor and the distance to the protected area can explain 91.8% of the value of the properties. With this, we also extract that 8.2% of the variability in prices are explained by other variables.

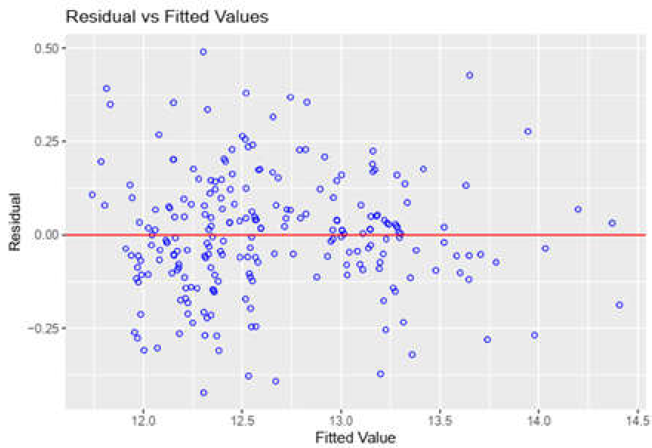

Figure 4 - Chart of standardized residuals versus adjusted values of model.
Source: Elaborated by the author.

In the graph of the values adjusted by the residues (Figure 4), it is noticed a better distribution of points indicating a possible homogeneity of variance, which tells us that the hypothesis of homoscedasticity is being met for this model. Similarly to the Model, the homoscedasticity was tested through the statistical test Breusch Pagan Test. The calculated probability was 0.2603998, being higher than the adopted significance level of 5%. In this case, the null hypothesis H0 is accepted and it is assumed that the model has a constant variance, i.e., the hypothesis of homoscedasticity is accepted.

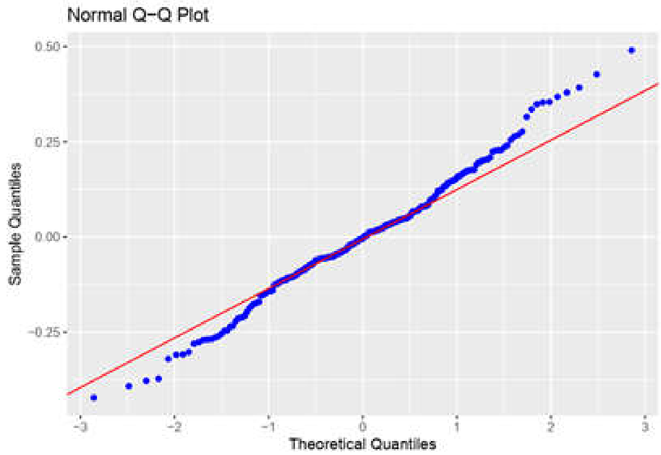

Figure 5 - Normal Q-Q plot of model 1. Source: Elaborated by the authors.

For the normality hypothesis it was used the Q-Q plot, which detects the normality assumption (Figure 5). As shown, the quantiles of the probability distribution of the residuals are much closer to the normality line than in the previous model shown. This gives us indications of the normality of the model's residuals. Another way used to detect the normality of the residuals was through the statistical tests previously shown (Appendix 1). In two of the tests (Shapiro-Wilk and Kolmogorov-Smirnov) we see that the p-value is greater than 0.05, thus we accept the null hypothesis that the residuals behave normally. For the hypothesis of absence of auto-correlation between residues we used Durbin-Watson statistical test. The result found for the probability p-value was 9.025*10-7. The value of the DW statistic was 1.3979, less than 2, which indicates a positive serial autocorrelation of the residues. In this case, according to Dantas (2013), the serial autocorrelation present in the model is not a problem for the estimation.

