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The Effects of Cultural Heritage on Residential Property Values: Evidence from Lisbon, Portugal

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Abstract

This paper examines the impact of historic amenities on residential housing prices in the city of Lisbon, Portugal. Our study is directed towards identifying the spatial variation of amenity values for churches, palaces, lithic (stone) architecture and other historic amenities via the housing market, making use of both global and local spatial hedonic models.

Our empirical evidence reveals that different types of historic and landmark amenities provide different housing premiums. While having a local non-landmark church within 100 meters increases housing prices by approximately 4.2%, higher concentrations of non-landmark churches within 1000 meters yield negative effects in the order of 0.1% of prices with landmark churches having a greater negative impact around 3.4%. In contrast, higher concentration of both landmark and non-landmark lithic structures positively influence housing prices in the order of 2.9% and 0.7% respectively.

Global estimates indicate a negative effect of protected zones, however this significance is lost when accounting for heterogeneity within these areas. We see that the designation of historic zones may counteract negative effects on property values of nearby neglected buildings in historic neighborhoods by setting additional

Further, our results from a geographically weighted regression specification indicate the presence of spatial non-stationarity in the effects of different historic amenities across the city of Lisbon with variation between historic and more modern areas.

Keywords: Spatial hedonic models, Historic amenities

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equals the marginal implicit price of purchasing that increase. However, households may be willing to pay different prices for different amenities depending on their generated net benefits and accessibility. Consequently, the capitalization of historic amenities into real estate values should not only differ across space but also across heritage categories.

For instance, non-landmark monuments such as minor historic fountains, statues or churches found throughout a neighborhood are local cultural heritage, generating values only for those who live in very close proximity to the amenity. While such a good might have both use and non-use values for residents of the neighborhood and visitors to that part of the city, we would not expect large values for residents who live at some distance from that location.[2] Therefore, it is likely that most benefits (value) of tangible immovable cultural heritage are captured through the local housing market.

In contrast, landmark monuments are likely to be national cultural heritage and as such hold some importance not just for the residents of a city but also for all citizens in the country. In this case, we would expect the gradient of the value of such monuments to fall less as we move away from them and the importance of their non-use value to be more significant compared to a non-landmark monument. This in turn suggests that the real estate market provides a lower bound for the estimated total value of such historic amenities, reflecting mostly its local use benefits (or disamenities). Some landmarks may further be considered as contributing to world heritage with global reaching values, with the Monastery of Jerónimos and Tower of Belém both designated as UNESCO world heritage sites in Lisbon.

This research raises the following two questions: What are the effects of proximity and concentration of tangible immovable cultural heritage on urban residential markets? Does the to pay for urban amenities, and in particular historic immovable amenities, vary across different categories of cultural heritage and over space?

We address these by identifying the variation of values for a broad set of urban historic amenities and the v in the housing market of Lisbon, Portugal. We define urban historic amenities in accordance with the UNESCO definition of cultural heritage representing the legacy of physical infrastructures inherited from past eras that are aesthetically pleasing to current residents, hold historic and architectural significance and are bestowed for the benefit of future generations.[3] The historic amenities of interest in this study are categorized as either churches, palaces, lithic (stone) structures or other residual historic amenities greater than 50 years old with

[2] The total value of historic heritage can be decomposed into use and non-use values. The use value includes the direct benefits of visiting, living or working in a heritage place and further indirect benefits associated with community image, aesthetic quality and social interaction. On the other hand, non-use values include a variety of intangible benefits that do not require a person to visit the heritage site. People may value the existence of the site as well as the option (although not necessarily the intention) to visit it. A person may also value the chance to bequeath a heritage place to future generations, as part of a shared cultural legacy.

[3] According to UNESCO cultural heritage encompasses several main categories of heritage namely tangible movable culture (books, works of art and coins), tangible immovable culture (buildings, monuments and archeological sites), tangible underwater culture (shipwrecks, underwater ruins and cities), intangible culture (folklore, oral traditions, performing arts and rituals) and natural heritage (including culturally significant landscapes and biodiversity). This study focuses exclusively on tangible immovable culture.

landmark amenities such as the iconic Castle of St. Jorge and both world heritage sites within their respective categories highlighted. Our protected zones, the reference for which comes from the *Câmara Municipal de Lisboa's* Urban Master Plan, are defined as the union of all areas in Lisbon where there exists a designated monument with an included 50 meter buffer or a listed special protected area.

We first develop an analytical urban model that includes herd behavior to discuss the effects that historic amenities have on residential property values. This theoretical framework emphasizes the importance of spatial heterogeneity of amenities in the formation of property values and sets the stage for the empirical component of this study providing the foundation for the choice of variables and model specification. We use a hedonic model to estimate the effect of amenity values via historic amenity concentration, proximity and location in a protected zone. Results indicate significant spatial autocorrelation in the residuals which is accounted for with a spatial error hedonic model as indicated by specification tests and the AIC criteria. Modeling this behaviour through spatial hedonic models reduces the sum of squared errors of prediction up to 4% relative to traditional ordinary least squares (OLS) models. Further, we extend the analysis to a local geographically weighted regression (GWR) model to investigate spatial non-stationarity and generate local estimates for historic amenity groups.

Our results highlight that different types of historic amenities have different premiums in the residential housing market, with an emerging pattern of positive localized price effects from higher concentration of amenities (within 50 or 100 meters) but negative effects for higher concentrations within a broader radius of 1000 meters. After correcting for spatial dependence we find that non-landmark churches within 100 meters increase housing prices by 4.2%. Negative price effects are found for higher concentrations of non-landmark churches within 1000 meters in the order of 0.1% with landmark churches having a larger (as expected) negative impact of around 3.4%. In contrast, higher concentrations of both landmark and non-landmark lithic structures within 1000 meters positively influence housing prices in the order of 2.9% and 0.7% respectively.

Further, while estimates indicate that concentrations of palaces yield strong positive effects of 13.9% within a distance of 50 meters, there are negative effects for higher concentrations in 100 and 1000 meters of 8.9% and 0.1% respectively. When disaggregated into landmark and non-landmarks however we find no significant effect suggesting that the public's general perception is regardless if a palace is considered a landmark, with higher concentrations of palaces valued for common architectural traits and ambient characteristics and not grandeur.

Naive OLS estimates without correcting for spatial dependence indicate a negative effect of being located in a protected zone of 1.6%. After accounting for this dependence or including interaction effects, these results become non-significant. Significant OLS effects are thus driven by the heterogeneity of protected zones such as those zones near open spaces or dilapidated buildings.

Our empirical evidence further highlights the capacity of the GWR model and suggests that inferences based on global models should be conducted with caution. GWR estimates demonstrate the heterogeneity of how proximity to historic amenities are capitalized into the residential housing market across space. We see a pattern of positive price effects for general monuments in the historic downtown with negative price effects extending towards the more modern secondary business district. Meanwhile, GWR estimates for proximity to different groups of historic amenities are in line with global proximity estimates, however we see meaningful variation in these impacts over space with the global effects from churches and lithic structures being driven by local estimates in specific areas of the city. Conversely, other residual historic amenities have a more constant positive price effect across the city, suggesting that global models may be appropriate for modeling these types of amenities.

The remainder of this paper is structured as follows. Section 2 reviews the existing literature. Section 3 develops our analytical model and section 4 describes the study region and presents our data. Then, section 5 presents our empirical strategy for assessing the impacts of proximity to historic amenities and protected zones on housing prices. Section 6 discusses the results from our traditional OLS model, global spatial model and local GWR. Finally, section 7 offers conclusions.

2. Existing Studies

A large body of literature has applied the hedonic pricing technique to explore the degree to which local heritage values and whether heritage designation of a property (i.e. ensuring the preservation of the dwelling's heritage characteristics) affects residential property values. These studies in general reveal that when dwellings or zones receive heritage designation, there are positive housing premiums through the intrinsic benefits of owning heritage properties and further potential tax exemptions and positive spillovers to nearby properties (Asabere et al. 1994, Coulson and Leichenko 2001, Deodhar 2004, Cebula 2009, Coulson and Lahr 2005, Ahlfeldt et al. 2012, van Duijn and Rouwendal 2013, Koster et al. 2016). There is further empirical evidence to show that higher income households prefer to reside in heritage zones and listed heritage buildings (Koster et al. 2016). Some results indicate however that there may be negative effects on housing prices from stringent regulatory frameworks and limitations on the alteration or maintenance due to heritage designation (Asabere et al. 1994).

In contrast, empirical studies focusing on the external effects of heritage from proximity or concentration are limited, in part due to the spatially detailed data required. To our knowledge, the few existing studies have focused on specific types of immovable cultural heritage such as churches and places of worships (Do et al. 1994, Carroll et al. 1996, Brandt et al. 2014) or examined global average effects of a pool of aggregated historic monuments (Lazrak et al. 2014).

Focusing specifically on the impact of proximity to churches, Do et al. (1994) estimate that houses closest to churches have decreased prices, however Carroll et al. (1996) using a similar strategy find a positive relationship. Both studies were conducted prior to the widespread use of spatial modeling techniques, and therefore ignore potentially important spatial autocorrelation in the data in which housing prices near each other are similar in price.

Introducing distance or concentration of historic amenities in a standard OLS framework provides a measure of their impact, however not accounting for spatial dependence when using housing price data may lead to biased and inefficient results. Brandt et al. (2014) add to the discussion from previous decades on valuing the effects of churches and places of worships by accounting for such spatial dependence. The authors estimate a 4.8% housing premium for a location within 100 to 200 meters of a place of worship. This effect remains significant and positive even after a building has lost its religious affiliation, indicating that households place value on buildings themselves for non-religious purposes potentially for architectural or cultural significance.

Similar in line to this research Moro et al. (2013) collect geo-located data on historic and cultural sites in Dublin to estimate the effect on housing prices. Sites are classified into broad categories to measure the effect of distance to the nearest historic building, church, Martello tower, archaeological site and a residual grouping of monuments (memorials, gardens and obelisks). The authors find in general find that increasing the distance to the nearest historic building has a negative effect on housing prices in the range of 0.07%, yet do not test or account for spatial dependence in housing prices and further consider only the global individual effect of each group separately without controlling for proximity to all other categories of cultural and historic amenities. Within categories, there is no distinction of the relative prominence of each site in terms of landmark status.

More recently, Lazrak et al. (2014) obtain improvements upon the results of a standard hedonic model by accounting for the spatial dependence both in their dependent variable and error term. The authors consider all listed monuments including registered architectural, religious, industrial and UNESCO heritage sites as their measure of historic amenities, and are able to study the internal effect of heritage designation on a property, the external effect of heritage density of an area and the effect of being located in a historically protected area of the city. The authors estimate a direct effect of heritage designation of 23.8% and an indirect effect for an additional monument within a 50 meter radius of 0.28%. The premium for being located in a protected historic district is estimated at 26.4%. These results assume however that different categories of monuments all have the same effect and the authors obtain a value for the average effect of historic and cultural heritage.

There are fewer applications of GWR modeling techniques to the housing market given the challenge of obtaining data with sufficient spatial variability and further due to the computational burden of geo-referencing data and estimating effects. These modeling techniques however are argued to be better suited for local policy decisions with heterogeneity across neighborhoods not accounted for in global models (Ali et al. 2007).

Bitter et al. (2007), Cellmer (2012) and Yu (2007) estimate GWR models on the standard set of housing characteristics and find significant spatial variation in housing prices across locations and gain model improvements by using localized techniques. In terms of valuing amenities through the housing market Cho et al. (2006), Cho et al. (2008) and Nilsson (2014) use the GWR techniques to value open spaces and natural amenities via property prices.

We expand the literature by obtaining GWR estimates for our categories of historic amenities, paying careful attention to measures of local multicollinearity. Under the presence of local multicolinearity, the standard spatial estimates of impacts at each location will have higher variance and will not be robust to slight changes in the model. Although we provide estimated effects which vary across the study area we make no attempt draw quantitative impacts or discuss the magnitude of these effects, rather using the GWR results as a complementary analysis to global estimates to examine spatial variability and patterns.

Our work thus adds to the latter set of empirical studies by conducting both global and local spatial analyses of the amenity values of historic monuments and categorized subgroups, highlighting those with landmark status. We also provide a theoretical foundation for variable choice and the need to account for spatial dependence in our model of residential housing prices and empirically use global spatial regression techniques to account for this dependence and locally weighted regression techniques to allow the housing parameters to vary over space. This latter technique better represents micro-market realities and the importance of location as a prime determinant of housing prices.

3. Analytical Model

Model Assumptions

We assume a representative household in a small open monocentric city, open in the sense that households are perfectly mobile within and between cities. In equilibrium, the utility level does not vary across location. The city is small and one of many with utility level determined in the national markets and exogenous to the city. Further, households are assumed to rent housing services from absentee landlords.

The household decision model conforms to some of the basic assumptions of the standard monocentric city model including a central business district (CBD) and commuting costs that depend on the residence-to-CBD distance. Thus, the relative position of all locations in the city are described by a single variable x, equal to the distance to the CBD. In addition, we assume that residential houses are characterized by the level of urban amenities associated with a specific location (e.g. view, open space, historic monument), $A(x, x_a)$. For simplicity we assume the CBD to be located at $x = 0$ and the urban amenity to be located at $x_a$with $x_a > 0$. Households take the level of urban amenities as given when choosing residential locations.

Households have preferences defined over urban amenities at their dwelling sites, A, housing services, Q, and the consumption of a composite non-housing numéraire good, C. Specifically, the household utility function is assumed to be:

$$U = u(Q, C) + \varphi(A) \tag{3.1}$$

where $u(\cdot)$ is utility from non-amenity goods and quasi-concave, and $\varphi(\cdot)$ is utility from urban amenities and concave. The urban amenity function is represented as follows:[4]

$$A = \frac{\tilde{A}}{N} f(x_a, x) \tag{3.2}$$

where $\tilde{A}$ represents the urban amenity capacity, N is the external consuming group size and $f(x_a, x)$ is a distance function that captures how far the household is located from the urban amenity. For simplicity, we assume that congestion effects associated with the urban amenity come from external (non-resident) visitors N.

