Department of Economic Sciences

Bachelor's degree in economics

Professional Acting Seminar

Effects of the contamination of the Reconquista River on the prices of rental properties for housing:

Evidence in the municipalities of Moreno and Merlo

Author: Lucas Ariel Enrich *Delivery Date: December 8, 2020*

Index

Theme:

The externalities resulting from the contamination of the Reconquista River and its link with the variations in the rental price of real estate for housing.

1. Introduction

The economic value of the environment is a complex problem because there is no direct market in which the price can be determined. From this problem, there are two approaches from economics sciences, the “ecological economy” that uses the principles of physics and the “environmental economy”, which uses the market principles to carry out environmental evaluations (Gorostiza, 2005)

Ecological economics thinks of the relationship between the economy and the environment as an open system of matter and energy. This approach is based on the principle of “*strong”* sustainability, which means that manufactured capital (both physical and human) and natural capital are complementary.

Environmental economics, in contrast, understands that manufactured capital and natural capital have some degree of substitutability, this means that advances in technology and capital investments are capable, to a certain extent and in certain circumstances, of replacing the services that provides the environment, so investments in the present (such as the development of technology in solar energy) have the capacity to sustain future consumption (in the example, of electricity when non-renewable fuels run out). This is the definition of the principle of "*weak”* sustainability, the substitutability between manufactured and natural capital.

This discipline seeks to value in monetary terms the services provided by nature using market analysis tools in order to incorporate them into the production and utility functions of agents to operationalize the problem of monetary measurement of the value of the environment, which can affect decision-making in both the public and private spheres.

The Reconquista River functions as a boundary between the parties of Merlo and Moreno. It is born at the confluence of the La Choza, El Durazno and La Horqueta streams, where the Ingeniero Roggero dam is located; and ends at the fork where the Reconquista Chico and Río Tigre are born. In total, the river is approximately 50 kilometers long.

Merlo and Moreno are two municipalities in the Greater Buenos Aires, 9% of the households in Moreno live in rented real estate according to the 2010 census, in the case of Merlo this number rises to 10%.

The rental value of real estate for housing is given, in addition to its structural characteristics (size, number of rooms and bedrooms, availability of garage, age, etc.), due to the heterogeneity of the environmental characteristics (both ecological and availability of access to urban services), which determine the well-being of the population that inhabits it. These characteristics make the demand for rentals for housing purposes partially a demand derived from these environmental-territorial services (Freeman, 1979).

In this sense, the rental price, among other things, depends on the environmental quality and, if it deteriorates, is expected to negatively affect prices, *ceteris paribus* the other price determinants.

1.1 Problematic situation:

The reports of the Reconquista River Commission (COMIREC, 2018) indicate that the origin of the contamination of the river and its tributaries is due to the fact that the discharge of polluting loads exceeds the purification capacity. Among the pollutants are organic and inorganic waste, coming from inadequate sewage drains, water from household cesspools and industrial waste without proper treatment, which fills up with solid and semi-solid waste that affects both surface and groundwater.. These pollutants, generated by economic agents that do not assume the cost of due treatment, constitute the negative environmental externality.

This situation worsens the quality of life of the population residing near the river. And given that 9% of Moreno's households and 10% of Merlo's live in a rented property (according to the 2010 census), the empirical verification of howo This phenomenon affects rental prices for housing, it may contribute to both the municipal authorities and the Reconquista River Commission authorities to incorporate it into the cost-benefit analysis of sanitation tasks.

1.2 Hypothesis:

Pollution is an externality that reduces the economic value of the lands attached to the Reconquista River because the tenants will be willing to pay a higher price to get away from the pollution and the owners will have to lower prices to attract them. This causes real estate rental prices for housing purposes to fall depending on its proximity to the river, the magnitude of this variation consists of the externality of environmental pollution

1.3 Objectives

1. Analyze the implicit marginal price of the Reconquista River as a function of distance
    1. Quantify the externality from the implicit marginal price obtained.
    2. Investigate the existence of the distance from which the implicit marginal price loses significance.
    3. Analyze the effect on urban census radius that could have properties whose rental price is reduced.

2. Theoretical Framework

2.1. Environmental and Ecological Economics

Quantifying the economic value of the environment is a complex problem because there is no direct market in which the price can be determined. Based on this problem, there are two approaches from economics, the "environmental economy", which uses market principles to carry out environmental evaluations, and the "ecological economy" that uses the principles of physics (Gorostiza, 2005)

Ecological economics thinks of the relationship between the economy and the environment as an open system of matter and energy. This approach is based on the principle of "*strong"* sustainability, which means that manufactured capital (both physical and human) and natural capital are complementary.

Environmental economics, in contrast, understands that manufactured capital and natural capital have some degree of substitutability, this means that advances in technology and capital investments are capable, to a certain extent and in certain circumstances, of replacing the services that provides the environment, so investments in the present (such as the development of technology in solar energy) have the capacity to sustain future consumption (in the example, of electricity when non-renewable fuels run out). This is the definition of the "*weak"*sustainability principle, the substitutability between manufactured and natural capital.

This discipline seeks to value in monetary terms the services provided by nature using market analysis tools in order to incorporate them into the production and utility functions of agents to operationalize the problem of monetary measurement of the value of the environment.

2.2 The Total Economic Value

Environmental economics recognizes the "Total Economic Value" of the environment (World Bank; 2004). It is understood that nature provides a certain amount of environmental services which can be globally categorized into use values and non-use values.

The use value corresponds to the utility that people perceive when they consume the environmental services mentioned to satisfy a need, these can be:

- Direct use, the environment provides environmental services that agents consume directly. These environmental services can end with the use or not, in which case we speak of consumptive use or non-consumptive use. An example of the first could be wood for furniture, of the second - using a river for recreational swimming.

- Indirect use, are those that are derived from the ecosystem and provide benefits outside of it, such as carbon sequestration by forests.

- Option values: This includes what individuals are willing to pay for the conservation of the environment for future use. Either for the generation itself or for the next generation (inheritance value).

Non-use values recognize the utility that comes from knowing that a natural resource exists, even if it will never be used, it is also called passive use value (World Bank; 2004).

Other non-use values are (Azqueta, 2002):

- Benevolence, the environmental good is valued because it is considered that other close people (family and friends) value it.

- Sympathy, which reveals the value of the sympathy that is had for the victims of natural disasters, even if they are not close friends.

- Symbolic, a natural resource can be part of cultural identity and is valued as such.

- Intrinsic, which recognizes the right of life of other forms of life for which its ecosystem is valued.

So the total economic value (TEV) is:

VET = Use Values + Non-Use Values

With this concept of value in mind, environmental economics proposes different valuation methods for monetary quantification, which allow us to approximate these mentioned values and, in the presence of the environmental externality, to quantify how much the utility of environmental services is reduced, measured in monetary terms.

2.3 Environmental Assessment Methods

Within environmental economics, two general valuation approaches are used: direct valuation, which are based on the stated preferences of the agents (for example, through surveys which gives rise, for example, to the contingent valuation method), and those of indirect valuation, which are based on revealed preferences, exploiting the link that the environment has, which does not have an explicit market, with a good that does; This link can be one of complementarity or substitutability (Cristeche, Penna; 2008).

In the case of the valuation of the environmental damage generated by the production of a good or service whose producer is not incorporated into its private costs and that causes damage to people outside the market of said good or service, it turns out that the social cost is greater than private, giving rise to externality.

The hedonic price method is an indirect valuation method that makes use of the weak complementarity between the environment and the market good to determine the implicit price of environmental services and externalities. The method was formalized by Rosen (1974) and is recognized nationally by INTA

(Cristeche, Penna; 2008), regionally by CEPAL (Vazquez, 2017) and internationally by international organizations such as the World Bank (Bolt, Ruta & Sarraf. 2005). The method has been used recently to assess the increase in crime in Acapulco, Mexico (Delgado, Wences; 2019), the environmental services in peri-urban areas in Wroclaw, Poland (Sylla, Lasota, Szewrański; 2019) and to assess the availability of its inhabitants to pay for sewers in Accra, Ghana (Amoah, Moffatt; 2017).

2.4 Determination of the price in multi-attribute goods

In the context of hedonic prices, the environmental variable is incorporated in the determination of the price of the related good, which is considered a multi-attribute good formed by $p(z) = p(z_1, z_2, \dots, z_n)$, where z is the related good and each $z_n$it is an attribute that contributes to the price. Rosen (1974) proposed the method in two stages: First, estimate the price function P (z) and then, if the environmental variable isz_k, the partial derivative of this estimate as a function of z_k It consists of the implicit marginal price of the environmental good, which corresponds to the market's willingness to pay for environmental services (Chay and Greenstone, 2005), which is equivalent to the monetary value of the externality.

To analyze market equilibrium in this context, Rosen (1974) formalizes the analysis of supply and demand.

To analyze the demand, part of the utility of a good, in this case the houses, which is given by n objectively observable characteristics, so that each good can be represented by a vector $z = (z_1, z_2, \dots, z_n)$. Every good z, in addition, has a market price, which depends on these characteristics $p(z) = p(z_1, z_2, \dots, z_n)$ with the particularity that each vector of characteristics is sold packaged, which means, for example, that two departments of a room do not equal one department of a room.

Each consumer, in this market, maximizes a utility given by $u = (z_1, z_2, \dots, z_n, X)$where X is the utility for consuming the multi-attribute good, that is, the utility of the whole is X more than the utility of the parts, this maximization is subject to the budget constraint

$max[u(z_1, z_2, \dots, z_n, X)]$ subject to $M = X + p(z)$

Where X is assumed to be unit price and M is income. The first order condition is:

$$\frac{\partial u_{zi}}{\partial u_X} = \frac{\partial p}{\partial z_i}; i = 1, \dots, n$$

Where the left side of the equality is the marginal rate of substitution between the characteristic z_i and money (remembering that the price of X is unit), and the right side is the implicit marginal price.