Discussion Of The Results

One way to interpret the model, according to Dantas (2013), is to make it multiplicative, thus taking the natural logarithm of the equation. For this, the eponential was applied on both sides of Equation 7. The result obtained was as follows:

$$VALUE = 5.767,53 * AREA^{0,89} * 1,05\ Nº\ SUITES * 1,20\ STANDARD * 1,01\ FLOOR * DIST.\ PROTECTED\ AREA^{-0,12} \quad (7)$$

From Equation 7 we can draw some statements regarding the relationship between the study variable, distance to the protected area, and the real estate market in Campina Grande. By interpreting the equation, we realize that when the distance increases by 1%, the price decreases by 0.12%. That is, the proximity to the protected area makes the value of the property increase by 0.12%. Thus, it can be seen that there is evidence that proves a real estate valuation caused by the existence of the protected area of the study. By plotting the curve of value versus distance from Equation 7, keeping the other variables fixed, this evidence can be seen graphically (Figure 6). Furthermore, we can analyze Figure 6 in a similar way to a demand curve. In this case, for each distance to a property's protected area, Equation 7 tells us what the value of that good that individuals choose for that location should be. For example: to live in a location that is 3.5 km from the green area individuals in Campina Grande are willing to pay approximately R$ 300,000.00, analyzing by the blue curve.

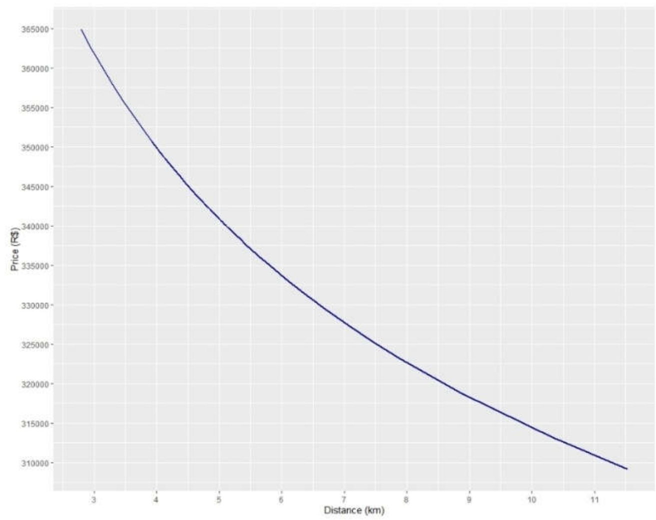

Figure 6 -Graph of value versus distance to protected area. Source: Elaborated by the authors.

In this perspective, we can also calculate the marginal willingness to pay that the economic agents involved in the real estate market in Campina Grande have for the environmental quality offered by the protected area. In this case, we will suppose that we are interested in apartments of normal standard (4) with private area of 100m², one suite and on the sixth floor. For this, we obtain a constant value, using Equation 7, of 803,216.07. Thus, through the first derivative of the function we find the marginal willingness to pay, which will be the rate of change for a 1m increase in distance. Thus, Equation 7 takes the following form:

$$MWTP = \frac{\delta P}{\delta Dist} = -96.385{,}93\ xDist.\acute{A}reaProtegida^{-1{,}12} \quad (8)$$

The negative sign indicates that the apartment consumer in Campina Grande is willing to substitute an extra monetary value for housing with higher environmental quality, that is, closer (less distance) to the protected area. In module, Equation 8 also shows that the marginal willingness to pay decreases as the apartment moves further away from the protected area (Figure 7). That is, we can state that the proximity to the protected area makes the benefit of this area perceived by people more sensitively. This is entirely reasonable, given that someone who lives closer to a valued area has a greater perception of the benefits of this location.