Representing income by y and commuting cost per mile t, disposable income at distance x is given by $y - tx$. Households consume housing with a rental price of R and a composite good with unit price, and have the following budget constraint:

$$y - tx = QR + C \tag{3.3}$$

Households maximize utility 3.1 with respect to budget constraint 3.3 by choosing x, C, Q and taking urban amenities as given. The first order conditions for the maximization problem yield the optimal choices of housing services and non-housing goods as:

$$C^*(y, t, R, x) \qquad Q^*(y, t, R, x) \tag{3.4}$$

Substituting these ordinary demand functions back into 3.1 yields the indirect utility function. In a spatial market equilibrium households must have no incentive to relocate, thus households attain the same exogenous level of utility $\bar{V}$, regardless of their location in the city.

$$V\big(y, t, R, x, \tilde{A}, N, x_a\big) = \bar{V} \tag{3.5}$$

Equation 3.5 implicitly defines the households rental bid price function for housing as:

$$R(y, t, x, \tilde{A}, N, x_a, \bar{V}) \tag{3.6}$$

The expression in 3.6 represents the price households are willing to pay for a unit of rental housing services at location x. When rents vary by 3.6 across the city, household utilities are identical across locations and households have no incentive to relocate.

To the extent that our model allows spatial variation in urban amenities, the spatial pattern of housing rents emerging from our model is more complicated than in the standard monocentric city model. In particular the willingness to pay for rental housing may no longer be a monotonically

[4] Exogenous urban amenities are modeled generally here. Brueckner et al. (1999) categorize exogenous urban amenities to include both historic (urban infrastructure from past eras) and natural (topographical features). Empirically this research focuses on historic amenities.

decreasing function from the CBD as seen in 3.7, since households may be willing to sacrifice proximity to the workplace for local urban amenities:

$$\frac{\partial R(y,t,x,A,\bar{V})}{\partial x} = \frac{1}{Q}\left\{-t + \frac{\tilde{A}}{N}\frac{\varphi_A f_x}{u_C}\right\} \lesseqgtr 0 \tag{3.7}$$

From Rental Price to Property Value

If the residential market works in accordance with conventional economic theory then the price of a house should be such that buyers are indifferent between renting and owing. Note however that rents are determined in the residential market for space use, not in the asset market for ownership. Equation 3.6 thus captures the fundamental forces driving residential rents. On the other hand when investors acquire an asset (real estate property), they are actually acquiring a current and future income stream. In a frictionless market, residential rents should cover the user cost of a property such that:

$$R_t = (i_t + d_t + m_t)P_{x,t} - \left[E_t\left(P_{x,t+1}\right) - P_{x,t}\right] \tag{3.8}$$

where i, is the interest rate, d, depreciation, and maintenance costs, m. Expected capital gains (or losses) are represented by the expected change in property value P_x between periods for investor at location x.

Rearranging 3.8 gives the equation for residential housing price in period t for investor (at location) x. This price is driven by the imputed rent, interest rate, depreciation rate and maintenance as well as from expected price in the following period.[5] For simplicity, we have that in equilibrium imputed rents are equal to market rents.

$$P_{x,t} = \frac{R_t}{1 + i_t + d_t + m_t} + \frac{E_t\left(P_{x,t+1}\right)}{1 + i_t + d_t + m_t} \tag{3.9}$$

Following Hott (2009) and Franco and Cutter (2014),
regarding the future property price depends on both social and non-social signals. Informational influence affects expectations of real estate price appreciation if investors look to others in deciding whether or not their real estate purchase will generate capital appreciation. In this sense, we write the expectation regarding future price as:

$$E_t\left(P_{x,t+1}\right) = (1-\lambda)E_t\left\{\sum_{j=1}\frac{R_{t+j}}{\prod_{n=1}^{j}(1 + i_{t+n} + d_{t+n} + m_{t+n})}\right\} + \lambda P_{-x,t} \tag{3.10}$$

where λ captures the magnitude of the information spillovers and weight that an investor x places on the value of all neighboring properties $P_{-x,t}$ at time t

[5] Imputed rents are defined as the implicit rent for home owners which account for the fundaments of rent interests, depreciation, and maintenance.

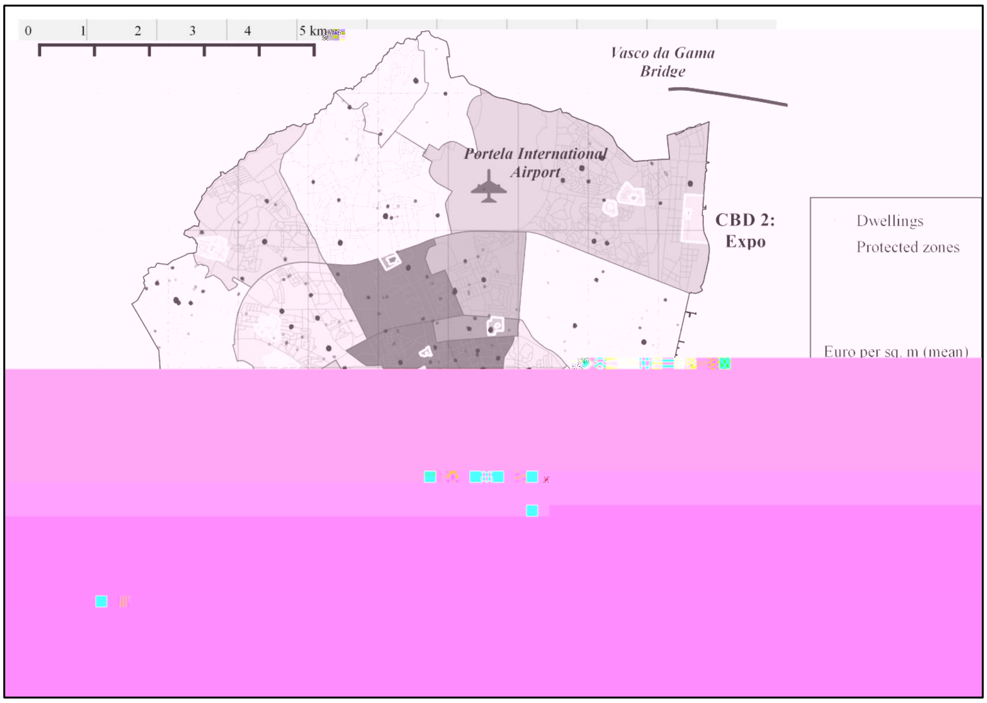
in the following period is the weighted sum of his expected stream of future rents and current value of neighboring properties.

or "Expo", is now a highly active commercial and residential area of the city located further inland along the river.

The main international transportation hub is the Lisbon Portela international airport and there are two further international train stations, one in each CBD, linking Lisbon to destinations in Spain and France. Two bridges connect the city to municipalities and motorways on the south of the Tagus River: the 25th of April Bridge and the Vasco da Gama Bridge. North of the 25th of April Bridge is the

Though many buildings were destroyed in the Great Earthquake of 1755, Lisbon maintains a rich history, and its historic buildings and cobblestone streets are juxtaposed against the newer buildings of modern Lisbon. Furthermore, the city has a wide variety of historic amenities representing Portuguese culture and history throughout the centuries. These amenities were primarily erected in the historic downtown core and concentrated along the river towards the historic zone of *Belém* located in the west, a pattern seen in many European capital cities. Overall, we identify twelve landmarks of prominence within the city due to their historic, architectural and touristic significance. Included among these landmarks are the Castle of St. Jorge, the National Pantheon and the two UNESCO World Heritage Sites, the Belém Tower and Jerónimos Monastery.

***Figure 1.* Protected Zones: Lisbon, Portugal**



The city also has designated special protected zones as seen in Fig. 1, including both monuments and surrounding green spaces and related areas relevant for historic or cultural reasons. The national department for culture and heritage (*Direção-Geral do Patrimonio Cultural)*, manages the designation of all protected zones and monuments, which are accompanied by a 50 meter protective buffer zone. Such areas have the goals of ensuring the preservation of the landscape and the visual integration of designated properties including green and public spaces relevant to this context. The locations of these protected zones are represented in figure 1 along with freguesia average price per square meter and dwelling locations. Figure A1 of the appendix presents the location of landmark and non-landmark historic amenities in the city.

4.2. Data

Residential property data for 2007 is obtained from *Confidencial Imobiliário*, a Portuguese organization providing information regarding the Portuguese real estate market. Observations without appropriate data for geo-coding were removed. The database contains the asking bid price and price per square meter of the property, a vector of structural characteristics (e.g. area, parking, view) and location characteristics (partial address, zip code, *freguesia*) for 11,708 two-bedroom apartment dwellings in the city.[8] The data were geo-coded, which allows for the assignment of each house to any spatially aggregate administrative district (such as a *freguesia* or city blocks). Geo-coding is also needed for the computation of an interpolated air quality value at the location of each housing unit (at the *freguesia* level) as well as to create spatial accessibility measures.

The locations of dwelling observations are illustrated in figure 1. The highest observation densities are found in the *freguesias* of *São Miguel* and *Socorro*, while average housing bid prices are highest in the *freguesia* of *Mártires*, all located in the primary CBD.[9] From figure 1, this area has high bid prices per square meter of living space. All 53 freguesias are represented by housing observations with the lowest density of 2.44 observations per hectare in *Marvila*.

We construct a geo-coded database of categorized historic amenities in Lisbon. Urban historic amenities are defined in accordance with the UNESCO definition of tangible and immovable cultural heritage. The final historic amenities of interest in this study include churches, palaces, lithic (stone) structures or other residual historic amenities (e.g. statues, fountains, funiculars) greater than 50 years old with landmark amenities within each group highlighted.[10]

From the collection of all historic amenities in the city we focus solely on those providing an external effect rather than analyzing residential premiums for properties with heritage designation. Buildings with official heritage designation (due to their façades or historic importance) are excluded from being considered a historic amenity and include theaters, cinemas, hotels, shops, transport stations,

[8] Although transaction prices are favored we are limited to using asking bid prices, which may introduce a positive bias in the results. This bias is consistent across all observations, and estimation results remain meaningful.
[9] *Mártires* was one of the oldest civil parishes dating to 1147. Despite having less than 400 inhabitants in an area of 0.10 km^2, the parish housed important historic amenities such as the Lisbon Opera House - Teatro Nacional de Sao Carlos (from 1793), the Basilica de Nossa Senhora dos Martires from the 18th th century and the statue of the Portuguese Poet Fernando Pessoa in Largo do Chiado. At the administrative reorganization of Lisbon on December 8, 2012 this parish was amalgamated with others in *Baixa* to become part of the parish *Santa Maria Maior*.
[10] Prior to 1964.

museums, hospitals and schools. These structures serve a dual purpose providing services to the community and are controlled for in their own respect. Further exclusions include churches or palaces that have been abandoned or become derelict. The final total includes 173 historic amenities: 74 churches, 33 palaces, 14 lithic structures and 52 other with the distribution of these amenities across historic areas of the city located in table A1 of the appendix and a full list of individual historic amenities located in table A2. The collection is built and categorized from various sources including *Câmara Municipal de Lisboa*, the Portuguese Ministry of Culture - *Instituto de Gestão do Património Arquitectónico e Arqueológico*, and the *Instituto da Habitação e da Reabilitação Urbana*.

Geo-referenced shape files of dwellings and historic amenities are created using **ArcMap 10.2**. These were imported to **R 3.1.2** to develop measures of local amenities for each dwelling. In particular, we generate distances to individual historic amenities to determine a dwellings proximity to alternative groupings of these amenities. This includes distance to the nearest monument overall, the nearest mutually exclusive landmark, non-landmark, or world heritage site, or the nearest historic amenity type of church, palace, lithic structures or others. We also calculate historic heritage concentration for varying buffer distances surrounding a dwelling location (50, 100 and 1000 meters).

Within each *freguesia*, city block census tracts are the primary unit of analysis for Census 2011 neighborhood level variables including population density, socio-demographic variables on education level and age, and variables related to the stock of buildings including the percentage of non-residential buildings, percentage of vacant buildings and percentage of buildings built in different decades since 1919. We further include the stock of neglected and dilapidated buildings within 1000 meters of housing observations using data obtained from *Câmara Municipal de Lisboa*. In total Lisbon is divided into 3,623 city blocks with an average of 69 per *freguesia*, of which our observations fall into 307.

Local urban amenities in Lisbon are obtained through the *Lisbon City Service Development Kit API* providing the geo-coded locations of different categories of amenities in the city. Using these locations, we calculate distances to control for proximity to employment centers, airport, health and education locales, fitness centers and stadiums, train stations, shopping centers, art amenities (i.e. galleries and museums) and culture amenities (i.e. libraries, theatres, auditoriums and cinemas). Endogeneity is expected due to potential causal relationship between housing prices and the location of art and culture amenities. Without an appropriate instrument, we include only those arts and culture amenities established at least ten years prior to the listing of dwellings in 2007 with arts and culture amenities built or established after 1997 excluded. We further control for the number of open spaces within given buffers and proximity to the nearest open space as a proxy for overall availability of green spaces in the neighborhood.

Maps from *Câmara Municipal de Lisboa* used for urban planning provide the location of freeways, metro stations (prior to 2007), bridges, viewpoints and regions in the city of high seismic risk or risk of flooding.[11] Further variables are constructed based on proximity to these urban features. The location of protected zones are also obtained from such maps and used to determined dwelling observations located in such areas. As the city of Lisbon sits atop many hills, the elevation profile and altitude of dwelling observations is obtained using ArcGIS Online maps with further interactions between a dwelling's elevation above sea level and proximity to city viewpoints. In particular, we are able to determine the focal point of each viewpoint and whether they overlook the Tagus River, a general view of the city or have a full 360 degree view.