Rosen (1974) defines the consumer supply function[1] $\theta = (z, u, y)$ from which it is obtained:

$$\frac{\partial \theta}{\partial z_i} = \frac{\partial u_{zi}}{\partial u_X}$$

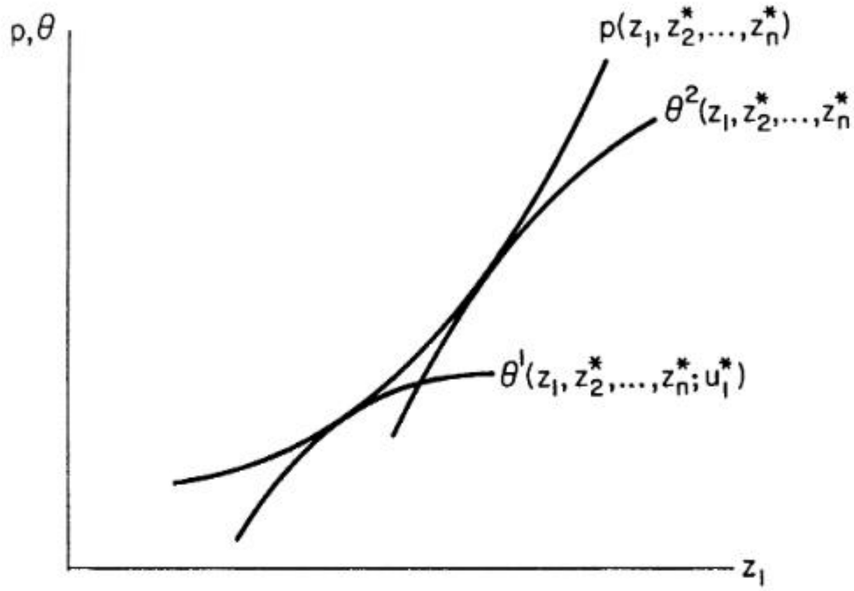
Finally, utility is maximized when:

$$\frac{\theta}{z_{zi}}(z^{eq}, u^{eq}, y) = \frac{\partial p(z^{eq})}{\partial z_i}; i = 1, \dots n$$

Where, z^{eq} Y u^{eq} are optimal.

[1] The consumer supply function or *bid function*, defines how much a consumer is willing to pay for the good z, given an income y, and a fixed utility index u

Regarding the offer, each owner or owner, intends to maximize the profit:



*Graphic 1 In l*the figure shows the consumers θ_1 Y θ_2, *the characteristics* (z_2 * … Z_n *) and the utility *u * are optimal, it shows the quantity demanded at different prices of* z_1 according to its indifference curves, and the price curve p (z *) that shows the equilibrium price for each level of z_1Source: Rosen (1974)

$$max(\pi) := N * p(z) - C(z, N, \beta)$$

Where N is the quantity sold (in the case of a real estate company, whoever sells it may be greater than 1), p (z) is the price and C (z, N) are the costs. The first order conditions in this analysis are:

$$\frac{p}{z_i} = \frac{C_{zi}}{N}, i = 1, \dots n$$

$$p(z) = C_N$$

The first equation indicates that the implicit marginal price of each characteristic z_i is equal to the marginal cost of its production, and the second that the price of a unit of z is equal to the total cost of production.

In the same way that you define the consumer supply function, define the producer supply function[2] $\phi = (z, \pi, \beta)$, from where you get:

[2] *offer function*, the price per unit that the producer is willing to accept with a constant profit and where the quantity produced is optimal.

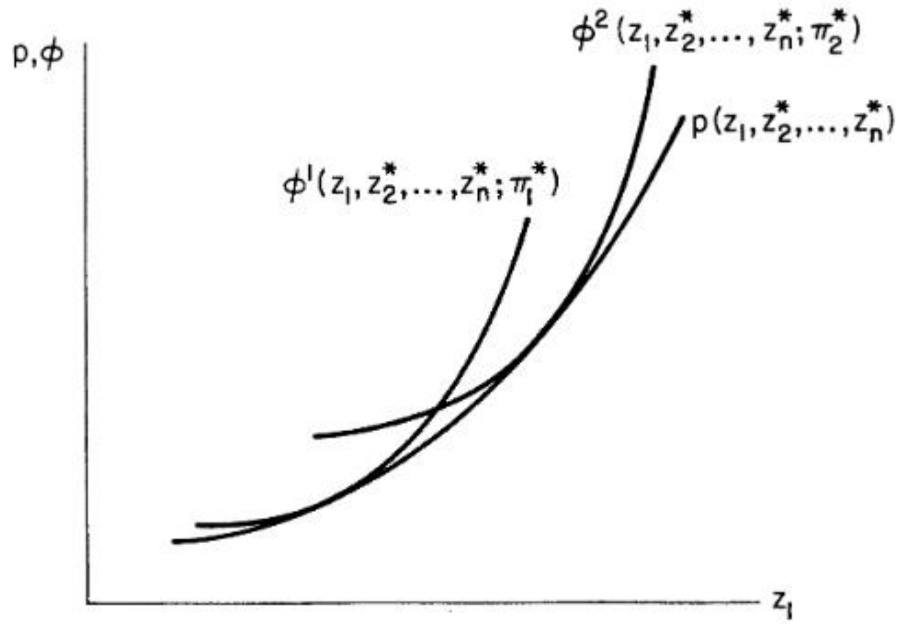
$$\frac{\phi}{z_i} = \frac{C_{zi}}{N}$$

As in the case of the consumer, the producer optimizes in:

$$\frac{\partial \phi}{\partial z_i}(z^{eq}, \pi^{eq}, \beta) = \frac{\partial p(z^{eq})}{\partial (z_i)}, i = 1, \ldots n$$

Y

$p(z^{eq}) = \phi(z^{eq}, \pi^{eq}, \beta)$



Graphic 2 Producers are shown in the figure ϕ_1 Yϕ_2, the characteristics (z_2 * … Z_n *) and the profit pi * are optimal, it shows the quantities of z_i that they are willing to offer at different prices of z_1, and the price curve p (z *) showing the equilibrium price for each level of z_1Source: Rosen (1974)

Finally, the market equilibrium occurs in the tangency of the producer supply functions and the consumer supply functions, which gives rise to the equilibrium price formation function of good z.

2.5 The real estate market

While so far the price formation of multi-attribute goods in general has been discussed, Freeman (1974) develops the analysis on the real estate market in particular and how it can be used for the valuation of the characteristics of the neighborhood. It is understood that the good the vector of characteristics of the good, in the general framework is,$z = (z_1, z_2, ..., z_n)$, while in particular the real estate market is:

$$P_h = f(S_h, N_h, X_h)$$

Where :

P_h = is the property price

S_h = are the structural characteristics of the house, for example: meters, rooms, among others

N_h = are the characteristics of the neighborhood.

X_h = are the characteristics of the environment, in this case, the proximity to the river

If the market is competitive and prices are in equilibrium, the bidders are the accepting price, and the implicit marginal prices are equal to the willingness to pay for these characteristics by consumers.

Then, the aforementioned author makes some clarifications regarding the required state of the market for this process to result in the implicit marginal price and says:

"... divergences from the complete equilibrium of the housing market in many circumstances will only introduce random errors in the willingness to pay ..." (Freeman, 1974)

His analysis continues for the necessary assumptions so that the method can be applied to the empirical valuation of environmental goods, these assumptions are summarized and updated by Gilbert (2013):

<u>Completeness</u>: All combinatorics of $z = (z_1, z_2, ..., z_n)$possible are on the market. Although this assumption is considered fulfilled if there are no significant missing and the combinatorics that exist are sufficiently varied

<u>Availability</u>: All properties for sale are available to all buyers, this simply indicates that the market is unified and that there are no extra-economic restrictions to enter.

<u>Market power</u>: The bidders must be accepting prices, the method cannot be applied in cases of monopolies or oligopolies.

The Argentine real estate market has some peculiarities that must be taken into account when complying with these assumptions and obtaining the necessary data:

Regarding the price to be taken as a dependent variable, Cristeche and Penna (2008) indicate three possibilities: transaction prices, consultation with experts, and consultation with owners.

The data available from two of the largest websites in the country in the real estate market (ZonaProp and Properati) are mostly offered by real estate companies or their own owners, which is directly equivalent to consulting experts and owners respectively. The problems with these prices have to do with potential biases, particularly in the sales market, where the published price does not necessarily correspond to the transaction price. But if these differences are independent of the variable of interest (in this case, the proximity to the river), the estimator is also unbiased (Ranconi, Casazza, Monkkonen, Reese; 2015).

The method implicitly also assumes non-prohibitive transaction costs, so that mobility can be made effective since if the transaction cost is greater than the availability to pay by a cleaner means, this preference will not be revealed..

Cristeche and Penna (2008) recommend the use of the rental market for the application in our country since, as they have a higher turnover, the published prices are more up-to-date. The housing rental market has the additional characteristic that the published offer price corresponds to the transaction price (compared to the purchase-sale market), has a considerable greater mobility and significantly lower transaction costs than the purchase-sale market. .

Finally, it is relevant to incorporate some measure that normalizes the willingness to pay for the economic status of the affected people because the willingness to pay is a direct function of the ability to pay. In this sense, the Unsatisfied Basic Needs Index (NBI) (Ranconi, Casazza, Monkkonen, Reese; 2015) or per capita income (Cristeche and Penna; 2008) has been used.

Although, when the area analyzed does not have a significant variation in income, it is not always incorporated in the estimation by hedonic prices, for example, in the estimation of willingness to pay for sewers in Accra, Ghana (Amoah, Moffatt 2017), or the impact of increased crime in Acapulco, Mexico (Delgado, Wences, 2019).

In section 3. it is found that the method applied to the real estate rental market for housing purposes meets the necessary assumptions and its results can be interpreted as the willingness to pay for environmental services.