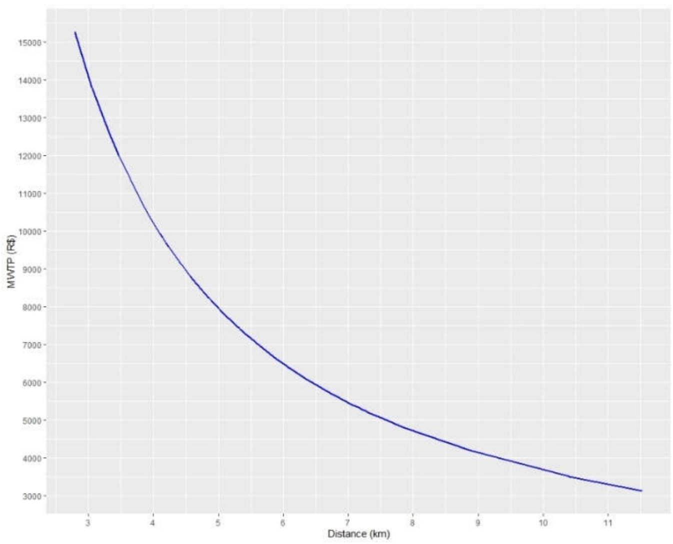

Figure 7 - MWTP versus distance to protected area graph. Source: Elaborated by the authors.

The results found differ from some research that has been conducted elsewhere in the world. In the survey by (Luttik, 2000) for example, the effect of an attractive landscape in that time period influenced property values by 5 to 12 %, much higher than what was found. (Morancho, 2003) estimated in his research that in the city of Castellón, Spain, when the property is 100m away from a green area the housing price can fall by 1800 Euros. For the city of Campina Grande, this variation in the value of the increase in 100m distance to the Parque do Poeta falls by approximately R$ 1.000,00 (160,00 €). These differences found in other cities in the world may have various causes, ranging from micro-scale influences, such as the structure of the real estate market in Campina Grande, which contains few supply agents, as well as the fact that part of the local population is unaware of the existence of the area, to macro-scale influences, such as the existing institutional weakness in Brazil that contributes to environmental degradation, as shown in the study by (Abman, 2018) in which he indicates a positive correlation between the establishment of democracy, protection of property rights and low levels of corruption with greater effectiveness in the governance of protected areas.

CONCLUSION

The objectives of the work were answered by the scientific methods shown, highlighting the relevance of this protected area in the perception of the real estate market of apartments in Campina Grande, in which are included all the people who perform transactions involving this type of good and who in their housing choice process take into consideration aspects of environmental quality, offered by the Parque do Poeta. From the results found we can observe possible causes of the institutional fragility of the Parque do Poeta, which show a low adhesion of the agents involved in the real estate market, reflected in the measured value of the parameter of the variable distance to the protected area. This value indicates the perception of the importance of having a protected green area close to one's place of residence. As the people involved in this market increase their desire to have a green area with a preserved nature accessible near them, there will be a positive variation in the value of the parameter, i.e., the impact of this area on real estate prices will increase. The need to use valuation techniques is felt when the public agent needs to apply the so-called Payment for Environmental Services (PES) for a protected area with a view to financing its protection. To this end, the work measured the benefits of the Poeta Park in monetary terms through an indirect technique of the same, the hedonic pricing method. The impossibility of using market mechanisms to measure the value of a public good led us to use a complementary good, the housing good, to from there arrive at the value of the protected area. In this paper, the economic value of the protected area was understood as the marginal willingness to pay for environmental quality, understood as a function of the proximity of the apartments to the protected area. The marginal willingness to pay was calculated in relation to the distance of the apartments from the Parque do Poeta. From it was found that the variation of willingness to pay for a natural environment in Campina Grande is higher when approaching the area. Finally, the work in question sought to contribute to the dissemination of protected areas in Brazil and also to expand the possibilities for more effective governmental actions. The importance of knowing the economic theory is important when the public agent is going to make a decision that will cause changes in market relations. Sometimes these actions that aim to increase the welfare of individuals can generate unexpected effects. In this sense, the application of PES needs to be studied in all its aspects and its possible impacts on the local society. Considering that in Brazil there is already a high tax burden and the implementation of new taxes tends to be frowned upon by the population, even if they are justified as something that really benefits everyone. This research tried to bring to this debate a technical approach to the issue that aims to legitimize the future application of PES in Parque do Poeta. Furthermore, the work was limited to the preliminary phase of PES application, the environmental economic valuation, and a specific theoretical methodological contribution was used, leaving open for future work to address possible forms of its application, as well as the use of other methodologies that will deepen the understanding of the phenomenon.