Additionally, average income at the *freguesia* level comes from the Ministry of Finance and obtained via *Câmara Municipal de Lisboa*. Average income in this respect is based on IRS tax submissions for the 2007 year.

Data on air pollution comes from *Agência Portuguesa do Ambiente* (QualAr). In particular, air pollution in the form of PM_{10} particulates is obtained from air quality monitoring stations located across the city.[12] As the location of these stations are not aligned with any administrative boundaries, the values of particulates are interpolated from the point locations of the stations to the midpoint locations of the *freguesias*. Moreover, in order to obtain sufficient variability (particulate measures are highly seasonal and spatially heterogeneous), we choose the average of the daily maximum for the worst quarter in 2007, derived from the hourly readings for all six stations.

Metadata and descriptive statistics for all variables included in the analysis are presented in table A3 and A4 of the appendix.

5. Empirical Methodology

5.1 Standard Hedonic Pricing Model

involve looking at the price of comparable houses in the neighborhood such that a dwellings listing price or assessment value is determined in part by the value of neighboring dwellings through a signaling mechanism quite often used by realtors, developers and other agents in the real estate market. This implies a direct spatial relationship between property values (dependent variable) in the sense that the price of a ence the price of other houses located relatively nearby, and vice-verse. In omitting spatially lagged housing prices, the classical OLS assumptions are violated with correlation between the error term (which captures the omitted variable) and the regressors and estimates for the remaining regressors will be biased and inconsistent (Anselin 1998).

Alternatively, omitted or unobserved variables such as outdoor maintenance expenditures or public perception of certain areas in a city may be correlated in space through an externality mechanism, which in turn can influence property prices in a particular neighborhood. Under Gauss-Markov assumptions the covariance between error terms must be zero, and when this unobservable spatial dependence between housing prices is present, this assumption is violated. With positive spatially autocorrelated errors, OLS tends to underestimate standard errors in hedonic regressions. If these unobserved amenities are correlated with neighborhood housing prices, OLS also yields biased coefficient estimates.

Spatial Weight Matrix

Let N represent the number of observations in our dataset. The $N \times N$ spatial weight matrix $\mathbb{W}$ describes for each observation in the sample which other nearby observations may be considered as its neighbors - i.e. which observations in proximity have an influence, and the level of intensity of this influence. This matrix is nevertheless a priori fixed and its elements take the following values:

$$w_{ij} = \begin{cases} 0 & i = j \\ f(w) & i \neq j \end{cases} \tag{5.2}$$

where $f(w)$ represents the neighbor weighting function.

We adopt two binary weighting scheme to indicate neighbors based on the 100 nearest dwellings and all dwellings within a radius of 500 meters. Within a 500 meter radius a dwelling has on average 400 neighbors and this distance covers a handful of city blocks, a reasonable area to define a neighborhood in which local amenities such as grocery stores are located. Specifying the 100 nearest dwellings allows for a tighter definition of neighbors and based on the dispersion of observations in the city, corresponds to dwellings located within a few streets of each other. We further include an inverse distance and inverse squared distance weight for neighbors within 500 meters.

For symmetric weight matrices based on neighbors within 500 meters and the inverse weights, we use the Cholesky decomposition algorithm for sparse matrices to obtain numerical solutions for the coefficient and standard error estimates. When working with the non-symmetric nearest 100-neighbors matrix, we use the LU factorization method. Table A5 of the appendix summarizes the properties of the 11,708×11,708 spatial weights.

5.2. Global Spatial Models

The general spatial hedonic form can be expressed as follows:

$$P = \beta_0 + \sum_{k=1}^{m} \beta_k z_k + \rho_{lag} \mathbb{W}P + \varepsilon \tag{5.3}$$

$$\varepsilon = \rho_{err} \mathbb{W}\varepsilon + u \qquad u \sim iid(\mathbf{0}, \sigma^2{}_{\mathrm{n}}) \tag{5.4}$$

where the m regressors z capture the effects on housing prices attributed to dwelling characteristics, S, neighborhood attributes, B, accessibility, D, and historic amenities, H. We account for spatial dependence by incorporating either the spatially lagged dependent variable $\mathbb{W}P$ with respective coefficient ρ_{lag} or by modeling the original OLS error ε as an autoregressive error term accounting for spatial correlation, $\mathbb{W}\varepsilon$, with respective coefficient ρ_{err} or by the inclusion of both terms in a mixed model whereby u follows classical error term assumptions. To simultaneously estimate these lag coefficient and β_k parameters spatial models are estimated via maximum likelihood method. From the above general specification, when $\rho_{lag} = 0$ we have a spatial error model (SEM) and with $\rho_{err} = 0$, the spatial autoregressive model (SAR).[13] With economic intuition for the inclusion of both such spatial dependencies, we further estimate the mixed spatial autoregressive model with autoregressive disturbances (SARAR) which includes both such spatial dependences.

5.3. Local Spatial Model

The OLS and spatial hedonic models are limited to estimating average global effects that historic amenities have on housing prices without accounting for potential spatial heterogeneity in the data. Global models assume a singular urban housing market, while in practice this assumption of spatial stationarity is rigid and it is likely that effects vary depending on location in a city. The effect of historic amenities in a historically rich downtown core may be different than the effect of historic amenities near the city limits.

Using nonparametric GWR models, we explore spatial non-stationarity by allowing for the estimation of coefficients at each location i using a weighted sub-sample of the data. This yields estimated effects attributed to each observed property value with regressor parameters varying across space (Brunsdon et al. 1996, Helbich et al. 2014, McMillen and Redfearn 2010). Such models capture the localized effect on residential housing prices attributed to specific historic amenities.

Geographically weighted parameter estimation uses the generalized method of moments framework. Coefficients are estimated at each observation location with a decaying Gaussian function used to obtain the entries of the individual $N \times N$ spatial weight diagonal matrix for each observation, weighing respective neighbors based on distance between observations and the optimal bandwidth for neighbor inclusion. Here, the optimal bandwidth window over which the local estimates of the

[13] When conducting respective LM tests, the hypothesis being tested is the significance of these parameters.

coefficients are estimated and used to weight the distance between observations is computed using cross validation and is adaptive in the sense that at each location the optimal number of nearest neighbors is used for local estimation.

6. Empirical Results

Historic amenities are introduced according to two attributes. First we differentiate between churches, lithic structures, palaces or other historic amenities, and second we highlight prominent landmark sites within each category which are assumed to have different impacts due to their size and significance to the city of Lisbon. Additionally, we isolate the effect due to the two UNESCO world heritage sites. To capture different impacts we estimate our models with distance to nearest amenities as well as the number of amenities within buffer zones to capture ensemble effects from the concentration of historic amenities. Using the location of protected zones in Lisbon, we further capture the effect of living in these areas on housing prices. The most preferred models under the concentration, proximity and protected zone specifications are presented with additional OLS estimates for alternative amalgamations of historic amenities available upon request.[14]

6.1 Global Diagnostic Tests

Multicollinearity and Heteroskedasticity Diagnostics

Measuring distance to historic amenities may potentially introduce multicollinearity between predictor variables as determined by the variance inflation factor (VIF). We control for distance to the primary CBD in all models, and introducing distance to historic amenities is problematic with many of these amenities, especially landmarks, clustered in this area as seen in the appendix figure A1. Models capturing the effect of proximity to historic amenities are limited in the level of disaggregation possible, with proximity to landmarks and world heritage groups introducing multicollinearity and therefore excluded from the analysis. Our VIF estimates indicate no multicollinearity in the concentration of historic amenities, with all statistics below the threshold value of 10.[15]

Results from the Breusch-Pagan test indicates the presence of heteroskedasticity in the OLS residuals, and thus robust standard errors are reported.

[14] Although the bulk of historic amenities are located outside the historic CBD (as seen in table 1), it is likely that the location of these amenities in the CBD are not exogenous when, for historical reasons, they would have been erected in the oldest and most central areas of the current city. To ensure results are not affected by the clustering of historic amenities in the primary CBD and historic area of the city (*Baixa* and *Belém* respectively) we remove observations from these areas and re-estimate the effects of historic amenities on the subset of all housing observations (N=11,251) located in non-historic areas of the city. Global OLS estimates for this subset yield consistent results with matching significance levels and patterns. Non-historic subset results available upon request.

[15] Some control variables, namely distance to the primary and secondary CBD as well as those used in creating interaction terms, have VIF levels above the threshold of 10. We are not interested in making inferences on these variables and the performance of the model is not influenced since multicollinearity only affects the standard error of variables with high VIF values. Estimates and standard errors for historic amenity variables of interest remain suitable for analysis. Full VIF estimates available upon request.

Tests for Spatial Dependence

Spatial regressions are extended to three classes of OLS models capturing varying impacts of historic amenities: (1) location inside a protected zone (along with interaction effects); (2) landmark and non-landmark historic amenity concentration by type; and (3) proximity to historic amenity types.[16]

Results from the Breusch-Godfrey test on the residuals of each OLS model suggest the presence of residual autocorrelation. These results indicate some underlying relationship influencing the data which is confirmed with the Moran I test statistic indicating significant positive global spatial autocorrelation in both the dependent variable and residuals. Table A6 of the appendix summarizes our test statistics of spatial dependence.

Spatial Lagrange multiplier (LM) tests are conducted to formally test for spatial dependence in the dependent variable and the error component of the OLS specifications. Results indicate significant LM and robust LM statistics across all weight matrices, indicating that the SEM, SAR and SARAR models are all appropriate for further spatial analysis. Out of these spatial specifications the preferred model is chosen based on the AIC and variable significance estimated under the different spatial weight matrices.

Choice of Spatial Model

Across specifications, spatial hedonic models improve over OLS models with decreases of up to 4% in the residual sum of squares (SSE). As expected, coefficient estimates for the spatial parameters associated to the SEM, the SAR and the SARAR are significant and indicate positive spatial dependence. Comparing the spatial models against their baseline OLS, results from the likelihood ratio and Wald test are consistent with the global Moran's I and LM tests and indicate significant spatial dependence.

Table 1. **Global OLS and SEM Diagnostics (SW1)**

	N	Global Adj. R^2	AIC	SSE	Rho Err	Wald Statistic	LR Statistic
Protected Zones							
OLS	11,708	0.6598	-2926.7	528.35	-	-	-
SEM	11,708	-	-2974.4	525.08	0.120	54.7***	49.6***
Protected Zones (Interactions)							
OLS	11,708	0.66006	-2930.5	527.73	-	-	-
SEM	11,708	-	-3091.7	517.55	0.444	185.0***	163.7***
Historic Amenity Concentration							
OLS	11,708	0.66174	-2977.8	524.61	-	-	-
SEM	11,708	-	-3015.9	521.96	0.109	37.9***	40.1***
Historic Amenity Proximity							
OLS	11,708	0.6612	-2971.8	526.05	-	-	-
SEM	11,708	-	-3008	523.53	0.106	30.8***	38.1***

*Notes: ***Significance at 1 p.c. level; **Significance at 5 p.c. level; *Significance at 10 p.c. level.*

[16] With a log-log specification we estimate the price elasticity of distance to historic amenities.

Significant variables under the OLS specification remain so under the spatial models. Using the AIC model selection criteria, all spatial models outperform their OLS counterpart and further all have reduced SSE. Based on the combination of LM tests, AIC and variable significance the preferred model is the SEM with inverse distance spatial weight (SW1) and subsequent analysis and comparisons focus on this model. Table 1 summarizes the AIC and SSE values as well as the LR and Wald test estimates for the alternative estimated spatial models under the weight matrix SW1.[17]

6.2. Global Model Results

OLS and SEM estimates for proximity to historic amenities, concentration of historic amenities, and dwellings in a protected zone are shown in table 2 (a, b, and c respectively) with complete list of estimated coefficients presented in table A7 in the appendix.[18] In addition to historic amenities, we report the effects of environmental amenities and neighborhood architectural characteristics capturing the overall locational ambiance which complements historic amenities. Further, we report impacts from elevation, view, flooding and seismic hazards which are specific to the geography of the city.

6.2.1. OLS Hedonic Price Results

Across all specifications structural, neighborhood and accessibility coefficients are consistent with expectations. Area is the most significant driver with a positive elasticity of housing price to square meterage. Other dwelling characteristics contributing positively to the value include whether the house is new, whether there is air conditioning and whether there is a pool.

At the local neighborhood level, higher population densities reduce property values while areas with higher average income command housing premiums. In terms of building stock characteristics, dwellings are negatively influenced by the number of neglected and dilapidated buildings within a 1000 meter radius while higher percentages of non-residential buildings in a city block, which proxies the level of mixed use of a neighborhood, increases prices. Neglected buildings are not only unsightly and more susceptible to fires but may attract unwanted activity in the form of squatters or usages for illicit purposes, signaling lower quality neighborhoods.

The city block percentage of buildings built in different time periods reveal that higher stocks of buildings built prior to 1919 and between 1946 to 1960, 1961 to 1970 and 1981 to 1990 have a positive effect on housing prices. This seems to suggest that buildings from different eras with respective stylistic, architectural, historic and quality characteristics are valued differently.

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[17] Full results on all SEM, SAR and SARAR estimates under each weight matrix defined in section 5 can be obtained upon request from the authors.

[18] In an attempt to capture potentially important neighborhood effects, interaction terms between our definitions of historic amenities and population density, distance to CBD's, distance to open space, distance to metro and *freguesia* level average income were estimated. These interactions along with interactions introduced in the proximity and concentration models however introduced VIF values exceeding the threshold for the variables of interest, compromising their interpretation. Additional OLS and spatial results at various levels of historic amenities aggregations (e.g. monuments; landmarks versus non-landmarks) available upon request.