2.5 State of the Art

An additional problem in the specification of the estimate, are the omitted variables that are linked to the general environmental context (spatially autocorrelated errors) and the endogeneity of the price (the effect that the neighbor's price has on a given property), which can generate a relevant bias, which required developments to update the framework presented by Rosen (1974). To deal with this problem (Kelejian & Piras chap 1, 2017), it is possible to incorporate variables that reflect such a situation into the specification of the model:

$$y = \rho W y + \beta X + e$$
$$e = u + \lambda W u$$

Where W is a proximity matrix formed by the elements w_{ij}which, in its two most used forms are:

$w_{ij} = 1$= 1; if “i” is a neighbor of “j”, 0 otherwise

$w_{ij} = 1/d_{ij}$, where d_{ij} is the distance between “i” and “j”, in meters or kilometers (this being the most common metric of “closeness”)

While Wy captures how much the price of a property depends on the price of neighboring / nearby properties (price endogeneity), measured through ρ, and Wu captures the effect of omitted variables (error with spatial autocorrelation), measured through λ

3. Analysis

3.1 Characterization of the area under analysis

Reconquista River

The reports of the Reconquista River Commission (COMIREC, 2018) indicate that the origin of the contamination of the river and its tributaries is due to the fact that the discharge of polluting loads exceeds the purification capacity. Among the pollutants are both organic and inorganic waste, coming from inadequate sewage drains, water from household cesspools and industrial waste without proper treatment, which fills up with solid and semi-solid waste that affects both surface and groundwater.

Works such as the aforementioned dam, canalization of channels and construction of embankments were necessary to prevent the flooding of the river from causing flooding in populated areas.

The contamination status of the Reconquista River causes negative effects of various kinds. Pollution is considered to mean a reduction in the environmental services produced by the river (to the point of generating disutility), becoming an externality that negatively affects the rental prices of nearby properties.

Merlo and Moreno

The municipalities under analysis are the first municipalities (since the river is born in them) to face high levels of environmental pollution on the banks of the reconquered river. The COMIREC reports mentioned indicate that upstream (in the Reconquista tributaries) there are areas where there is agricultural development and it is where there is greater biodiversity, which is an indicator that the contamination before Merlo and Moreno is less. The analysis is taken as a whole because the Reconquista functions as a political boundary between the two.

Table 1 shows that they are municipalities with high population density, as a whole they have 4566 inhabitants / km², while the average for the metropolitan area of Buenos Aires is 3342 inhabitants / km² (2010 Census, INDEC), where approximately 10 % of homes are rented

General characteristics of the municipalities Merlo and Moreno

	Merlo	**Brown**	**Total**
Municipality Area (km²)	170	46	216

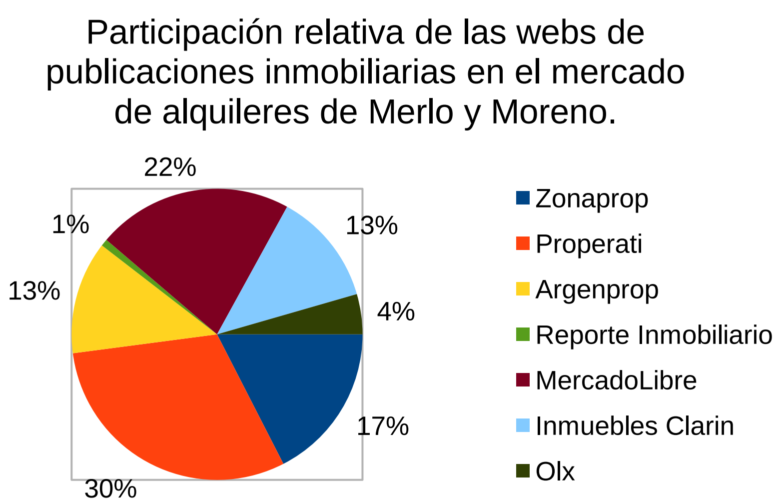
Number of households	135383	114125	249508
Population Density	3084	10049	4566
Number of Tenant Households	14926	11171	26097
Number of Tenant Households%	11.03%	9.79%	10.46%

Table 1 Own elaboration based on data from the 2010 Census (INDEC)

3.2 Construction of the database

3.2.1 Data sources for rental properties

The data collection of real estate for housing purposes was carried out via two sources of virtual publication of rentals on the ZonaProp and Properati websites, which add up to 47% (Graph 3) of the publications for rental for housing in Merlo and Moreno among the portals of publication considered. The period surveyed corresponds between June 2019, when the survey begins, and February 2020, when it stops, since as of March 2020 Decree 320/2020 was published which freezes rental prices as a result of the COVID pandemic, which constitutes a change in regulation. In this way, it is avoided to introduce into the analysis the economic effects that these changes in the legal framework may introduce.



Graphic 3 Source: Own elaboration based on the own survey of each website: Number of rental publications on each of the websites for the municipalities of Merlo and Moreno.

From each portal, the structural data of the houses and their geolocation were collected. The data obtained are described below.

Zoneprop

In the case of ZonaProp, the survey was made monthly between the months of June 2019 and February 2020 of the properties for rent. The variables surveyed are shown in table 2:

WEBS	The web address of the publication
Kind	Property Type, can take values: PH, Apartment, House
Antiquity	Number of Years old, -1 years corresponds to "Under Construction" properties, and 0 years to "Brand New" properties.
Price	Nominal Rental Price, in Argentine pesos.
Meters	Property size, in square meters
Bedrooms	Number of bedrooms
Garage	Number of garages, when not declared, it is considered 0 garages
Latitude	Geolocation
Longitude	Geolocation
Direction	Direction declared with height
Real estate	Who published, can take the name of a real estate or be a direct owner
Weather	How many days have passed since the start of publication and the survey date
Environments	Number of bedrooms
Toilets	Number of Bathrooms

Picture 2 Own elaboration based on the survey carried out in ZonaProp

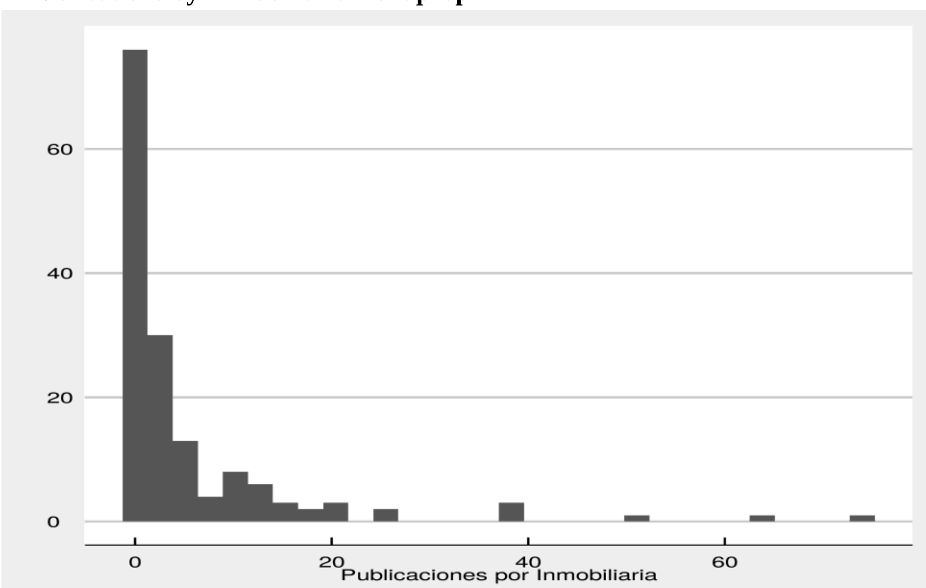
The WEBS variable functions as a unique identifier for each record since, as the survey was done monthly and there were publications that lasted more than a month, it serves to distinguish the different publications and avoid duplicate records. The Publication Time allows you to distinguish which of two different surveys with the same identifier is the most recent.

The type of property, the age, the meters, the main rooms and the garages, are the variables that account for the structural characteristics of the house.

The geolocation by Latitude and Longitude will then allow incorporating both the urban services variables and the environmental variable of interest, since the distance between two georeferenced points is considered. Due to the way in which each publication is recorded, there may be manual errors in the georeferencing record, that is why it is considered that those points that are outside the towns of Merlo and Moreno are errors and are eliminated from the final database.

The analysis of the number of publications per real estate agency allows verifying the fragmentation of the market, which results in the absence of agents with market power, which, as discussed in the theoretical framework, is key to the validity of use of the method.

Publications by Inmobiliaria Zonaprop



Graphic 4 Source: Own elaboration based on the survey on the Zonaprop website

The histogram (Graph 4) shows the number of publications per real estate, which have an average of 5.68 publications per real estate, but a median of 2 publications for each one.

This is understood as sufficient evidence that there is no market power on the part of the supply, and, since by definition the rental for housing is demanded one per family, there is no market power in the supply either.

<u>Properati</u>

It is a website whose data sources are available for public use[3]Therefore, downloading the data corresponding to housing rentals is a more direct operation, the selected data is restricted to the same dates as those collected in Zonaprop in order to maintain consistency. Table 3 shows the columns that the downloaded database has:

Variables available from the database provided by Properati

go	Unique identifier
start_date	Publication start date
end_date	End date of publication
Lat	georeference, latitude
lon	georeference, longitude
l1	Country, Argentina only
l2	Province, in this case, it only takes the GBA West variable
l3	Municipality
l4	Location
rooms	Number of romos
bedrooms	Number of Bedrooms
bathrooms	Number of Bathrooms
surface_total	Total surface of the property
surface_covered	Covered área
price	Rental Price
currency	Currency, only Argentine Pesos
price_period	Payment frequency, only Monthly
title	Notice title
description	Description
property_type	Property type: Apartment, PH, House
operation_type	Type of operation: Rental Only

Picture 3Own elaboration based on the database provided by Properati

[3]https://www.properati.com.ar/data

Given that Properati and Zonaprop function as direct competitors for the publication of advertisements, it is assumed that the distribution of advertisements by Real Estate Agency is similarly atomized, which is necessary so that the assumption that there are no agents with market power is fulfilled. Regarding the form of data entry, as notices are processed by a specialized provider in order to make the data available to the public, they are mostly complete and without systematic errors.