REFERENCES

Abman, R. (2018). Rule of Law and Avoided Deforestation from Protected Areas ☆.Ecological Economics, 146(August 2017), 282–289. https://doi.org/10.1016/j.ecolecon.2017.11.004

ABNT (2008). NBR 14653-6: Avaliação de bens: Parte 6: Recursos Naturais e Ambientais. Rio de Janeiro.

Bishop, K. C., Kuminoff, N. V, Banzhaf, H. S., Boyle, K. J., Gravenitz, K. Von, Pope, J. C., … Timmins, C. D. (2020). Best Practices for Using Hedonic Property Value Models to Measure Willingness to Pay for Environmental Quality. 14(2), 260–281. https://doi.org/10.1093/reep/reaa001

Bruce, P., & Bruce, A. (2017). Practical statistics for data scientists: 50 essential concepts. O'Reilly Media, Inc.

Chang, W. (2018). R graphics cookbook: practical recipes for visualizing data. O'Reilly Media.

Costa, N., Aleixo, R., Bragagnolo, C., Campos-silva, J. V., Jepson, P. R., James, R., … Malhado, M. (2019). Are Protected Areas undervalued ? An asset-based analysis of Brazilian Protected Area Management Plans.Journal of Environmental Management, 249(January), 109347. https://doi.org/10.1016/j.jenvman.2019.109347

Dantas, R. A. (2003). Modelosespaciaisaplicadasaomercadohabitacional um estudo de casoparacidade do Recife. Tese (DouturadoemCiênciasEconômicas) - Universidade Federal de Pernambuco.

Dantas, R. A. (2005). Engenharia de Avaliações: umaintrodução à metodologiacientífica. Pini.

Félix, A. C. T., Fontgalland, I. L., Limeira Filho, A. A., Pereira, A. P., & de Fátima Martins, M. (2021). Mobilidadeurbana no contexto do município de Campina Grande/PB: umaabordagem à luz do paradigma das cidadessustentáveis. RevistaIbero-Americana de CiênciasAmbientais, 12(2), 725-732.

Félix, A. C. T., & Fontgalland, I. L. (2021).Custoseconômicos da diminuição dos serviçosecossistêmicosnasunidades de conservação da Amazônia.RevistaIbero-Americana de CiênciasAmbientais, 12(2), 715-724.

Félix, A. C. T., & Fontgalland, I. L. (2021).Áreasprotegidas no Brasil e no mundo: quadrogeral de suaimplementação. Research, Society and Development, 10(12), e187101219970-e187101219970.

Frör, O. (2007). Rationality Concepts in Environmental Valuation. Peter Lang International Academic Publishers.

Gujarati, D. N. (2021).Essentials of econometrics. SAGE Publications.

Luttik, J. (2000). The value of trees , water and open space as reflected by house prices in the Netherlands. 48, 161–167.

Morancho, A. B. (2003). A hedonic valuation of urban green areas. 2046(December 2003). https://doi.org/10.1016/S0169-2046(03)00093-8

Rosen, S. (1974). Hedonic Prices and Implicit Markets : Product Differentiation in Pure Competition Author (s): Sherwin Rosen Published by : The University of Chicago Press Stable URL : https://www.jstor.org/stable/1830899 Hedonic Prices and Implicit Markets : Product Differentiation in Pure Competition. 82(1), 34–55.

Seabra, D. M. S. (2016). AMENIDADES URBANAS E VALOR DAS RESIDÊNCIAS : UMA ANÁLISE EMPÍRICA PARA A CIDADE DO RECIFE. 143–169.

Taylor, L. O. (2008). 1 Theoretical Foundations and Empirical Developments in Hedonic Modeling. (2005), 15–37. https://doi.org/10.1007/978-0-387-76815-1

Wickham, H., & Grolemund, G. (2016). R for data science: import, tidy, transform, visualize, and model data. O'Reilly Media, Inc.

Wooldridge, J. M. (2016). Introductory Econometrics.

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