Table 2a. Global OLS and SEM Results: Proximity to Historic Amenities

Variables	OLS		Spatial Error	
	Coeff. (Std. err.)		Coeff. (Std. err.)	
Accessibility to CBD's				
log(Dist. to Baixa)	-0.08972***	(0.013)	-0.09032***	(0.0152)
log(Dist. to Expo)	-0.13886***	(0.015)	-0.13774***	(0.0172)
Environmental Amenities				
log(Dist. to Nearest Open Space)	-0.21159***	(0.064)	-0.21200***	(0.0695)
Count of Open Spaces 50 m	0.03147**	(0.012)	0.02911**	(0.0131)
Count of Open Spaces 200 m	-0.02544***	(0.004)	-0.02407***	(0.0046)
Count of Open Spaces 500 m	0.00623***	(0.001)	0.00608***	(0.0017)
Count of Open Spaces 1000 m	0.00183***	(0.000)	0.00184***	(0.0004)
log(Dist. to Freeway)	0.07342	(0.100)	0.06409	(0.1089)
log(PM10 Particulates)	-0.59421***	(0.173)	-0.60905***	(0.1875)
log(PM10 Particulates)*log(Dist. to Nearest Open Space)	0.05780***	(0.017)	0.05784***	(0.0193)
log(PM10 Particulates)*log(Dist. to Freeway)	0.05386***	(0.019)	0.05558***	(0.0212)
Architectural Ambiance and Neighborhood				
log(% Buildings built pre 1919)	0.00358***	(0.001)	0.00360***	(0.0006)
log(% Buildings built 1919 to 1945)	-0.00140**	(0.001)	-0.00150**	(0.0006)
log(% Buildings built 1946 to 1960)	0.00186***	(0.001)	0.00190***	(0.0005)
Natural Hazard Risk				
High Flood Risk Dummy	-0.05703***	(0.009)	-0.05619***	(0.010)
High Seismic Risk Dummy	-0.00852	(0.007)	-0.00918	(0.007)
Views				
log(Dist. to Viewpoint)	0.02762	(0.022)	0.03147	(0.024)
log(Elevation)	0.02701	(0.033)	0.03271	(0.036)
log(Dist. to Viewpoint)*log(Elevation)	-0.00396	(0.005)	-0.00493	(0.006)
Historic amenities (Proximity)				
log(Dist. to Nearest Church)	-0.00035	(0.004)	-0.00058	(0.004)
log(Dist. to Nearest Palace)	0.0007	(0.004)	0.00063	(0.005)
log(Dist. to Nearest Lithic)	-0.01026*	(0.006)	-0.01012	(0.006)
log(Dist. to Nearest Other)	-0.03462***	(0.004)	-0.03355***	(0.005)

Notes: ****Significance at 1 p.c. level; **Significance at 5 p.c. level; *Significance at 10 p.c. level.*

Table 2b. Global OLS and SEM Results: Concentration of Historic Amenities

Variables	OLS		Spatial Error	
	Coeff. (Std. err.)		Coeff. (Std. err.)	
Accessibility to CBD's				
log(Dist. to Baixa)	-0.12297***	(0.013)	-0.12243***	(0.0144)
log(Dist. to Expo)	-0.12135***	(0.014)	-0.12009***	(0.0154)
Environmental Amenities				
log(Dist. to Nearest Open Space)	-0.15821**	(0.063)	-0.16812**	(0.0673)
Count of Open Spaces 50 m	0.03043**	(0.014)	0.02826*	(0.0148)
Count of Open Spaces 200 m	-0.02316***	(0.004)	-0.02179***	(0.0048)
Count of Open Spaces 500 m	0.00831***	(0.001)	0.00812***	(0.0018)
Count of Open Spaces 1000 m	0.00169***	(0.0004)	0.00171***	(0.0004)
log(Dist. to Freeway)	0.21717**	(0.101)	0.20729*	(0.1102)
log(PM10 Particulates)	-0.45952***	(0.169)	-0.48822***	(0.1833)
log(PM10 Particulates)*log(Dist. to Nearest Open Space)	0.04062**	(0.017)	0.04337**	(0.0187)
log(PM10 Particulates)*log(Dist. to Freeway)	0.04527**	(0.019)	0.04719**	(0.0212)
Architectural Ambiance				
log(% Buildings built pre 1919)	0.00330***	(0.001)	0.00333***	(0.0006)
log(% Buildings built 1919 to 1945)	-0.00159***	(0.001)	-0.00166***	(0.0006)
log(% Buildings built 1946 to 1960)	0.00167***	(0.001)	0.00168***	(0.0005)
Natural Hazard Risk				
High Flood Risk Dummy	-0.05434***	(0.009)	-0.05327***	(0.0107)
High Seismic Risk Dummy	0.00764	(0.007)	0.0053	(0.0080)
Views				
log(Dist. to Viewpoint)	0.03256	(0.022)	0.03594	(0.0244)
log(Elevation)	0.027	(0.033)	0.03307	(0.0367)
log(Dist. to Viewpoint)*log(Elevation)	-0.00433	(0.005)	-0.00533	(0.0061)
Historic amenities (Concentration)				
Count of Landmark Church 100m	0.04393	(0.035)	0.04561	(0.0351)
Count of Landmark Church 1000m	-0.03441***	(0.007)	-0.03448***	(0.0074)
Count of Non-Landmark Church 50m	-0.00006	(0.061)	0.0057	(0.0625)
Count of Non-Landmark Church 100m	0.03999**	(0.017)	0.04244**	(0.0180)
Count of Non-Landmark Church 1000m	-0.00110***	(0.0003)	-0.00092**	(0.0003)
Count of Landmark Palace 50m	0.021	(0.041)	0.01606	(0.0408)
Count of Landmark Palace 1000m	-0.00204	(0.005)	-0.00048	(0.0057)
Count of Non-Landmark Palace 50m	0.09237	(0.072)	0.0902	(0.0720)
Count of Non-Landmark Palace 100m	-0.04642	(0.049)	-0.04183	(0.0492)
Count of Non-Landmark Palace 1000m	-0.00162	(0.001)	-0.00178	(0.0011)
Count of Landmark Lithic 50m	-0.08701	(0.063)	-0.08058	(0.0636)
Count of Landmark Lithic 1000m	0.03205***	(0.009)	0.02963***	(0.0096)
Count of Non-Landmark Lithic 50m	0.04198	(0.032)	0.04953	(0.0331)
Count of Non-Landmark Lithic 1000m	0.00623	(0.004)	0.00707*	(0.0041)
Count of Non-Landmark Other 50m	0.05710**	(0.026)	0.05886**	(0.0276)
Count of Non-Landmark Other 100m	-0.04451***	(0.017)	-0.04395**	(0.0176)
Count of Non-Landmark Other 1000m	-0.00087*	(0.0004)	-0.00093*	(0.0004)

Notes: ****Significance at 1 p.c. level; **Significance at 5 p.c. level; *Significance at 10 p.c. level.*

Table 2c. **Global OLS and SEM Results: Protected Zones**

Variables	**OLS**		**OLS with Interaction**		**Spatial Error**		**Spatial Error with Interaction**	
	Coeff. (Std. err.)		**Coeff. (Std. err.)**		**Coeff. (Std. err.)**		**Coeff. (Std. err.)**	
Accessibility to CBD's								
log(Dist. to Baixa)	-0.12852***	(0.012)	-0.13222***	(0.013)	-0.12749***	(0.014)	-0.12580***	(0.020)
log(Dist. to Expo)	-0.09321***	(0.013)	-0.08608***	(0.014)	-0.09443***	(0.014)	-0.07831***	(0.021)
Environmental Amenities								
log(Dist. to Nearest Open Space)	-0.22159***	(0.061)	-0.24350***	(0.063)	-0.22154***	(0.067)	-0.28329***	(0.092)
Count of Open Spaces 50 m	0.03497***	(0.012)	0.02057	(0.014)	0.03163**	(0.013)	0.0141	(0.015)
Count of Open Spaces 200 m	-0.02323***	(0.004)	-0.02282***	(0.005)	-0.02212***	(0.004)	-0.01719***	(0.005)
Count of Open Spaces 500 m	0.00663***	(0.001)	0.00784***	(0.001)	0.00639***	(0.001)	0.00535***	(0.001)
Count of Open Spaces 1000 m	0.00180***	(0.000)	0.00182***	(0.000)	0.00181***	(0.004)	0.00177***	(0.004)
log(Dist. to Freeway)	0.17527*	(0.097)	0.17888*	(0.100)	0.16025	(0.107)	0.15077	(0.151)
log(PM10 Particulates)	-0.60572***	(0.171)	-0.66647***	(0.173)	-0.62153***	(0.187)	-0.77595***	(0.248)
log(PM10 Particulates)*log(Dist. to Nearest Open Space)	0.05959***	(0.016)	0.06491***	(0.017)	0.05951***	(0.018)	0.07520***	(0.025)
log(PM10 Particulates)*log(Dist. to Freeway)	0.05160***	(0.019)	0.05610***	(0.020)	0.05382**	(0.021)	0.06139**	(0.029)
Architectural Ambiance								
log(% Buildings built pre 1919)	0.00384***	(0.0005)	0.00389***	(0.0005)	0.00384***	(0.0006)	0.00352***	(0.0007)
log(% Buildings built 1919 to 1945)	-0.00193***	(0.0005)	-0.00194***	(0.0005)	-0.00202***	(0.0006)	-0.00233***	(0.0008)
log(% Buildings built 1946 to 1960)	0.00213***	(0.0005)	0.00207***	(0.0005)	0.00215***	(0.0005)	0.00233***	(0.0007)
Natural Hazard Risk								
High Flood Risk Dummy	-0.05111***	(0.0096)	-0.04948***	(0.0098)	-0.05044***	(0.0105)	-0.04298***	(0.0140)
High Seismic Risk Dummy	-0.00837	(0.0072)	-0.00803	(0.0073)	-0.00898	(0.0080)	-0.01141	(0.0110)
Views								
log(Dist. to Viewpoint)	0.05990***	(0.02201	0.06036***	(0.0224)	0.06203**	(0.0243)	0.07534**	(0.0342)
log(Elevation)	0.07327**	(0.03315	0.07103**	(0.0339)	0.07645**	(0.0365)	0.09261*	(0.0512)
log(Dist. to Viewpoint)*log(Elevation)	-0.01153**	(0.0055)	-0.01120**	(0.0056)	-0.01210**	(0.0060)	-0.01518*	(0.0085)
Historic amenities (Protected Zones)								
Protected Zone Dummy	-0.01637*	(0.009)	-0.03114	(0.0231)	-0.01501	(0.0098)	-0.04873	(0.0336)
Protected Zone Dummy*No. of Dilapidated Buildings 1000 m			0.00026*	(0.0001)			0.00035*	(0.0001)
Protected Zone Dummy*No. of Open Spaces 50 m			0.08838**	(0.0361)			0.05343	(0.0413)

Notes: ****Significance at 1 p.c. level; **Significance at 5 p.c. level; *Significance at 10 p.c. level.*

landmark churches dominates given their size, prominence and cultural significance in relation to non-landmark churches which are in general used for more practical purposes.

Comparatively, palaces and other historic amenities have a strong positive price effect at 50 meters of 12% and 9%, however higher concentrations at 1000 meters have a reduced negative effect of 0.2% and 0.1% respectively. The local effects of these amenities are stronger than the effect of churches. While churches may be attributed with increased congestion and bell tolling during services, palaces and other historic amenities are primarily aesthetic and may not attract as many non-residents to the area. Similarly, landmark lithic structures (Castle of St. Jorge, Belém Tower and the Aqueducts) have a positive price effect of 3% within 1000 meters.

Although palaces in general have a positive effect on housing prices, when disaggregated into landmarks and non-landmarks, there is no significant effect. This suggests that the public's general perception of palaces is regardless of whether a palace is considered a landmark or not. In general, higher concentrations of palaces seem to be valued for their common architectural traits and surrounding open space and not for their size or grandeur.

In terms of proximity to historic amenities, monuments in general have a positive price effect. As distance to the nearest monument decreases, residential prices increase by approximately 0.01% per meter. There is little difference in the effect of landmark and non-landmark amenities both increasing prices by similar magnitudes to monuments overall. Similar to models of concentration, we see no effect when isolating world heritage sites.

Both lithic and other historic amenities have a positive effect on prices in the range of 0.01% and 0.03% respectively. This complements the measures of concentration which reveals that these amenities located within 50 meters are capitalized into housing prices.

6.2.2. SEM Results

In general, estimates from the spatial specification decrease in magnitude, correcting potential biases and inefficient standard errors by controlling for spatial dependence in the error term.

Dwelling characteristics remain significant and positively influence housing prices however, although average income remains significant its effect decreases among all spatial specifications indicating that spatial dependence captures some of the neighborhood quality effect which is signalled by income. Similar decreases in magnitude are seen in the negative effects due to higher neighborhood population density.

Flooding risk consistently has a significant and negative effect on housing prices in the order of 5% across specifications after accounting for spatial dependence and although not significant, seismic risk in general tends to have a negative effect. A possible explanation is that while flooding incidents are frequent every year and well publicized, earthquakes even if frequent, are very subtle with larger ones quite rare. As a result, housing prices in Lisbon do not seem to capitalize seismic hazards from building collapse and fire hazards, reflecting only geographic differences in flooding risk even after removing the effects of spatial autocorrelation.