In order to fulfill the assumption of completeness of the market, these two sources are unified by selecting the structural variables of each publication, resulting in Table 4:

Structural variables of the dwelling that appear in both ZonaProp and Properati

go	WEBS
price	Price
Lat	Latitude
Lon	Longitude
surface_total	Meters
rooms	Environments
property_type	Kind
bathrooms	Toilets
bedrooms	Bedrooms

Picture 4 Own elaboration based on the survey carried out on the ZonaProp websites and the data provided by the Properati website

Finally, the assumption of availability is considered duly fulfilled due to the nature of the source: they are data accessible to the general public for which it is not necessary to have any type of credential (the information, therefore, is available to all potential consumers) and there are no legal restrictions for anyone to have access to rentals.

Once these structural data have been defined, it is necessary to incorporate the data of the direct environment, urban services and the environmental variable.

3.2.2 Direct Environment Variables

For the direct environment variable, the census radius to which the registry belongs is located and a column is added referring to the index of unsatisfied basic needs (NBI) of that census radius, the percentage of dwellings in insufficient structural conditions, the percentage of dwellings without mains water and the percentage of dwellings without drainage, it is understood that these percentages correspond to the probability that the particular registry has the characteristic.

In order to incorporate urban services, a manual survey of railway transshipment centers in the region was carried out, the added variable is then "distance, in meters, to the nearest railway transshipment center". And, they take advantage of the open data of the province of Buenos Aires[4] to incorporate, in the same way, distance in meters to:

- Firemen
- Schools
- Police stations
- Public health facilities

3.2.3 Environmental Variables

For the definition of the environmental variable, the digital cartography of rivers of the National Geographic Institute is used to determine the distance, in meters, of each record to the Reconquista River. From the distance it is necessary to define the variable "proximity", since the correct specification of the econometric model depends on it.

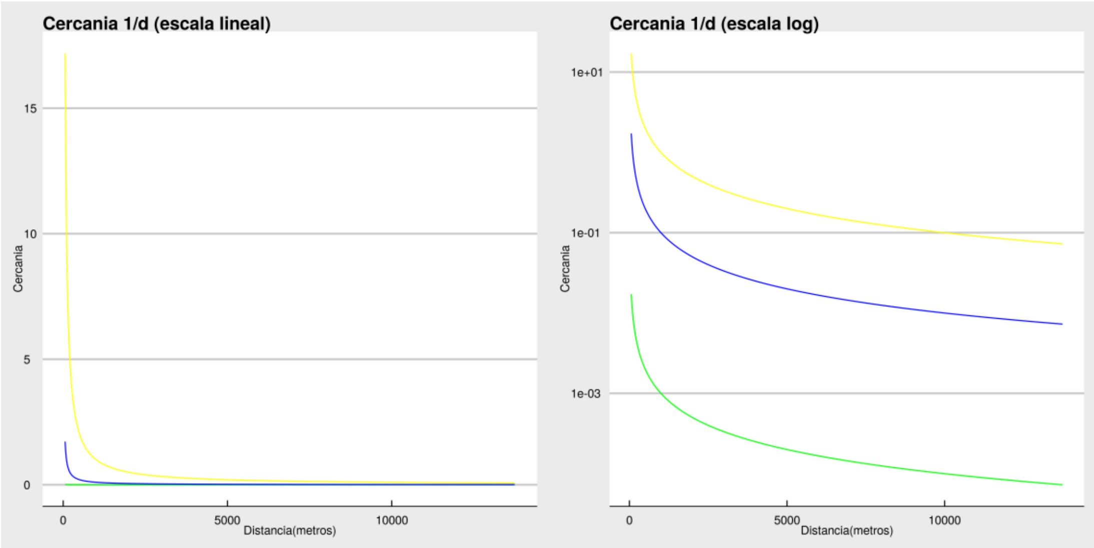
The central characteristic of the concept of "closeness" is that it tends to 0 when the distance increases indefinitely, that is, that closeness is a monotonic descending function of the distance (Kelejian & Piras; 2017).

That is why, on the one hand, the definition of closeness mentioned in the theoretical framework is used, which is given by:

Closeness = 1 / distance.

[4]https://catalogo.datos.gba.gob.ar/

However, the relationship is not directly in kilometers, it can be per meter, or per 100 meters (approximation to the length of one block). Different definitions of closeness imply that the effects of the externality fade more or less quickly.



Graphic 5Closeness as a function of distance: 1 / d, Left: Linear scale, Right: Logarithmic scale. Own elaboration based on calculations made

Graph 5 shows a green line that corresponds to a proximity defined as 1 / meters, the blue one corresponds to 1 / (meters * 100), (that is, approximately 1 / block) and the yellow one, which corresponds to 1 / kilometers, as can be seen immediately, this measure of proximity depends on the choice of the unit of measure

These three variables are added as indicators of proximity with the names of "closeness_meters", "closeness_blocks", "closeness_km" respectively.

On the other hand, *closeness* can be defined that fall linearly with the distance until reaching a distance "k" where the proximity is defined as 0:

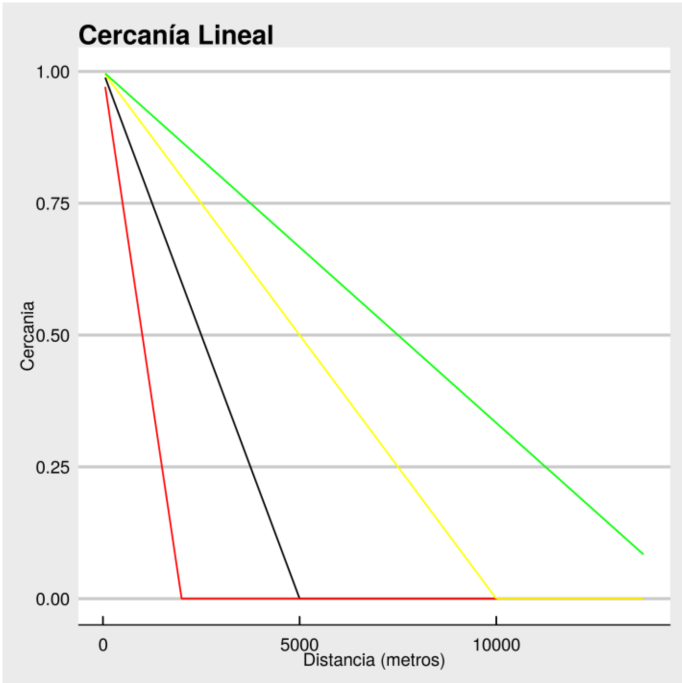
$$c = \begin{cases} \frac{(k-d)}{k}, & if d < k \\ 0, & d \geq k \end{cases}$$

Where:

c: closeness

d: Distance in km,

k: Hypothetical maximum distance within which the rental properties are located that reduce their price due to their proximity to the river. The closeness is divided by "k" so that the closeness index starts at 1 for all k.



Graphic 6Closeness as a function of Distance, linear. Source: Own elaboration based on calculations made

In graph 6, red is k = 2km, black is k = 5km, yellow is k = 10km, green is k = 15km, and they are incorporated as “near_lineal2”, “near_lineal5”, ”near_lineal10” and ”near_lineal15” respectively.

The selection of the environmental variable finally used will be given by the econometric analysis. The environmental variables to consider are:

closeness_meters	1 / dists
closeness_quadras	1 / (dists / 100)
nearness_kilometers	1 / (dists / 1000)
near_lineal2	(2000-dists) / 2000 for distances less than 2km, 0 for greater
near_lineal5	(5000-dists) / 5000 for distances less than 5km, 0 for greater

near_lineal10	(10,000-dists) / 10,000 for distances less than 10km, 0 for greater
near_lineal15	(15000-dists) / 15000 for distances less than 15km, 0 for greater

Picture 5 Own Elaboration based on the survey carried out and Geospatial Information of the IGN

Finally, the construction of the database to be used in the econometric analysis is made up of 1200 records that have 3 types of variables:

- Structural characteristics of the house.
- Neighborhood characteristics.
    - Of the census radius.
    - Access to urban services.
- Environmental variable: proximity to the Reconquista River.

Variables to use

Identifier		go	
Structural Features		price	Nominal Price in Pesos
		Lat	georeference
		Lon	georeference
		surface_total	Total area
		rooms	Amount of Environments
		property_type	Property Type (PH, Apartment, House)
		bathrooms	Number of Bathrooms
		bedrooms	Number of rooms
Neighborhood Features	Characteristics of Radio Censal	NBI	Index of Unsatisfied Basic Needs of the census radius
		drain	% of properties without drainage in the census radius
		insuf_prop	% of properties whose construction quality is insufficient in the census radius
		hogtot	Number of Households in the census radius
		watered down	% of properties with mains water in the