The amenity value of proximity to a scenic viewpoint maintains a negative and significant impact on housing prices when accounting for a dwellings location in a protected zone. This is perhaps due to pedestrian congestion from both tourists and locals with many viewpoints simultaneously acting as an alternative to the local nightlife with kiosks and patios serving food and drink until late in the evening. In contrast, housing prices rise as elevation increases since higher elevations are associated with some type of view and less risk of floods. Yet, the amenity value from being located farther from a scenic viewpoint rises as elevation of the dwelling increases and this interaction effect is still significant.

Even after controlling for spatial dependence we see positive and significant global spatial coefficients associated with buildings from different eras. This reveals that the market values different historic architectural features, which are themselves a testimony of the past and its influence on Lisbon's built heritage. The external effect from higher concentrations of buildings from different eras of Lisbon's history are found to have significant effects, with buildings built prior to 1919 generating a premium of 0.001% and those built between 1946 and 1960 generating a premium of 0.003%.

Accessibility variables follow economic intuition, with decreasing prices moving from CBD's in the order of 0.12%, and increasing prices from the airport of 0.06%. Note, nevertheless, that the importance of the significant spatial effects of proximity to *Baixa* and Expo vary across our three main specification models the same way as in the OLS model. Specifically, as we move from capturing historic amenities through protected zones to heritage concentration at certain radii to cultural heritage proximity in meters, the importance of being located near *Baixa* decreases (from 0.127% to 0.122% to 0.090%) while the importance of being located near Expo increases (from 0.094% to 0.120% to 0.137%). This is actually in accordance with the fact that *Baixa* is not only the main hub of historic amenities but it is simultaneously an important shopping and banking district in the city. As finer and more disaggregated measurements of historic amenities are included, the more disentangled these two effects can be traced in the model.

Protected Zones

Baseline OLS estimates indicate that being located in a protected zone has a negative impact on housing prices in the range of 1.6%. Controlling for spatial dependence or spatial heterogeneity via interaction effects however renders this effect insignificant indicating that global OLS models may incorrectly attribute a negative effect to protected zones due to the underlying spatial relation.

While a protected zone provides guarantees that surrounding properties will not be demolished and replaced, or their exteriors modified in ways that are not in harmony with the historic character and integrity of the neighborhood, this type of zoning curtails a homeowner's property rights which may negatively impact housing values. In the case of Lisbon, this problem was compounded not only by the ownership system, mostly vertical, but also by the existence of rent control laws (abolished only in

2012), which greatly contributed to the lack of investment and under keeping of the housing stock in historic areas and elsewhere in the city. Over the last 20 years, the municipality of Lisbon and other Portuguese public agencies related to the rehabilitation of the urban housing stock and preservation of historical buildings, have provided public grants and other fiscal advantages to homeowners/landlords wishing to restore or rehabilitate their properties within such districts in attempt to incentivise investment, renewal and gentrification of historic areas in *Baixa*.

The vast majority of Lisbon's protected zones house a disproportionate amount of buildings and landscapes that have special architectural, social and historic interests compared to other locations in the city, and some protected zones even overlap with districts that carry a prominent status because of the landmark monuments within their boundaries. As such, these latter protected zones may carry more prestige than that conveyed by simple local designation.

It is interesting to note then, that negative price discounts are still observed in spatial models of protected zones, however because the effect is not statistically significant we cannot infer that the disadvantages stemming from restrictions on property rights and past housing regulations are largely balanced by the positive effects from preserving the charm of these neighborhoods and from the public fiscal incentives to rehabilitate housing units in historic zones. Further, we cannot state that residential values in protected zones are lower compared to zones without this designation.

It is also worth pointing out that protected zones in *Baixa* are replete with post-earthquake architectural marvels from the 18th-century onward, aesthetically pleasing wide streets and avenues. In contrast, inland inner-city protected zones north of *Baixa* namely in the neighborhoods of *Bica*, *Alfama* and *Castelo* are characterized by dense housing stocks of low quality and very long narrow streets inherited from Medieval eras. These areas are also known for their lack of parking and social facilities. As these two examples illustrate, some protected zones may have a set of other locational attributes not valued by the market despite the historic characteristics which make these areas worthy of designation. This, in turn, would imply that the market valuation of residing in protected zones may differ across space.

Two remarks are therefore in order. First, the choice of protected zones and thus which parts of Lisbon are worth preserving may be correlated with unobserved location attributes, which may have biased the previous OLS coefficient on protected zones. Second, the global spatial coefficient related to protected zones may still be biased if there is difference in unobserved housing quality or in the level of stringency of local preservation ordinances in these zones. As such, global spatial estimates may mask locational variations in historic amenity values.

Including interaction effects with protected zones from table 2c indicates that unobservable location effects may be responsible for driving the significance of the effect under the OLS specification. By including interactions with the number of dilapidated dwellings within 1000 meters and open space buffers at 50 meters, OLS results for the impact of protected zones on housing prices are no longer significant. Yet, these OLS interaction coefficient estimates are positive and significant suggesting that being located in a protected zone attenuates the disamenity value associated with blight and increases the amenity value of very localized green surroundings. Thus, historic ambience and open space seem to be complementary goods. After controlling for spatial dependence in the error term, significant interactions of protected zones and open space buffers at 50 meters are no longer significant, though a positive and significant value for the interaction between protected zones and dilapidated dwellings within 1000 meters remains. This is an interesting result since it seems to suggest that this zoning regulation may reduce the negative effects of concentration of neglected buildings on property values by creating an incentive for rehabilitation in these areas and by setting regulations that ensure that these chronic eyesores do [20]

Historic Amenities

Results when disaggregating by type of historic amenities are in line with the conclusions from OLS estimation and show that different categories elicit different effects on housing prices. It is thus important to take into account the heterogeneity of historic amenities when conducting such analysis.

Spatial results indicate that higher concentrations of landmark and non-landmark churches in a 1000 meter radius have a negative impact on prices, with landmark churches having a greater effect. Locally (within 100 meters) the use value of a non-landmark church is significant at around 4.2% with residents valuing the accessibility to a congregation point. This contrast between the effects of churches locally versus 1000 meters is potentially due to congestion effects that are generated by churches which provide active services to the communities and are a localized meeting point drawing in both residents and non-residents for weekly mass, weddings and funerals. Although having a church nearby may be a benefit to residents, additional non-landmark or landmark churches in the area beyond the first serve little purpose to residents and may in fact have negative externalities with the tolling of bells and high activity during services. With more activity occurring around landmark churches, which additionally draw in tourist and those not in the congregation, this negative impact on price is more pronounced.

Whereas churches actively provide services to the public, lithic and other historic amenities are primarily purely aesthetic with little non-use value to non-local residents. When controlling for spatial dependence, we see that non-landmark lithic structures elicit a positive effect on housing prices, an effect which is not captured under the standard OLS specification. Higher concentration of both landmark and non-landmark lithic structures therefore positively influence housing prices in the order of 2.9% and 0.7% respectively. As expected, the effect from landmark lithic structures is larger in magnitude reflecting the fact that landmark amenities have a greater non-use value to not only residents of the area, but also to other residents in the city and abroad.

[20] There are several fiscal incentives and grants to motivate maintenance and rehabilitation of buildings in protected zones. However, if a property owner fails to maintain his building(s) and allows severe deterioration to occur, he may be cited by the city to totally or partially demolish the building and must correct the violations or risk being fined for every day within violation. Through this process, the city works to address the problem of blighted properties in the local historic zones by getting property owners to act responsibly and perform minimal maintenance of their properties.

Even in controlling for spatial dependence, we see no significant effect from the disaggregation of landmark and non-landmark palaces. For other historic amenities however more amenities within 50 meters is positive but, similarly to the baseline OLS specification, higher concentrations of these amenities in 100 or 1000 meters has a negative effect. While housing prices capitalize a positive effect from being in an area with historic amenities, too many of these amenities in the broader area may be reflective of areas which are dense with historic amenities and attractive to non-residents.

In terms of proximity to historic amenities, other historic amenities consistently have a positive effect on housing prices in the range of 3.3%. When controlling for spatial dependence, this magnitude is slightly lower than under the baseline specification. Although the effect of proximity to lithic structures in general had a positive impact on housing prices in the baseline model, this effect is lost when estimating the spatial models.

6.3. Geographically Weighted Regression Results

In this section we explore the assumption that the effect of historic amenities on housing prices remains constant across locations in the city, complementing the global analysis of historic amenities by estimating localized GWR models. It should nevertheless be emphasized that this analysis is exploratory and not used for hard inferences on exact magnitudes but rather to discuss spatial patterns.

Local Multicollinearity

The effects of multicollinearity are amplified in localized regressions due to the smaller spatial sample used for estimation, and if spatial heterogeneity exists within the data some locations may exhibit local multicollinearity while others do not (Wheeler and Tiefelsdorf 2005). In estimating these models we remove dummy and count variables due to their limited variability since geographic subsets of these variables may imply perfect multicollinearity rendering the model indeterminable.[21] This implies thus that GWR models are estimated exclusively using proximity to historic amenities as our measure of interest so as to measure the elasticity of housing prices with respect to monument proximity.

Including many predictor variables measuring distance to amenities may introduce high correlation in the model. Further to removing dummy and count variables, we make use of a principal component analysis (PCA) to reduce multicollinearity from control variables from which we make no inferences.[22] Our historic measures of interest are not included in this PCA transformation and enter independently to model the effect that proximity to categories of historic amenities have on housing prices.[23]

[21] For example we may be unable to estimate GWR parameters at a location in the city where the geographic subset of dwellings are all non-new (*new=0*) and without a view of the Tagus (*view=0*).
[22] The PCA technique creates linearly independent vectors (principal components) that captures the variability exhibited in the control variables, with the principal components included in the model in place of the control variables themselves.
[23] This is just one way in which multicollinearity can be addressed. We have further explored ridge GWR techniques (RGWR) where standard GWR models are extended by introducing a small bias to the diagonal (ridge) of the design matrix to increase the difference between the diagonal and off-diagonal elements, which represent the co-variation between predictors (Wheeler 2007). A spatial ridge parameter is estimated at each location in such a way as to ensure local condition numbers less than or equal to a threshold value of 30. RGWR provides similar spatial patterns and

Multicollinearity is diagnosed using the local version of the VIF from which we interpolate and plot the contours of the areas within which the local VIF values meet the threshold criteria of less than 10. In these areas, multicollinearity is not expected to influence the estimates and we further highlight areas of mild multicollinearity (with VIF values between 10 and 20). We make no inferences from estimates in areas that have local VIF values above 20, as these estimates are not robust.

GWR Diagnostics

Where appropriate, diagnostic results and estimates from the GWR procedure are compared against a baseline OLS and SEM spatial hedonic model with identical specifications. GWR estimations yield 11,708 coefficients for each parameter that can be mapped across the study area. We estimate different specifications focusing on: (1) proximity to monuments in general, (2) proximity to mutually exclusive landmark, non-landmark and world heritage site, and (3) proximity to the nearest church, palace, lithic structure or other historic amenity.

Table A8 of the appendix presents model diagnostics for the GWR specifications and comparable OLS and SEM models. There are improvements when moving from global to local models in terms of the SSE in the order of an 8% reduction. Diagnostics from the GWR specification indicate a strong fit with the lowest AIC value and a higher global R^2 in comparison to the OLS specification. The Moran I statistic indicates positive spatial autocorrelation in the OLS residuals which is significantly reduced in either (global or local) spatial model.

In terms of multicollinearity, proximity to world heritage sites and landmarks in general are affected the most with high local VIF values from the GWR modelling. Given that these variables measure distances to a limited number of points in the city, it is intuitive that the local VIF values for these measures consistently exceed our threshold. As such, we make no inferences about the spatial variability of how the residential real estate market values world heritage sites or landmark amenities. Other measures of historic amenity proximity have appropriate VIF values which are mapped across the study area and are the focus of further analysis.

The index of spatial variation measures the relative variability of local GWR estimates in comparison to the global model, in which we impose that values greater than 1.5 indicate significant spatial variation in local estimates.[24] Further, Monte Carlo simulations are conducted to indicate whether the estimated coefficients vary significantly in relation to the null hypothesis that any random permutation of data across locations are equally as likely, with p-values indicating that the estimated coefficients for historic amenities from the GWR do indeed exhibit significant spatial variability.

The impact of proximity to other historic amenities has the least spatial variability according to our index. The residential real estate market thus consistently values these smaller non-landmark amenities

magnitudes of parameter estimates, however lack diagnostic values associated with these estimates and thus the GWR estimation procedure focusing on local VIF values for multicollinearity diagnostics are preferred.

[24] The Index of Spatial Variance is estimated as the standard deviation of all local estimated parameters as a fraction of the standard error of the OLS estimator.

which are numerous and located throughout the city. These amenities may therefore be estimated appropriately with global models whereas the remaining historic amenities of interest have significant spatial non-stationarity which is masked when using global techniques. Overall, the results from our test for spatial variability validates the use of a localized model for the analysis of this data.

GWR Impacts of Historic Amenities

For brevity, GWR estimates in table 3 are reported by quantile range. Under the OLS specification, proximity to churches and palaces have a negative price effect with prices increasing as we move farther from these amenities while other historic amenities have a positive price effect. After controlling for global spatial dependence proximity to other historic amenities remains significant, consistent with the previously estimated global models. Although the larger the bandwidth the more the GWR model parameters approach their global values, results indicate that marginal effects vary significantly across the study area. For example the coefficient value of the 25th percentile for proximity to the nearest monument is -0.0355 while the value at the 90th percentile is 0.0284. The distribution of the results of local estimates are presented in table 4. Consistent with the global models, lithic and other historic amenities in general have more GWR negative elasticities indicating more areas in Lisbon where prices are higher closer to such amenities.

Table 3. **GWR Results**

	OLS	Spatial Error (SW1)	GWR 25th Percentile	GWR Median	GWR 90th Percentile	Index of Spatial Variation	Monte Carlo P-Value
Monument Proximity							
log(Dist. to Monument)	-0.0035	-0.0010	-0.0355	-0.0178	0.0284	6.07	0.00
VIF	2.5898		3.9018	5.1913	11.1237		
Landmark, Non-Landmarks, World Heritage Proximity							
log(Dist. to Landmark)	0.0077	0.0094	-0.0245	-0.0135	0.0448	4.13	0.00
VIF	8.5685		10.0778	18.5665	75.0890		
log(Dist. to Non-Landmark)	-0.0076*	-0.0032	-0.0327	-0.0169	0.0281	5.29	0.00
VIF	2.8904		4.2427	5.5711	12.1329		
log(Dist. to World Heritage)	0.0968***	0.0711**	-0.2724	0.0832	1.2424	162.45	0.00
VIF	17.3655		56.3414	343.392	3711.06		
Historic Amenity Proximity							
log(Dist. to Nearest Church)	0.0136***	0.0115	-0.0112	0.0010	0.0506	5.04	0.00
VIF	2.7866		4.4707	6.9859	21.7174		
log(Dist. to Nearest Palace)	0.0104**	0.0113	-0.0110	-0.0030	0.0242	5.57	0.00
VIF	3.9549		5.8511	10.0109	23.7558		
log(Dist. to Nearest Lithic)	-0.0035	-0.0082	-0.0383	-0.0231	-0.0041	4.50	0.00
VIF	7.1704		5.6221	11.7064	42.7626		
log(Dist. to Nearest Other)	-0.0309***	-0.0190**	-0.0398	-0.0293	-0.0065	3.81	0.00
VIF	6.1026		5.4141	9.1433	25.3552		

Notes: ****Significance at 1 p.c. level;* ***Significance at 5 p.c. level;* **Significance at 10 p.c. level.*

***Table 4*. Distribution of GWR Results**

	Min	Max	Mean	Median	Pos./Neg.	1 S.D. of 0
Monument Proximity						
log(Dist. to Monument)	-0.1357	0.1595	-0.0157	-0.0178	0.3207	89.03
Standard Error	0.0044	0.0937	0.0133	0.0106		
Landmark, Non-Landmarks, World Heritage Proximity						
log(Dist. to Landmark)	-0.2384	0.7223	-0.0182	-0.0135	0.6056	99.27
Standard Error	0.0061	0.5623	0.0319	0.0171		
log(Dist. to Non-Landmark)	-0.1295	0.1647	-0.0145	-0.0169	0.3965	89.17
Standard Error	0.0049	0.0959	0.0143	0.0110		
log(Dist. to World Heritage)	-17.2028	4.1431	-0.6307	0.0832	1.9543	95.53
Standard Error	0.0203	20.2458	0.6349	0.2140		
Historic Amenity Proximity						
log(Dist. to Nearest Church)	-0.1003	0.1572	0.0040	0.0010	1.1249	83.05
Standard Error	0.0050	0.1082	0.0161	0.0113		
log(Dist. to Nearest Palace)	-0.1667	0.1340	-0.0020	-0.0030	0.6435	91.38
Standard Error	0.0053	0.1721	0.0177	0.0140		
log(Dist. to Nearest Lithic)	-0.3016	0.0879	-0.0292	-0.0231	0.0460	99.97
Standard Error	0.0067	0.1981	0.0194	0.0142		
log(Dist. to Nearest Other)	-0.0651	0.1373	-0.0256	-0.0293	0.0976	98.72
Standard Error	0.0052	0.3148	0.0147	0.0107		

Spatial Patterns of Historic Amenity Values

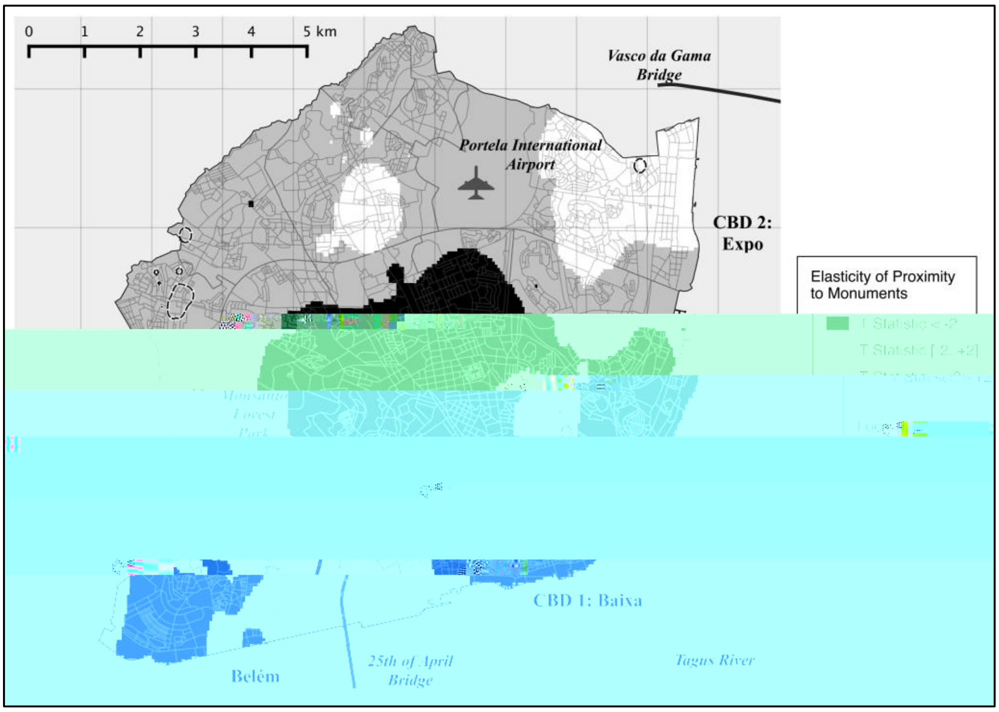
From figure 2 there is a pattern of positive price effects for monuments in the primary CBD where the bulk of historic amenities are located, indicating that in this area the residential real estate market capitalizes on proximity to monuments. In contrast, proximity to these monuments and specifically non-landmarks and churches, have a negative influence on prices in the secondary CBD which is characterized by high-rise buildings, commercial real estate, more modern amenities and much fewer historic monuments. Holding constant the influence of churches, palaces and lithic structures however, other residual historic amenities still have a positive influence on dwellings in this area.

Adjacent to the west of the international airport is the historic neighborhood of *Lumiar* which has in recent decades experienced a sharp increase in residents. This area is now home to the modern *José Alvalade* football stadium (inaugurated in 2003) and the *Quinta das Conchas* urban park, one of the most prominent in the city. Here, the residential real estate market is influenced negatively by proximity to monuments, and specifically non-landmarks and churches. While other historic amenities have a consistently positive influence across the city, in this area we see non-significant effects.

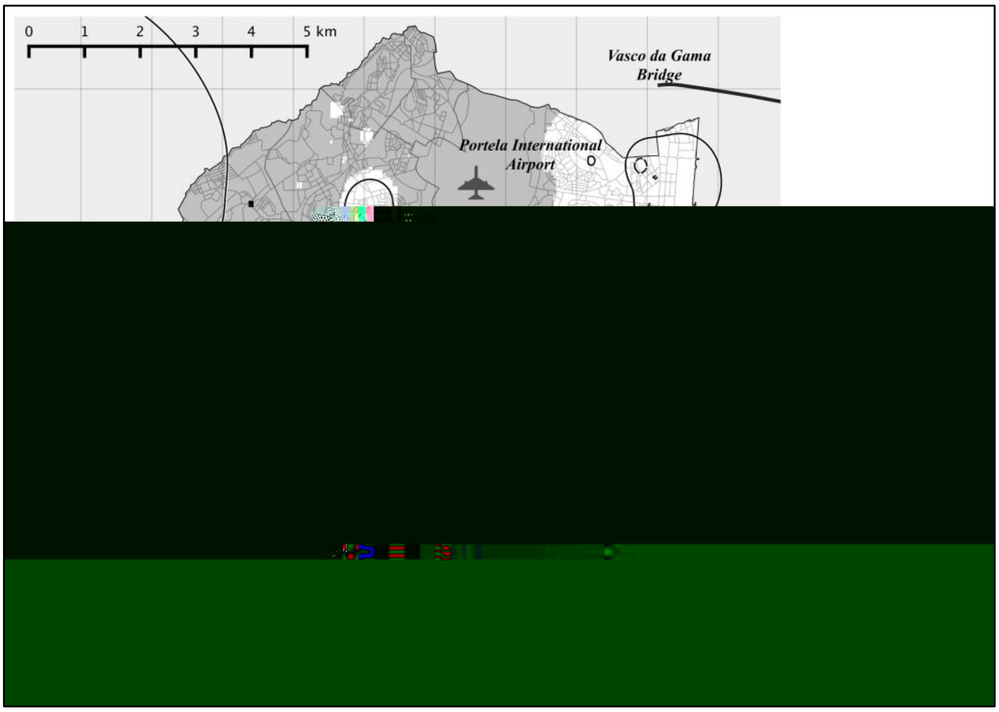
The spatial pattern for individual historic amenities are located in figure A2 of the appendix. In areas where churches are sparsely located there is a pattern of moderate negative price effects compared to the CBD where there are many more churches and no significant effects. These results show that GWR estimates of churches are in line with global estimates, however the global effects are being driven by specific locations in the city namely the city peripherals outside of the primary CBD. The negative influence of church proximity is strongest in areas where there is a more constant distribution of these amenities rather than in the downtown core where churches and landmark churches are clustered together in a smaller geographic area.

***Figure 2.* GWR Spatial Variation**

Panel A: All Monuments



Panel B: Non-Landmarks



Further in line with the global models, proximity to palaces overall has no significant influence on the residential real estate market across space. Global results of proximity to lithic structures indicate no significant influence either, however GWR estimates highlight that this global average may be the result of the spatially varying negative and non-significant coefficients. These results highlight the importance of exploring spatial non-stationarity since global models may mask underlying spatial patterns which are important for policy discussions.

Positive price effects for lithic structures are found outside the historic CBD and extending towards the secondary CBD, with the most significant effects in the area of Lisbon where the historic Aqueducts run. These areas surrounding the primary CBD are built less densely and include several parks and open spaces. Interestingly, we further see strong positive price effects in a specific area of *B lem* where there is lithic and landmark lithic (Tower of *B lem*) structures and open space, and also in the area of the city where the *Quinta das Conchas* urban park is located. Thus, from local GWR estimations it appears that lithic structures tend to have positive price influences in areas with accessibility to open spaces.

7. Conclusion

This research has determined the effects of concentration and proximity to historic amenities on residential real estate. These effects however are not constant when disaggregating by different types of historic amenities as well as landmark and non-landmark amenities. The impacts on the housing market due to these amenities exhibit spatial non-stationarity comparing local to global effects.

From a policy perspective, these findings highlight the importance of conceptualizing the amenity value not just in terms of structural characteristics but how those characteristics interact with or are conditioned by social, economic and other local contextual features. With municipal policies directed at specific urban neighborhoods, local models capture important neighborhood effects when compared to global models capturing averages for the entire city. While global effects indicate a significant negative impact of protected zones, when accounting for the heterogeneity of these areas this effect disappears. We see that the designation of historic protected zones may counteract the negative effects on property values of nearby neglected buildings in historic neighborhoods by setting additional

In the sense of usage, we find in general that direct proximity to historic amenities tend to have a positive price effect, while higher concentrations in a broader radius have weaker negative effects. While being located in direct proximity to a historic amenity is capitalized into dwelling premiums, higher concentrations may attract non-residents to the area. Our results indicate that historic ambience and open space are complements in Lisbon suggesting that greening policies that increase open space areas near historic monuments and within protected zones can add additional property premiums.

As expected, landmark historic amenities have a stronger magnitude owing to their broader non-use value not only to local residents but to others located in the city. We do not find however any significant impacts attribute to world heritage sites in the city.

These results imply that when deciding on historic amenity investment and preservation, local governments must take into consideration that the resulting effects of such policies will impact dwellings closer to the amenity more than residents further away. Under a constrained budget, investment decisions on the preservation and maintenance of historic amenities should target those with the highest potential spill-over effects. If these investments are valued through the housing market and prices increase, especially from landmarks which have effects of larger magnitudes, there are important discussions to have regarding increases in property tax revenue while balancing gentrification.