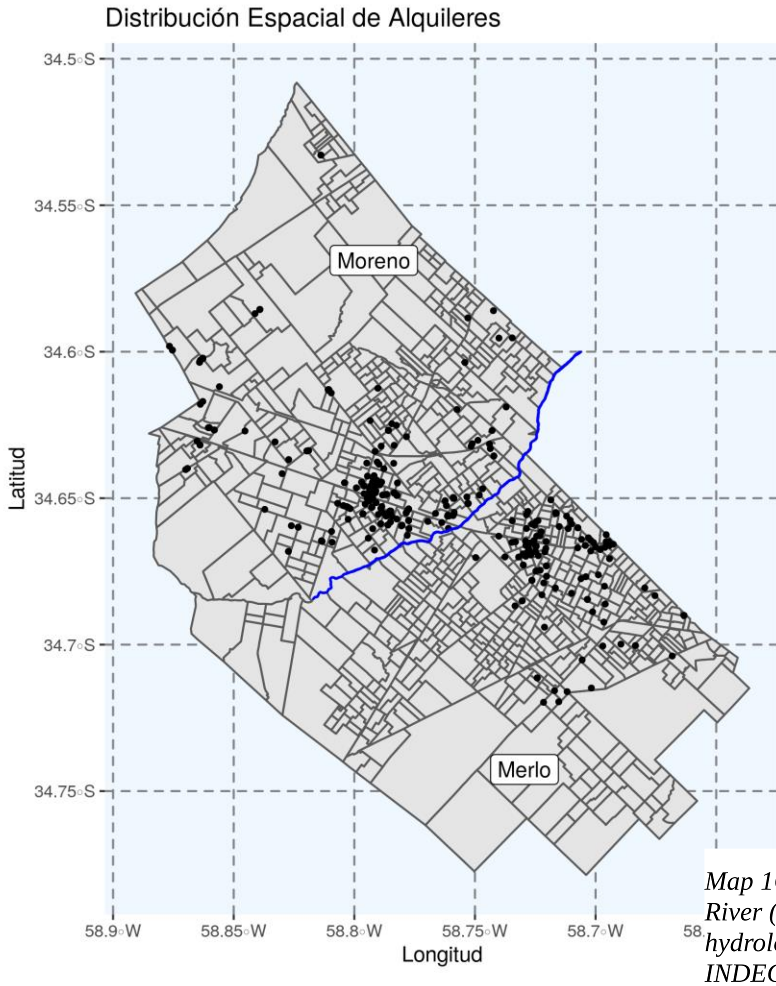
			census radius
	Urban Services	transport	Distance in meters to the nearest railway transfer center
		firemen	Distance in meters
		education	Distance in meters
		Police station	Distance in meters
		Health	Distance in meters
Environmental Variable		dists	Distance to Reconquista River in Meters
		closeness_meters	1 / dists
		closeness_quadras	1 / (dists / 100)
		nearness_kilometers	1 / (dists / 1000)
		near_lineal2	(2000-dists) / 2000 for distances less than 2km, 0 for greater
		near_lineal5	(5000-dists) / 5000 for distances less than 5km, 0 for greater
		near_lineal10	(10,000-dists) / 10,000 for distances less than 10km, 0 for greater

Picture 6 Own elaboration based on the survey made to the ZonaProp and Properati websites, and the calculations made based on the digital cartography of the Reconquista River (National Geographic Institute)

So far, there is a consolidated database of 1,200 records. Of which 59% belong to Moreno's party and 41% to Merlo's party.

3.2.5 Data Selection

The Index of Unsatisfied Basic Needs incorporates variables of the situation of overcrowding, general sanitary deficiencies and housing of poor construction, it is used as a control variable to homogenize the data, filtering those data whose UBN does not exceed 15% for the given census radius and that belong to the census radius defined as "urban" (the census divides them into urban, rural, or semi-urban radios). On the other hand, those records with missing data are eliminated. Finally, 372 records remain to be modeled, of which 227 are from Moreno (61%) and 145 (39%) from Merlo (Map 1).



Map 1Geographic distribution of the sample (point) and Reconquista River (blue). Own elaboration based on the survey carried out, hydrological data from the National Geographic Institute (IGN) and INDEC 2010 census radii

Regarding the link that the independent variables may have with each other, for example if the proximity to the river implies fewer sewers or smaller houses, a multicollinearity analysis will be carried out based on the variance inflation factor (FIV) and the Condition Index (CI) of each coefficient (Gujarati & Porter, 2009)

3.3 Econometric Analysis

3.3.1 Specification

The specific specification to estimate (without correction for spatial autocorrelation) is a log-linear model, due to being the specification frequently used in this type of study (Amoah, A., & Moffatt, PG (2012) & Delgado, J., & Wences, G. (2019)):

$$ln(price) = \beta_0 + \beta_1 surface + \beta_2 bedrooms + \beta_3 bathrooms + \beta_4 Depto + \beta_5 PH +$$
$$+\beta_6 desague + \beta_7 insufprop + \beta_8 hogtot + \beta_9 aguared$$

$$+\beta_{10}transporte + \beta_{11}bomberos + \beta_{12}educacion$$
$$+\beta_{13}comisaria + \beta_{14}salud + \beta_{15}C + u$$

Where the variables are those that were previously defined and "Dept." and “PH” are binary variables that take a value of 1 if the observation is an apartment or PH respectively, or 0 if not, in order to incorporate the type of property into the regression (the types that appear are: “Apartment”, “PH ”And“ Home ”)

Where "C" is the closeness metric that best fits. After several iterations through the options of “C” mentioned above, “Cercania_lineal5” is selected, which is also, from those considered, the one with the greatest statistical significance (Table 8).

Statistical significance of the different definitions of “Closeness” considered (part 1 of 2)

	closeness_meters	closeness_quadras	nearness_kilometers
Estimator	-3,591000	-0.035910	-0.003591
T	-0.204000	-0.204000	-0.204000
p.value	0.838379	0.838379	0.838379
R squared fitted	0.657900	0.657900	0.657900

Picture 7Own elaboration based on the data of Zonaprop, Properati, Open Data of the Province of Buenos Aires and hydrological data of the IGN. . For more details see Statistical Annex

Statistical significance of the different definitions of “Closeness” considered (part 2 of 2)

	Cercania_lineal2	**Cercania_lineal5**	Cercania_lineal10	Cercania_lineal15
Estimator	-0.074550	**-0.283400**	-0.369600	-0.396400
t	-0.859000	**-3.200000**	-2,794000	-2,092000
p.value	0.390718	**0.001495 ****	0.005484 **	0.037154 **
R squared fitted	0.658600	**0.667400**	0.665200	0.662000

Picture 8Own elaboration based on the data of Zonaprop, Properati, Open Data of the Province of Buenos Aires and hydrological data of the IGN. For more details see Statistical Annex

3.3.2 Multicollinearity:

The use of NBI to homogenize the data was commented at the beginning of the section, this is complemented with the multicollinearity analysis from the Variance Inflation Factor (FIV) and Condition Index (CI), since if the independent variables have a systematic link between them, the error of the estimators is greater, impairing the interpretability of the resulting coefficients and achieving, in the worst case, that a variable loses statistical significance, the IVF and IC of each coefficient obtained by ordinary least squares (OLS) from the previously selected variables are:

Multicollinearity Analysis: Variance Inflation Factors (VIF) and Condition Indices (CI)

	IVF	IC
Intercept		1
near_lineal5	2.51	2.05
Education	4.88	2.93
Hogtot	1.43	3.31
insuf_prop	3.41	3.45
surface_total	1.32	4.92
Bedrooms	2.38	6.2
property_typeDepartment	2.51	6.65
property_typePH	1.73	8.11
Aguared	3.9	9.51
Drain	4.14	10.48
Bathrooms	2.12	11.17
Health	3.29	13.53
Firemen	2.3	14.43
Transport	7.52	28.64

Picture 9 Own elaboration based on data from Zonaprop, Properati, hydrological data from IGN and open data from the Province of Buenos Aires.

The VIFs are below 10 and the CIs are less than 30, which is why it is considered that although there is moderate multicollinearity in some variables, it does not harm the analysis carried out or the interpretability of the coefficients (Gujarati & Porter, 2009), particularly the variable of interest, “near_linear5”, is among the variables with the lowest multicollinearity detected (the lowest CI, and among the lowest VIF).

3.3.3 Spatial Variables.

To account for the spatial endogeneity of the price and the spatially related omitted variables, once the specification has been determined, it is necessary to correct for spatial autocorrelation since, otherwise, the estimators may be biased (Anselin & Bera, 1998).
Spatial autocorrelation is the formalization of Tobler's first law of geography:

"Everything is linked to everything else, but those things that are closer have a greater relationship than the things that are further away"(Tobler, 1970)

In the case of the omitted variables, the prediction error of the rental price of a property will have a systematic link (either positive or negative) with the prediction errors of nearby properties. And spatial endogeneity can be defined as "how much the rental price of a property affects on the prices of the surrounding properties."

East The process requires the definition of a spatial weighting matrix that measures the closeness of each observation to each other observation.

The result of this is a spatially weighted square matrix, W, constructed by:

$$W = w_{ij}, i = 1, \ldots, n, j = 1, \ldots, n$$

It is further defined that:

if j = i, w_{ij}= 0

Since the closeness of each observation on itself is considered to be 0[5](Kelejian & Bera, 2017). The rest of the elements of the matrix can be given by the selection of different criteria, among them are:

5 The authors speak of "closeness" when the geographical relationship is continuous (for example in km) and they speak of a record being "neighbor" of another if the criterion is binary (it is a neighbor or it is not), the difference is that the first is continuous and the second is discrete. Here, when considering both possibilities, they are used synonymously, so when the authors say that the nearness with respect to itself is 0, what is said is that an observation is not a neighbor of itself.

$w_{ij} = 1$ if "i" is a neighbor of "j", 0 otherwise.

$w_{ij} = 1/d_{ij}$, where d_{ij} is the distance between "i" and "j".

The autocorrelation analysis depends on the specific specification of this weight matrix. The matrices formed by:

$w_{ij} = 1$, if properties "i" and "j" are less than "k" meters, where k = {100, 500, 1000, 3000}.
$w_{ij} = 1/d_{ij}$, where d_{ij} is the distance in meters between "i" and "j"

Operationalization requires a test that verifies whether the errors are spatially autocorrelated. For this, the spatial autocorrelation test of Moran's I (Moran, 1950) is used.

The I of Morán is a statistic made up of:

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} \quad w_{ij} (x_i - \acute{x})(x_j - \acute{x})}{\sum_{i=1}^{n} \quad (x_i - \acute{x})^2}$$

Where $S_0 = \sum_{i=1}^{n} \sum_{j=1}^{n} \quad w_{ij}$ Y w_{ij} are the elements of the spatial weighting matrix W.

What this test seeks to test is how much of the own variation is linked to the variation of the neighboring observations.

The expected value of I for the null hypothesis of "no-autocorrelation" is, $I_0 = \frac{-1}{n-1}$ where the variance of I for the null hypothesis is also known, so if the estimated I is statistically higher, the null hypothesis is rejected and it is considered to be in the presence of spatial autocorrelation.

In the case of the errors of the previously selected linear model, all the definitions considered of closeness, for the construction of the matrix of spatial weights W, show that there is spatial autocorrelation (Table 10).

Moran's I on the errors of the linear model and their significance for each specification of the W matrix.

	1 / d	Less than 100mts	Less than 500mts	Less than 1km	Less than 3km
I estimated	11.75	15.09	11.22	9.28	8.67
p.value	0.00%	0.00%	0.00%	0.00%	0.00%

Picture 10 Own elaboration based on data from Zonaprop, Properati, hydrological data from IGN and open data from the Province of Buenos Aires.

The correction methods for spatial autocorrelation, as said, are by endogeneity and error analysis, which gives rise to the models:

Autoregressive Spatial Model (SAR):

$$y = \rho W y + \beta X + e$$
$$e = u + \lambda W u$$

Where the characteristic is the variable Wy, which captures how much the price of each observation varies due to the price of the adjacent ones, measured through ρ.

Spatial Errors Model (SEM):

$$y = \beta X + e$$

$$e = u + \lambda W u$$

Where the characteristic is the variable Wu, which captures the effects of the spatially related omitted variables, measured through λ.

Finally, 10 models are evaluated: the SEM, SAR model and for each one, the 5 specifications mentioned by W. It is evaluated, via the Moran's I test on errors, if the model is sufficiently explanatory of the variations. When identifying it, the Akaike Information criterion (AIC) is used to compare the goodness of fit between the spatially corrected model and the OLS model.

Moran's I on the remaining errors for each spatial model and significance for each specification of the W matrix.

		1 / d	Less than 100mts	Less than 500mts	Less than 1km	Less than 3km
HE	Moran's I	5.91	10.34	6.64	4.60	1.99
	p.value	0.00%	0.00%	0.00%	0.00%	2.00%
SEM	Moran's I	6.39	10.33	6.62	4.60	**1.64**
	p.value	0.00%	0.00%	0.00%	0.00%	**5.10%**

Picture 11Own elaboration based on data from Zonaprop, Properati, hydrological data from IGN and open data from the Province of Buenos Aires. For more details of the evaluated models, see statistical annex.

Finally, only the model of spatial errors captures the spatial variability in such a way that the test of its errors allows accepting the null hypothesis of "non-autocorrelation", whose proximity criterion is dichotomous for those properties at a distance of less than 3 kilometers. (table 11).

3.3.4 The implicit marginal price

Below is the table of results and estimators of the selected model (Table 12)

Statistical summary of the selected model

Variable	Estimator	std.error	T	p.value
Intercept	9.290496	0.159848	58.120741	0.000000 ***
near_lineal5	**-0.302807**	**0.112613**	**-2.688916**	**0.007168 ****
education	0.000048	0.000091	0.527886	0.597579
hogtot	-0.000477	0.000184	-2.593697	0.009495 **
transport	0.000036	0.000021	1.695843	0.089916
insuf_prop	-1.093746	0.303947	-3.598475	0.000320 **
surface_total	0.000072	0.000030	2.433555	0.014951 *
bedrooms	0.215726	0.026536	8.129513	0.000000 ***
property_typeDepartment	-0.292646	0.050930	-5.746026	0.000000 ***
property_typePH	-0.268304	0.066374	-4.042337	0.000053 ***
watered down	-0.001479	0.000764	-1.935599	0.052917

drain	0.002895	0.000813	3.559470	0.000372 *
bathrooms	0.130843	0.035715	3.663497	0.000249 *
Health	-0.000055	0.000031	-1.738156	0.082183
firemen	0.000006	0.000013	0.495170	0.620480
lambda	0.623996	0.116615	5,350918	0.000000 ***

Picture 12 Own elaboration based on data from Zonaprop, Properati, hydrological data from IGN and open data from the Province of Buenos Aires

In this analysis, the implied marginal price (PMI) is:

ln (PMI) = $\frac{\partial ln(P)}{\partial x_{15}}$ = -0.3028

$$PMI = e^{(-0.3028)}$$

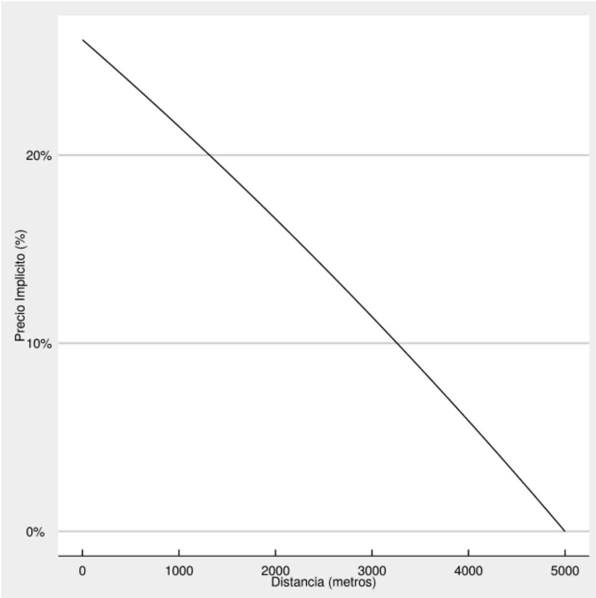
The implicit price (PI) for each neighborhood "C" of each property is, then:

$$PI = e^{(-0.3028)*C}$$

Which is a function of proximity, for a proximity index of 1, which will have a property 0 meters from the river, the rental price is reduced by approximately 26%, which is equivalent to the implicit price of moving away from the river.

Finally, it should be mentioned that the bias product of the spatially related omitted variables is not very large since the coefficient resulting from the analysis with correction, -0.302807, is within the confidence interval product of the OLS regression for that same variable, which is [-0.457, -0.1092], its point estimator being -0.28339. The Akaike information criterion (AIC) for the spatial model is 208.8, while for the linear model it is 218.73, which constitutes an improvement in the goodness of fit.

Implicit price for moving away from the river at each distance (meters).

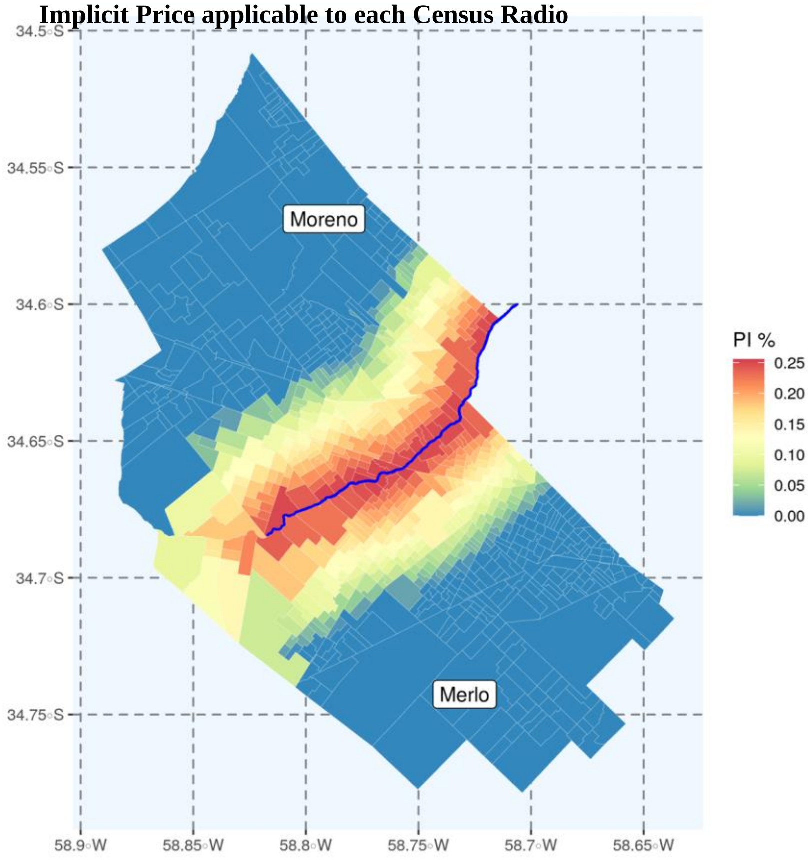


Graphic 7 Own elaboration based on data from Zonaprop, Properati, hydrological data from IGN and open data from the Province of Buenos Aires

4. Quantification of Externality

4.1 Assign the PI according to the distance to the census radii

Implicit Price applicable to each Census Radio



From the analysis carried out so far, it is possible, to quantify the externality, to assign the impact of the IP in each census radius. If the geographic center of each census radius is taken and its distance to the river is calculated as it was calculated for each observation in the sample, it can be obtained which is the PI that would apply, approximately, to the properties that are rented there (Map two).