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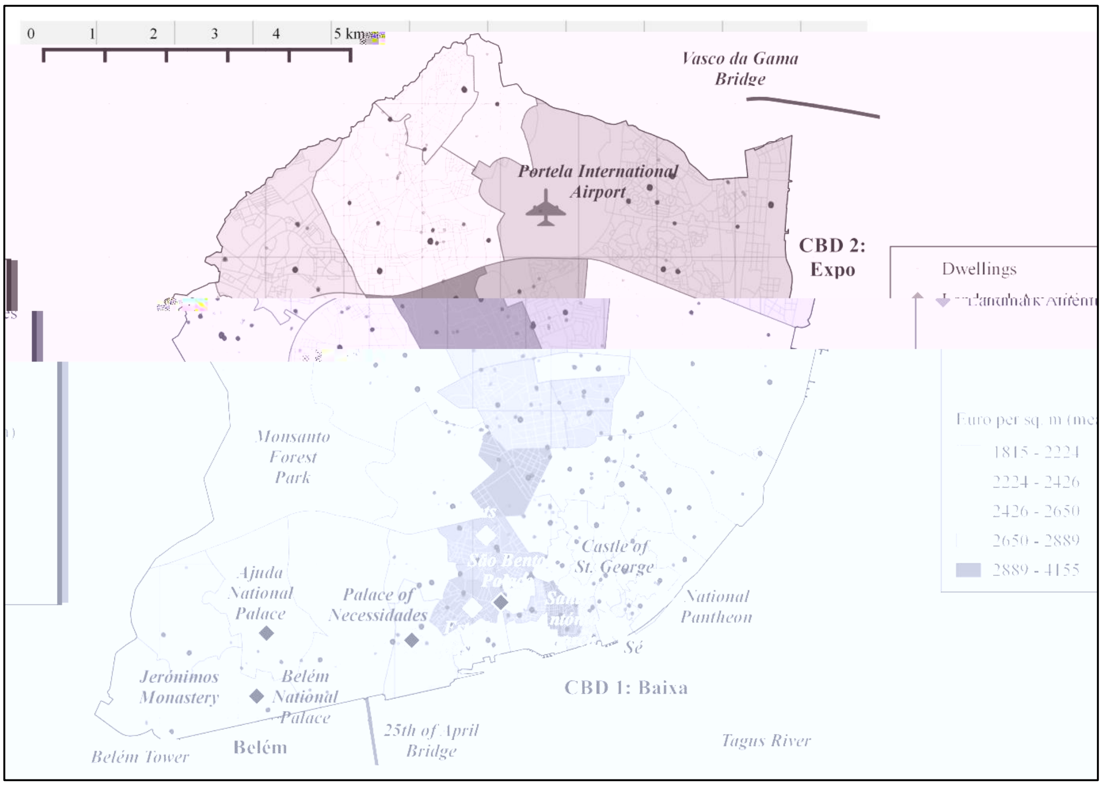
Appendix

***Figure A1.* Historic Amenities: Lisbon, Portugal**

Panel A: Landmarks



Panel B: Non-Landmarks

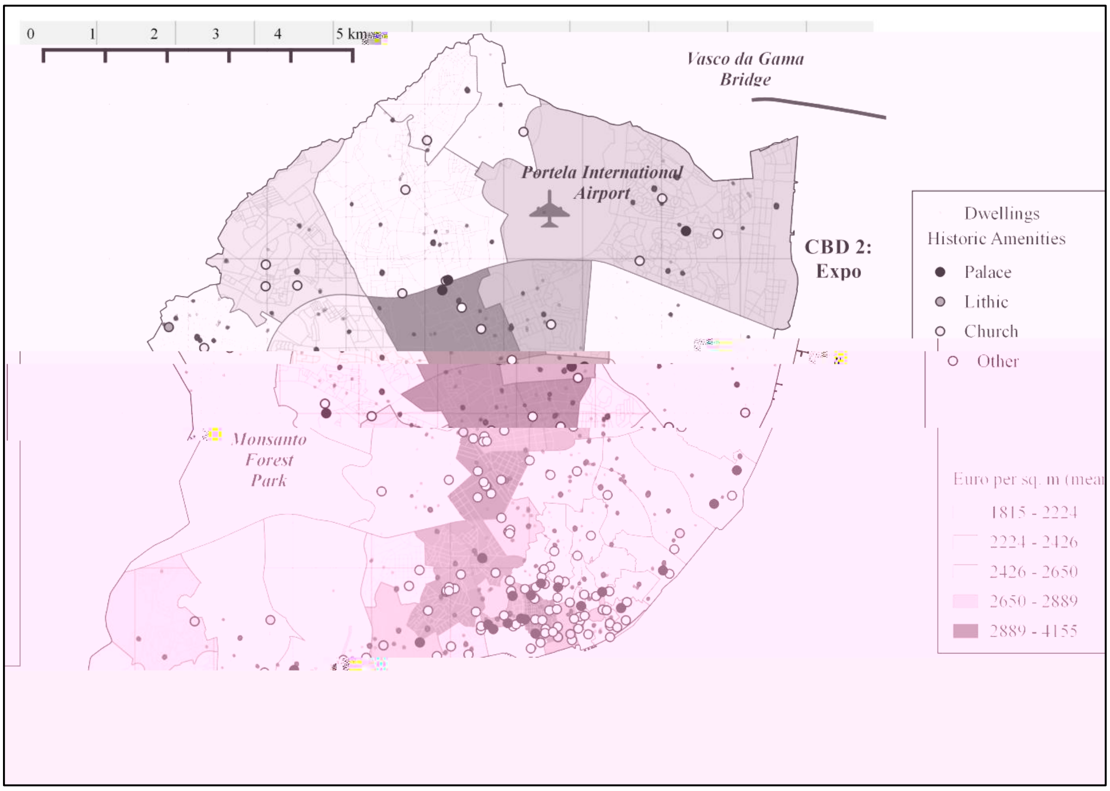


Table A1. Historic Amenities Across Lisbon

	Historic Amenities			Landmarks
Baixa	38	Church:	19	National Pantheon Lisbon Cathedral (*Sé*) Santo António Church Castle of St. Jorge
		Palace:	4	
		Lithic:	3	
		Other:	8	
Belém	9	Palace:	2	Monastery of Jerónimos Tower of Belém Belém National Palace
		Lithic:	1	
		Other:	3	
Non-Historic Zones	125	Church:	50	Estrela Basilica Ajuda National Palace São Bento Palace (Assembly of the Republic) Palace of Necessidades Aqueducts
		Palace:	23	
		Lithic:	6	
		Other:	41	

Table A2. Individual Historic Amenities of Lisbon

Churches: *Churches (Igreja); Chapels (Capela); Convent (Convento); Monastery (Mosteiro)*		
Estrela Basilica	**Monastery of Jerónimos**	**National Pantheon**
Lisbon Cathedral (*Sé*)	**Santo António Church**	Igreja de Chelas
Igreja de Sao Tiago e Sao Martinho	Igreja Paroquial do Castelo	Igreja Paroquial de Santa Justa e Rufina
Igreja Paroquial de Santa Justa	Igreja Paroquial da Graca	Igreja Paroquial do Lumiar
Igreja Paroquial de Sao Nicolau e Sao Juliao	Igreja Paroquial de Carnide	Igreja Paroquial dos Olivais
Igreja de Sao Joao da Praca	Igreja da Luz	Igreja Paroquial da Madalena
Igreja de Nossa Senhora do Loreto	Mosteiro de Nossa Senhora da Piedade da Esperanca	Igreja Paroquial da Ameixoeira
Igreja Paroquial de Nossa Senhora do Socorro	Igreja Paroquial de Sao Cristovao	Igreja de Sao Jose
Igreja Paroquial de Sao Paulo	Igreja Paroquial do Campo Grande	Igreja Paroquial de Sao Vicente de Fora
Igreja de Nossa Senhora da Quietacao	Capela de São Sebastião da Mouraria	Convento de Santos-o-Novo
Igreja Paroquial de Sao Mamede	Convento de Nossa Senhora dos Remedios	Igreja Paroquial das Merces
Convento de Sao Domingos de Benfica	Igreja Paroquial da Penha de Franca	Igreja Paroquial de Telheiras
Mosteiro de Santa Teresa de Jesus	Igreja Paroquial de Sao Sebastiao da Pedreira	Igreja Paroquial de Santa Catarina
Igreja Paroquial de Marvila	Igreja Paroquial do Beato	Igreja Paroquial do Sacramento
Igreja Paroquial de Sao Miguel	Convento de Sao Pedro de Alcantara	Igreja Paroquial da Charneca
Igreja Paroquial da Encarnacao	Igreja Paroquial de Santos-o-Velho	Igreja Paroquial da Pena
Igreja do Menino Deus	Igreja Paroquial de Santo Estevao	Igreja Paroquial de Santa Engracia
Igreja Paroquial de Santa Isabel	Igreja Paroquial de Benfica	Igreja Paroquial da Ajuda
Igreja do Corpo Santo	Igreja Paroquial dos Anjos	Igreja Paroquial de Sao Francisco de Paula
Igreja Paroquial dos Martires	Igreja Paroquial de Alcantara	Igreja de Nossa Senhora das Dores
Igreja Paroquial de Campolide	Mosteiro de Nossa Senhora da Conceicao dos Cardais	Mosteiro de Nossa Senhora da Encarnacao
Mosteiro de Corpus Christi	Igreja Paroquial de Sao Joao de Brito	Igreja Paroquial de Santo Eugenio
Igreja Paroquial de Fatima	Igreja Paroquial de Santo Condestavel	Igreja Paroquial de Sao Joao de Deus
Igreja Paroquial de Olivais Sul	Igreja de São Roque	Igreja Paroquial de Sao Vicente de Paulo
Igreja Paroquial de Sao Domingos de Benfica	Igreja Paroquial de Santa Joana Princesa	

Palaces: *Palaces (Palácio); Mansions (Palacete); Nobel Houses (Solar/ Casa)*		
Ajuda National Palace	**São Bento Palace**	**Belém National Palace**
Palace of Necessidades	Palacete dos Viscondes e Condes dos Olivais e Penha-Longa	Palácio Ratton
Solar da Quinta dos Lagares d'El-Rei	Palácio dos Condes de Almada	Palácio dos Condes de Figueira
Palácio de Xabregas	Palácio do Marquês de Tancos	Palácio dos Almadas
Palácio Sabugosa	Palácio de Santo Estêvão	Palácio do Conde de Vimioso
Palácio marqueses de Fronteira	Palácio das Chagas	Palácio da Flor da Murta
Palácio Foz	Palácio Burnay	Palácio Palha
Casa da Quinta da Pimenta	Palácio Ludovice	Casa da Junqueira
Palácio de Santa Catarina	Palácio Valada-Azambuja	Palácio do Marquês de Angeja
Palácio dos Duques de Lafões	Casa da Fonte do Anjo	Palacete na Rua de Pedrouços, 97 a 99
Palácio do Barão de Quintela e Conde de Farrobo	Palácio Palmela	Palacete na Rua Jau
Stone/ Lithic Architecture: *Towers (Torres); Arches (Arcos); Windmills (Moinho); Columns (Pelourinho);*		
Aqueducts	**Castle of St. Jorge**	**Tower of Belém**
Pelourinho de Lisboa	Forte de Santa Apolónia	Obelisco Aquático
Moinhos do Casalinho da Ajuda	Moinhos do Caramão da Ajuda	Arco Triunfal da Rua Augusta
Portas de Benfica	Aos Restauradores de 1640	Padrão dos Descobrimentos
Arco de São Bento		
Other Historic Amenities: Statues (*Estátuas);* Monuments *(Monumentos);*Fountains *(Chafariz);* Funicular *(Elevador);* Crosses *(Cruzeiro)*		
Estátuas Lusitanas de Montalegre	Padrão do Campo Pequeno	Cruzeiro das Laranjeiras
Chafariz D'El Rei	Cruzeiro de Arroios	Adamastor
Lápides das Pedras Negras	Chafariz da Esperança	Chafariz de Carmo
Neptuno	Chafariz das Janelas Verdes	D. José I
Chafariz do Desterro	Luís de Camões	D. Pedro IV
Figura masculina com cão (sem título)	Figura masculina com leão (sem título)	Ascensor do Lavra
Ascensor da Glória	Ascensor da Bica	Campo dos Mártires da Pátria
Elevador de Santa Justa	Afonso de Albuquerque	Duque de Saldanha
Cavador	Actor Taborda	Guardadora de Patos/ A Filha de Rei Guardando Patos
Maria da Fonte	Despertar	França Borges
Monumento ao Povo e aos Heróis da Guerra Peninsular	Figura feminina (sem título)	Marquês de Pombal
A Dor	A Arte A Ciencia	Rosa Araújo
Figuras femininas (sem título)	La Grande Sauterelle	Antero de Quental
Figura feminina com veado (sem título)	Mulher Vendo-se ao Espelho	Figura feminina (sem título)
Vento Garroa	Figura feminina (sem título)	Figura feminina com cavalo (sem título)
Figura feminina (sem título)	O Segredo	A Família
Estátua de Alexandre Herculano	Estátua de Almeida Garrett	Estátua de António Feliciano de Castilho
Monumento ao poeta Chiado		

** Landmark historic amenities indicated in* ***bold***

Table A3. Descriptive Statistics

Variables	N	Mean	St. Dev,	Min	Max
Dependent					
log(Price)	11,708	12.152	0.365	10.463	13.911
Structural					
log(Area)	11,708	4.407	0.265	3.219	5.481
New Dummy	11,708	0.179	0.383	0	1
View of Tagus Dummy	11,708	0.062	0.241	0	1
Pool Dummy	11,708	0.007	0.086	0	1
Parking Dummy	11,708	0.114	0.318	0	1
Fireplace Dummy	11,708	0.025	0.156	0	1
Double Windows Dummy	11,708	0.207	0.405	0	1
Air Conditioning Dummy	11,708	0.119	0.323	0	1
Elevator Dummy	11,708	0.228	0.42	0	1
Accessibility					
log(Dist. to Baixa)	11,708	8.142	0.696	4.191	9.118
log(Dist. to Expo)	11,708	8.826	0.466	7.254	9.6
log(Dist. to Airport)	11,708	8.349	0.502	6.378	9.273
log(Dist. to Nearest Cultural Amenity)	11,708	6.082	0.863	3.213	8.337
log(Dist. to Nearest Arts Amenity)	11,708	6.563	0.928	2.668	7.826
log(Dist. to Nearest Public Parking)	11,708	5.8	1.063	2.129	8.019
log(Dist. to Nearest Train Station)	11,708	6.827	0.868	0.101	8.536
Count of Metro Stations 100 m	11,708	0.061	0.239	0	1
log(Dist. to 25th April Bridge)	11,708	8.499	0.566	6.352	9.292
log(Dist. to Nearest Fitness Amenity)	11,708	6.406	0.538	4.261	7.69
log(Dist. to Nearest School)	11,708	5.085	0.729	1.499	6.907
log(Dist. to Nearest University)	11,708	6.162	0.819	3.239	7.825
log(Dist. to Nearest Health Amenity)	11,708	5.021	0.706	2.395	7.134
log(Dist. to Nearest Hospital)	11,708	6.481	1.091	1.885	8.069
log(Dist. to Nearest Shopping Center)	11,708	6.259	1.052	2.636	8.694
log(Dist. to Nearest Security Amenity)	11,708	6.351	0.604	2.797	7.552
log(Dist. to Nearest Fire station)	11,708	6.821	0.664	3.339	8.231
log(Dist. to Nearest Cemetery)	11,708	6.998	0.83	3.089	8.107
log(Dist. to Freeway)	11,708	6.934	0.894	-1.067	8.319
log(Dist. to Stadium)	11,708	7.313	0.64	1.474	8.425
Environmental Amenities					
log(Dist. to Nearest Open Space)					