Map 2 Own elaboration based on data from Zonaprop, Properati, hydrological data from the IGN, open data from the Province of Buenos Aires and 2010 census radii (INDEC)

4.2 Quantification of Externality

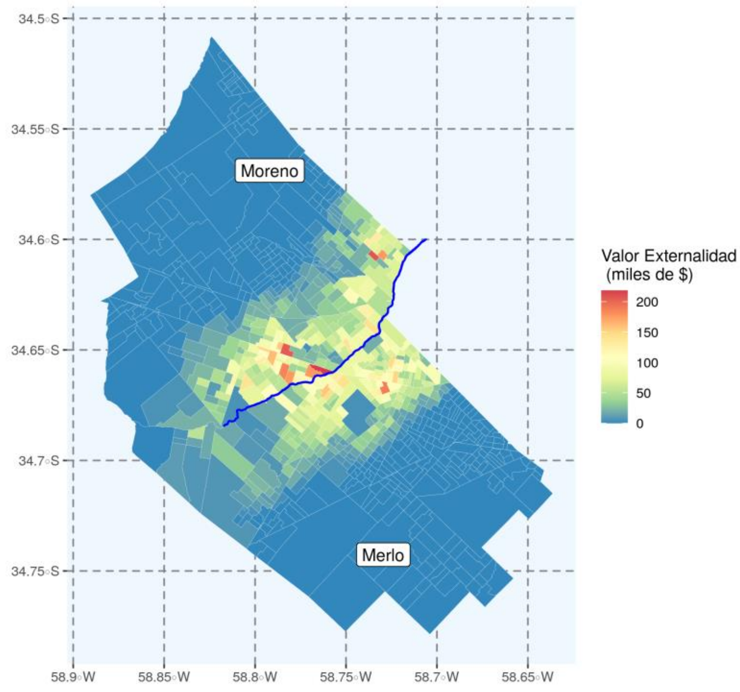
Now, having the estimate of how much the price falls as a function of distance, and having estimated the rental price formation function, the intercept of the regression is used as the homogeneous price index (PHg) [6]:

$$\ln (PHg) = \frac{\partial ln(P)}{\partial x_0} = 9.290497$$

Solving for the price:

$$PHg = e^{9.290497} = 10834.56$$

Value of the External in each Census Radio



Map 3. Own elaboration based on data from Zonaprop, Properati, hydrological data from the IGN, open data from the Province of Buenos Aires and 2010 census radii (INDEC)

If this price is multiplied by the percentages obtained for each census radius in the previous section, and that result is multiplied by the number of homes for rent in that same radius (according to the 2010 census), when adding the values obtained , the estimate is obtained of how much, in Argentine pesos, the externality is affecting the housing rental market in Merlo and Moreno, which is $ 22,641,594 per month, which, divided by the

vith respect to x0, it provides a constant price for all

26,097 homes for rent, results in an average amount to pay per household to get away from the Reconquista River for $ 867.59 per household (Map 3).

For the final valuation, the update is considered taking the net current value (NPV) in perpetuity (which considers the assumption that the externality problem will never be solved) based on the conversion of the annual term amount, multiplied by the change to the average UVA index between June 2019 and February 2020, at the average interest rate of the same index for mortgage loans in the same term (Table 13).

Monthly value	$ 22,641,954.00
Annual Value (Monthly * 12)	$ 271,703,448.00
Annual Value Converted to UVA = 42.26	UVA 6,429,248.71
NPV (i = 6.96%, in perpetuity)	UVA 92,252,892.65

Picture 13 Own elaboration based on data from Zonaprop, Properati, hydrological data from IGN, open data from the Province of Buenos Aires and 2010 census radii (INDEC)

Conclusions

The hypothesis that establishes an inverse relationship between the distance to the Reconquista River and the rental prices for housing, is corroborated for the parties of Merlo and Moreno. This link gains statistical significance up to 5km, at greater distances it loses it; Therefore, it can be concluded that the externality of the contamination of the River affects the inhabitants who are up to 5 km from the river, those who live further away, do not have a significant link.

The implicit price, as a percentage of the rental price, applied to the census radii can be seen in Map 2, and the valuation for each one, based on a reference price, in Map 3. The sum of these values is $ 22,641,954 per month, which corresponds to a current value (in perpetuity), in Purchasing Value Units (to express it in real terms) of UVA 92,252,892.65 (table 13).

This work corroborates that environmental pollution, in this case from the Reconquista River, has effects on other markets for goods and services, in this case rentals for housing in Merlo and Moreno that reduce social utility. Other investigations of this type could include this verification in other parties, on other environmental phenomena and other related markets (for example, instead of rents, take the tax valuation of land and real estate)

Bibliography

Amoah, A., & Moffatt, PG (2012). Estimating demand for reliable Piped-Water services in urban ghana: An application of competing valuation approaches. School of Economics University of East Anglia.

Anselin, Luc, and Anil K Bera. 1998. "Spatial Dependence in Linear Regression Models with an Introduction to Spatial Econometrics." Statistics Textbooks and Monographs 155. MARCEL DEKKER AG: 237–90.

Azqueta, Diego (2002) Introduction to Environmental Economics Ed. Mc Graw-Hill Professional. Chap 2

World Bank. (2004). How much is an ECOSYSTEM Worth?

Bolt, Katherine; Ruta, Giovanni; Sarraf, Maria (2005).*Estimating the cost of environmental degradation: a training manual in English, French and Arabic.* Environment working paper series; not. 106 Washington, DC: World Bank Group.

COMIREC (Reconquista River Commission). (2018). Global Environmental and Social Impact Assessment (EIASG). pp 33-34

Cristeche, E., & Penna, JA (2008). Methods of economic valuation of environmental services (ISSN 1851-6955 N ° 3 ed.). National Institute of Agricultural Technology (INTA).

Chay, K & Greenstone, M (2005) Does Air Quality Matter? Evidence from the Housing Market [Journal of Political Economy, 2005, vol. 113, no. 2] The University of Chicago.

Delgado, J., & Wences, G. (2019). A hedonic approach to the valuation of the effect of criminal violence on housing prices in Acapulco City. Empirical Economics.https://doi.org/10.1007/s00181-019-01804-3

FREEMAN, AM (1979). The Hedonic Price Approach to Measuring Demand for Neighborhood Characteristics: The Economics of Neighborhood, 191-217.https://doi.org/10.1016/b978-0-12-636250-3.50015-5

Gilbert, Stanley (2013). Applying the Hedonic Method. National Institute of Standards and Technology US Department of Commerce

Gujarati, NG & Porter, DC (2009) Econometrics. Fifth Edition, ed. McGraw Hill Kelejian, Harry & Piras, Gianfranco (2017). Spatial Econometrics. First Edition.ELSEVIER. Chap 1 and 2

Ranconi, Casazza, Monkkonen, Reese (2015). Analysis of the characteristics of the operation of the land market in three cities of Argentina: Buenos Aires, Córdoba and Rosario. Working document n ° 9. Center for Research and Social Action (CIAS)

Ramos Gorostiza, JL (2005). Natural environment and economic thought: history of a reunion Principles N Magazine*or. 2/2005*. Complutense University.

Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. Journal of Political Economy, 82 (1), 34-55. Retrieved November 15, 2020, fromhttp://www.jstor.org/stable/1830899

Sylla, M., Lasota, T., & Szewrański, S. (2019). Valuing Environmental Amenities in Peri-Urban Areas: Evidence from Poland. Sustainability, 11 (3), 570.https://doi.org/10.3390/su11030570

Vásquez, F. (2017). Theoretical-practical course: “Methodologies for the economic valuation of the environment”. ECLAC.

Tobler, WR (1970). A Computer Movie Simulating Urban Growth in the Detroit Region. Economic Geography, 46, 234.

STATISTICAL ANNEX

<u>Linear Models</u>

.variable	.stat	Model 1	Model 2	Model 3	Model 4	**Model 5**	Model 6	Model 7
(Intercept)	Estimate	9.1813769 ***	9.1813769 ***	9.1813769 ***	9.1988036 ***	**9.3298882 *** **	9.5398460 ***	9.5768286 ***
	Std Err	[0.1408848]	[0.1408848]	[0.1408848]	[0.1422848]	**[0.1464616]**	[0.1896368]	[0.2356542]
near_km	Estimate	0						
	Std Err	[0.0175909]						
close_quadras	Estimate		-0.04					
	Std Err		[0.1759091]					
near_meters	Estimate			-3.59				
	Std Err			[17.5909087]				
near_linear2	Estimate				-0.07			
	Std Err				[0.0867525]			
near_lineal5	Estimate					**-0.2833929 *** **		
	Std Err					**[0.0885470]**		
near_lineal10	Estimate						-0.3695649 ***	
	Std Err						[0.1322623]	
near_lineal15	Estimate							-0.3963995 **
	Std Err							[0.1894930]
transport	Estimate	0.0000322 *	0.0000322 *	0.0000322 *	0.0000294 *	**0**	0	0
	Std Err	[0.0000165]	[0.0000165]	[0.0000165]	[0.0000167]	**[0.0000170]**	[0.0000178]	[0.0000183]
education	Estimate	0	0	0	0	**0**	0	0
	Std Err	[0.0000911]	[0.0000911]	[0.0000911]	[0.0000908]	**[0.0000897]**	[0.0000910]	[0.0000909]
hogtot	Estimate	-0.0003444 *	-0.0003444 *	-0.0003444 *	-0.0003666 *	**-0.0004040 ** **	-0.0004068 **	-0.0003888 **
	Std Err	[0.0001891]	[0.0001891]	[0.0001891]	[0.0001906]	**[0.0001873]**	[0.0001884]	[0.0001891]
insuf_prop	Estimate	-1.1909452 ***	-1.1909452 ***	-1.1909452 ***	-1.1726304 ***	**-1.0699393 *** **	-1.1781247 ***	-1.1848637 ***
	Std Err	[0.3006684]	[0.3006684]	[0.3006684]	[0.3009267]	**[0.2984847]**	[0.2969765]	[0.2983606]
surface_total	Estimate	0.0000733 **	0.0000733 **	0.0000733 **	0.0000724 **	**0.0000702 ** **	0.0000763 **	0.0000763 **
	Std Err	[0.0000312]	[0.0000312]	[0.0000312]	[0.0000312]	**[0.0000308]**	[0.0000309]	[0.0000311]
bedrooms	Estimate	0.2227765 ***	0.2227765 ***	0.2227765 ***	0.2244835 ***	**0.2317443 *** **	0.2267399 ***	0.2251465 ***
	Std Err	[0.0280968]	[0.0280968]	[0.0280968]	[0.0280738]	**[0.0277487]**	[0.0277283]	[0.0278472]
property_typeDepartment	Estimate	-0.2678798 ***	-0.2678798 ***	-0.2678798 ***	-0.2682071 ***	**-0.2553034 *** **	-0.2606836 ***	-0.2622140 ***
	Std Err	[0.0533451]	[0.0533451]	[0.0533451]	[0.0532273]	**[0.0526931]**	[0.0527813]	[0.0530413]
property_typePH	Estimate	-0.2479813 ***	-0.2479813 ***	-0.2479813 ***	-0.2466865 ***	**-0.2376134 *** **	-0.2323829 ***	-0.2350234 ***
	Std Err	[0.0701381]	[0.0701381]	[0.0701381]	[0.0700606]	**[0.0692010]**	[0.0695866]	[0.0699723]
watered down	Estimate	-0.0014904 *	-0.0014904 *	-0.0014904 *	-0.0015717 *	**-0.0016971 ** **	-0.0017008 **	-0.0016649 **
	Std Err	[0.0008045]	[0.0008045]	[0.0008045]	[0.0008095]	**[0.0007959]**	[0.0007995]	[0.0008041]
drain	Estimate	0.0018527 **	0.0018527 **	0.0018527 **	0.0019103 **	**0.0025037 *** **	0.0020632 ***	0.0019612 **
	Std Err	[0.0007993]	[0.0007993]	[0.0007993]	[0.0008011]	**[0.0008135]**	[0.0007935]	[0.0007953]
bathrooms	Estimate	0.1327841 ***	0.1327841 ***	0.1327841 ***	0.1332989 ***	**0.1306224 *** **	0.1269589 ***	0.1282608 ***
	Std Err	[0.0381136]	[0.0381136]	[0.0381136]	[0.0380509]	**[0.0375622]**	[0.0377430]	[0.0379278]
Health	Estimate	-0.0000651 **	-0.0000651 **	-0.0000651 **	-0.0000602 **	**-0.0000509 * **	-0.0000655 **	-0.0000637 **
	Std Err	[0.0000264]	[0.0000264]	[0.0000264]	[0.0000269]	**[0.0000262]**	[0.0000258]	[0.0000260]
firemen	Estimate	0	0	0	0	**0**	0	0
	Std Err	[0.0000060]	[0.0000060]	[0.0000060]	[0.0000063]	**[0.0000070]**	[0.0000072]	[0.0000073]
	N	372	372	372	372	**372**	372	372
	R2	0.67	0.67	0.67	0.67	**0.68**	0.68	0.67
	adj R2	0.66	0.66	0.66	0.66	**0.67**	0.67	0.66
	AIC	229.21	229.21	229.21	228.48	**218.73**	221.2	224.72

* p <0.1; ** p <0.05; *** p <0.01

Spatial Models

Error Model

Variable		1 / w	w100	w500	w1000	w3000
(Intercept)	Estimate	9.3046732 ***	9.4604601 ***	9.3521786 ***	9.3237413 ***	9.2904965 ***
	std. Error	0.154676	0.165784	0.170169	0.170148	0.159848
near_lineal5	Estimate	-0.251527 **	-0.2604043 **	-0.2586989 **	-0.2460435 **	-0.3028071 ***
	std. Error	0.098960	0.106012	0.116400	0.120674	0.112613
transport	Estimate	0.000022	0.000017	0.000029	0.000019	3.59e-05 *
	std. Error	0.000018	0.000020	0.000021	0.000022	0.000021
education	Estimate	0.000083	0.0001897 *	0.000115	0.000164	0.000048
	std. Error	0.000098	0.000104	0.000106	0.000106	0.000091
hogtot	Estimate	-0.0003184 *	-0.0004103 *	-0.000272	-0.000302	-0.0004772 ***
	std. Error	0.000186	0.000221	0.000205	0.000199	0.000184
insuf_prop	Estimate	-1.0970662 ***	-1.1418249 ***	-0.9548425 ***	-1.0286393 ***	-1.0937459 ***
	std. Error	0.297609	0.356801	0.367890	0.353145	0.303947
surface_total	Estimate	6.51e-05 **	8.74e-05 **	8.19e-05 **	0.000113 ***	7.2e-05 **
	std. Error	0.000029	0.000036	0.000038	0.000039	0.000030
bedrooms	Estimate	0.2079038 ***	0.1939733 ***	0.2081433 ***	0.2133221 ***	0.2157255 ***
	std. Error	0.025902	0.024084	0.025947	0.026858	0.026536
property_typeDepartment	Estimate	-0.2812267 ***	-0.321559 ***	-0.318077 ***	-0.2881138 ***	-0.2926461 ***
	std. Error	0.049078	0.050521	0.050493	0.051180	0.050930
property_typePH	Estimate	-0.2958755 ***	-0.2815168 ***	-0.3186104 ***	-0.2809242 ***	-0.2683041 ***
	std. Error	0.064854	0.067983	0.067133	0.067161	0.066374
watered down	Estimate	-0.0013102 *	-0.0016789 *	-0.0016348 *	-0.001303	-0.0014791 *
	std. Error	0.000793	0.000953	0.000956	0.000920	0.000764
drain	Estimate	0.0026347 ***	0.0023794 **	0.0028532 ***	0.0022361 **	0.0028953 ***
	std. Error	0.000806	0.000969	0.000988	0.000968	0.000813
bathrooms	Estimate	0.1269504 ***	0.0954933 ***	0.1026449 ***	0.1091854 ***	0.1308432 ***
	std. Error	0.034909	0.030885	0.034227	0.035531	0.035715
Health	Estimate	-0.000042	-5.87e-05 *	-7.36e-05 **	-6.26e-05 *	-5.45e-05 *
	std. Error	0.000030	0.000031	0.000034	0.000035	0.000031
firemen	Estimate	-0.000005	-0.000008	-0.000006	-0.000005	0.000007
	std. Error	0.000009	0.000008	0.000009	0.000010	0.000013
lambda	Estimate	0.5128651 ***	0.4922475 ***	0.3591672 ***	0.3813358 ***	0.6239965 ***
	std. Error	0.084601	0.039118	0.064645	0.089832	0.116615

N	372	372	372	372	372
AIC	196.82	152.04	198.55	206.61	208.8

* p <0.1; ** p <0.05; *** p <0.01

Autoregressive Spatial Model

Variable		1 / w	w100	w500	w1000	w3000
(Intercept)	Estimate	5.7214219 ***	6.5388469 ***	7.9993082	9.2708537	14.1815741 **
	Std.Error	1.1279235	1.0224869	1.0067755	1.4062931	2.2824876
near_lineal5	Estimate	-0.2178461 ***	-0.1965376 ***	-0.2365996 ***	-0.2455315 ***	-0.3175757 ***
	Std.Error	0.0859079	0.0774777	0.0998429	0.1214702	0.1270457
transport	Estimate	1.3e-06 **	7.2e-06 **	1.13e-05 **	1.8e-05 **	7.5e-05 **
	Std.Error	0.0000169	0.0000142	0.0000202	0.0000264	0.0000298

education	Estimate	-0.0000233	0.0001027	0.0001093	0.0001627	1.59e-05 **
	Std.Error	0.0000952	0.0000774	0.0000944	0.0001089	0.0000918
hogtot	Estimate	-0.0003300	-0.0003046	-0.0002998	-0.0003020	-0.0005775
	Std.Error	0.0001709	0.0001591	0.0001876	0.0001984	0.0001895
insuf_prop	Estimate	-0.9887929 *	-0.7836462 *	-0.8614959	-1.0261927	-1.1966008 ***
	Std.Error	0.2750141	0.2718773	0.3321740	0.3579774	0.3127623
surface_total	Estimate	6.45e-05 ***	4.81e-05 ***	6.16e-05 ***	0.0001118 ***	6.68e-05 ***
	Std.Error	0.0000275	0.0000276	0.0000352	0.0000417	0.0000294
bedrooms	Estimate	0.2043608 **	0.1666807 *	0.2058692 *	0.2134468 ***	0.206946 **
	Std.Error	0.0248213	0.0256595	0.0259483	0.0268524	0.0263215
property_typeDepartment	Estimate	-0.2609005 ***	-0.2088878 ***	-0.2907276 ***	-0.2877057 ***	-0.2989303 ***
	Std.Error	0.0471316	0.0531287	0.0501372	0.0514113	0.0505641
property_typePH	Estimate	-0.2724682 ***	-0.1853802 ***	-0.2819373 ***	-0.280418 ***	-0.2842983 ***
	Std.Error	0.0617467	0.0619984	0.0662038	0.0674056	0.0658101
watered down	Estimate	-0.001217 ***	-0.0011715 ***	-0.0014111 ***	-0.0013029 ***	-0.0012824 ***
	Std.Error	0.0007295	0.0006810	0.0008590	0.0009211	0.0007576
drain	Estimate	0.0019625 *	0.0016958 *	0.0023591	0.0022264	0.0031032 *
	Std.Error	0.0007715	0.0007196	0.0009190	0.0010300	0.0008432
bathrooms	Estimate	0.1188201 **	0.0892432 **	0.1030498 **	0.1091476 **	0.1265159 ***
	Std.Error	0.0335379	0.0276960	0.0341496	0.0358799	0.0353351
Health	Estimate	-4.59e-05 ***	-3.67e-05 ***	-5.61e-05 ***	-6.22e-05 ***	-9.18e-05 ***
	Std.Error	0.0000254	0.0000226	0.0000296	0.0000353	0.0000381
firemen	Estimate	-4.4e-06 *	-0.0000064	-6.2e-06 *	-5.2e-06 *	4.44e-05 **
	Std.Error	0.0000072	0.0000058	0.0000077	0.0000098	0.0000230
lambda	Estimate	0.2329975	0.2571444 **	0.2205593 *	0.3763751 ***	0.8593194 ***
	Std.Error	0.1873453	0.1262455	0.1209099	0.1277208	0.0562051
rho	Estimate	0.3912745 ***	0.3027213 ***	0.1455318	0.005778	-0.5404397 **
	Std.Error	0.1222652	0.1066337	0.1071733	0.1527586	0.2442030

N	372	372	372	372	372
AIC	188.79	149.18	199.51	208.61	205.38

* p <0.1; ** p <0.05; *** p <0.01