Architectural Ambiance					
log(% Buildings built pre 1919)	11,708	-4.354	6.705	-19.105	4.605
log(% Buildings built 1919 to 1945)	11,708	-3.475	6.523	-19.571	4.605
log(% Buildings built 1946 to 1960)	11,708	-3.574	6.525	-19.085	4.605
log(% Buildings built 1961 to 1970)	11,708	-5.472	6.158	-17.982	4.605
log(% Buildings built 1981 to 1990)	11,708	-7.644	4.908	-17.066	4.605
log(% Buildings built 1991 to 1995)	11,708	-7.845	4.693	-18.412	4.605
log(% Buildings built 1996 to 2000)	11,708	-8.322	4.175	-17.824	4.605
log(% Non-Residential Buildings)	11,708	-6.32	5.756	-19.665	4.605
log(% Vacant Buildings)	11,708	1.962	5.144	-14.417	4.605
Count of Dilapidated Buildings 1000 m	11,708	100.063	76.905	3	353
log(Average Freguesia Income)	11,708	10.186	0.311	9.27	10.819
log(Population Density)	11,708	-4.47	0.934	-11.657	-2.35
log(% Population w. Superior Education)	11,708	2.189	2.887	-17.026	4.5
log(% Population under 19)	11,708	2.353	2.156	-15.974	4.123
log(% Population over 65)	11,708	2.991	1.032	-13.449	4.605
Natural Hazard Risk					
High Flood Risk Dummy	11,708	0.144	0.351	0	1
High Seismic Risk Dummy	11,708	0.462	0.499	0	1
Views					
log(Dist. to Viewpoint)	11,708	6.293	0.94	2.21	7.688
log(Elevation)	11,708	4.005	0.808	0	4.963
Historic amenities					
Protected Zone Dummy	11,708	0.143	0.35	0	1
Count of Landmark Church 100m	11,708	0.004	0.061	0	1
Count of Landmark Church 1000m	11,708	0.309	0.539	0	3
Count of Non-Landmark Church 50m	11,708	0.002	0.039	0	1
Count of Non-Landmark Church 100m	11,708	0.019	0.147	0	2
Count of Non-Landmark Church 1000m	11,708	8.702	7.966	0	27
Count of Landmark Palace 50m	11,708	0.003	0.051	0	1
Count of Landmark Palace 1000m	11,708	0.526	0.744	0	2
Count of Non-Landmark Palace 50m	11,708	0.001	0.038	0	2
Count of Non-Landmark Palace 100m	11,708	0.003	0.057	0	2
Count of Non-Landmark Palace 1000m	11,708	2.123	2.783	0	11
Count of Landmark Lithic 50m	11,708	0.001	0.032	0	1
Count of Landmark Lithic 1000m	11,708	0.107	0.321	0	2
Count of Non-Landmark Lithic 50m	11,708	0.006	0.076	0	1
Count of Non-Landmark Lithic 1000m	11,708	0.705	0.78	0	3
Count of Non-Landmark Other 50m	11,708	0.013	0.115	0	1
Count of Non-Landmark Other 100m	11,708	0.038	0.203	0	2
Count of Non-Landmark Other 1000m	11,708	5.562	6.105	0	20
log(Dist. to Nearest Church)	11,708	5.894	0.791	1.979	7.754
log(Dist. to Nearest Palace)	11,708	6.632	0.941	3.723	8.218
log(Dist. to Nearest Lithic)	11,708	7.086	0.916	2.471	8.726
log(Dist. to Nearest Other)	11,708	6.855	1.07	1.028	8.577

Table A4. **Variable Description**

Variable Description	**Units**	**Source**
Dependent		
Price: Lis b	Euro	Confidencial Imobiliário
Structural		
Area: Square meters of living area	m2	Confidencial Imobiliário
New or used dwelling	Dummy	Confidencial Imobiliário
View of Tagus River	Dummy	Confidencial Imobiliário
Existence of a pool	Dummy	Confidencial Imobiliário
Existence of parking space	Dummy	Confidencial Imobiliário
Existence of fireplace	Dummy	Confidencial Imobiliário
Existence of double windows	Dummy	Confidencial Imobiliário
Existence of air conditioning	Dummy	Confidencial Imobiliário
Existence of elevator	Dummy	Confidencial Imobiliário
Accessibility		
Distance to Baixa; Primary CBD	m	GIS Calculation
Distance to Parque das Nações (Expo); Secondary CBD	m	GIS Calculation
Distance to Lisbon Portela international airport	m	GIS Calculation
Distance to nearest cultural amenity	m	GIS Calculation
Distance to nearest arts amenity	m	GIS Calculation
Distance to nearest public parking	m	GIS Calculation
Distance to nearest train station	m	GIS Calculation
Number of metro stations within 100 m	Count	GIS Calculation
Distance to the 25th of April Bridge	m	GIS Calculation
Distance to nearest fitness area: sports centres, track fields, swimming pools, sports fields	m	GIS Calculation
Distance to nearest public or private school	m	GIS Calculation
Distance to nearest university or college	m	GIS Calculation
Distance health centre, clinic, or pharmacy	m	GIS Calculation
Distance to nearest public or private hospital	m	GIS Calculation
Distance to nearest shopping centre	m	GIS Calculation
Distance to nearest security amenity (police station)	m	GIS Calculation
Distance to nearest fire station	m	GIS Calculation
Distance to nearest cemetery	m	GIS Calculation
Distance to nearest freeway	m	GIS Calculation
Distance to nearest sporting stadium	m	GIS Calculation
Environmental Amenities		
Distance to nearest open space	m	GIS Calculation
Count of open space within 50 m	Count	GIS Calculation
Count of open space within 200 m	Count	GIS Calculation
Count of open space within 500 m	Count	GIS Calculation
Count of open space within 1000 m	Count	GIS Calculation
Freguesia level concentration of pm10 particulates	Concentration	GIS Calculation

Architectural Ambiance and Neighborhood		
Per cent of buildings constructed prior to 1919	Percent	Census 2011
Per cent of buildings constructed 1919-1945	Percent	Census 2011
Per cent of buildings constructed 1946-1960	Percent	Census 2011
Per cent of buildings constructed 1961-1970	Percent	Census 2011
Per cent of buildings constructed 1981-1990	Percent	Census 2011
Per cent of buildings constructed 1991-1995	Percent	Census 2011
Per cent of buildings constructed 1996- 2000	Percent	Census 2011
Per cent of non-residential buildings	Percent	Census 2011
Per cent of vacant dwellings	Percent	Census 2011
Count of dilapidated buildings within 1000 m	Count	GIS Calculation
Average income at the Freguesia level	Euro	Câmara Municipal de Lisboa
Subsection population density	Resident/ m2	Census 2011
Per cent of population with superior education	Percent	Census 2011
Per cent of population less than 19 years old	Percent	Census 2011
Per cent of population over 65 years old	Percent	Census 2011
Natural Hazard Risk		
Located in area of high flooding risk	Dummy	GIS Calculation
Located in area with high potential seismic damage	Dummy	GIS Calculation
Views		
Distance to the nearest viewpoint over the city, river, or with 360 degree view	m	GIS Calculation
Elevation: Dwelling altitude	m	GIS Calculation
Historic amenities		
Protected Zone: Located in historically protected area of the city	Dummy	GIS Calculation
Count of Landmark Church 100 m	Count	GIS Calculation
Count of Landmark Church 1000 m	Count	GIS Calculation
Count of Non-Landmark Church 50 m	Count	GIS Calculation
Count of Non-Landmark Church 100 m	Count	GIS Calculation
Count of Non-Landmark Church 1000 m	Count	GIS Calculation
Count of Landmark Palace 50 m	Count	GIS Calculation
Count of Landmark Palace 1000 m	Count	GIS Calculation
Count of Non-Landmark Palace 50 m	Count	GIS Calculation
Count of Non-Landmark Palace 100 m	Count	GIS Calculation
Count of Non-Landmark Palace 1000 m	Count	GIS Calculation
Count of Landmark Lithic 50 m	Count	GIS Calculation
Count of Landmark Lithic 1000 m	Count	GIS Calculation
Count of Non-Landmark Lithic 50 m	Count	GIS Calculation
Count of Non-Landmark Lithic 1000 m	Count	GIS Calculation
Count of Non-Landmark Other 50 m	Count	GIS Calculation
Count of Non-Landmark Other 100 m	Count	GIS Calculation
Count of Non-Landmark Other 1000 m	Count	GIS Calculation
Distance to nearest church	m	GIS Calculation
Distance to nearest palace	m	GIS Calculation
Distance to nearest lithic structure	m	GIS Calculation
Distance to nearest other historic amenity	m	GIS Calculation

***Table A5.* Spatial Weight Matrices**

	Description	Number of locations	Number of nonzero links	Percentage nonzero weights	Average number of links
SW1:	Inverse distance for all properties within 500 m	11,708	4,682,292	3.415	399.92
SW2:	Inverse distance squared for all properties within 500 m	11,708	4,682,292	3.415	399.92
SW3:	All properties within 500 m	11,708	4,682,292	3.415	399.92
SW4:	100 Nearest Neighbors	11,708	1,170,800	0.854	100

***Table A6.*Test Statistics of Spatial Dependence**

	Global Moran's I (Dependent)	Z-score (Dependent)	Global Moran's I (Residuals)	Z-score (Residuals)	LM Error	LM Lag	Rob. LM Error	Rob. LM Lag
Protected Zones								
SW1	0.2586***	131.6	0.0261***	16.08	173.7***	35.09***	155.4***	16.75***
SW2	0.2721***	52.28	0.0359***	7.742	48.52***	32.58***	28.62***	12.67***
SW3	0.2262***	213.4	0.0165***	23.61	239.8***	26.46***	229***	15.68***
SW4	0.2373***	195.8	0.0127***	15.89	109.3***	265***	20.56***	176.2***
Protected Zones (Interactions)								
SW1	0.2586***	131.6	0.0249***	15.61	158***	32.66***	141.1***	15.77***
SW2	0.2721***	52.28	0.0345***	7.521	44.8***	30.3***	26.36***	11.85***
SW3	0.2262***	213.4	0.0155***	22.84	210.4***	24.55***	200.6***	14.8***
SW4	0.2373***	195.8	0.0120***	15.45	96.22***	235***	17.2***	155.9***
Historic Amenity Concentration								
SW1	0.2586***	131.6	0.0224***	14.29	127.9***	30.12***	113.2***	15.42***
SW2	0.2721***	52.28	0.0323***	7.113	39.42***	27.82***	22.84***	11.25***
SW3	0.2262***	213.4	0.0131***	19.88	150.6***	22.99***	142.5***	14.92***
SW4	0.2373***	195.8	0.0097***	13.09	63.21***	215***	6.6***	158.4***
Historic Amenity Proximity								

Table A7. **Global OLS and Spatial Error Results**

Variables	OLS		OLS with Interaction		Spatial Error		Spatial Error with Interaction	
	Coeff.	(Std. err.)	Coeff.	(Std. err.)	Coeff.	(Std. err.)	Coeff.	(Std. err.)
Protected Zones								
Structural								
log(Area)	0.78392***	(0.008)	0.78188***	(0.008)	0.78150***	(0.008)	0.77391***	(0.008)
New Dummy	0.15605***	(0.005)	0.15638***	(0.005)	0.15532***	(0.005)	0.15495***	(0.005)
View of Tagus Dummy	0.06021***	(0.008)	0.06077***	(0.008)	0.06023***	(0.008)	0.06174***	(0.008)
Pool Dummy	0.11954***	(0.023)	0.12059***	(0.023)	0.11969***	(0.023)	0.11475***	(0.023)
Parking Dummy	0.06936***	(0.007)	0.06892***	(0.007)	0.06921***	(0.007)	0.07027***	(0.007)
Fireplace Dummy	0.02938**	(0.013)	0.02963**	(0.013)	0.02919**	(0.012)	0.02935**	(0.012)
Double Windows Dummy	0.01524***	(0.005)	0.01466***	(0.005)	0.01549***	(0.005)	0.01605***	(0.005)
Air Conditioning Dummy	0.14390***	(0.006)	0.14379***	(0.006)	0.14108***	(0.006)	0.13755***	(0.006)
Elevator Dummy	0.01726***	(0.005)	0.01756***	(0.005)	0.01652***	(0.005)	0.01368**	(0.005)
Accessibility								
log(Dist. to Baixa)	-0.12852***	(0.012)	-0.13222***	(0.013)	-0.12749***	(0.014)	-0.12580***	(0.020)
log(Dist. to Expo)	-0.09321***	(0.013)	-0.08608***	(0.014)	-0.09443***	(0.014)	-0.07831***	(0.021)
log(Dist. to Airport)	0.03682***	(0.013)	0.03462**	(0.013)	0.03510**	(0.015)	0.0211	(0.021)
log(Dist. to Nearest Cultural Amenity)	0.02400***	(0.004)	0.02478***	(0.004)	0.02397***	(0.005)	0.02321***	(0.007)
log(Dist. to Nearest Arts Amenity)	-0.01546***	(0.004)	-0.01486***	(0.004)	-0.01479***	(0.005)	-0.01353*	(0.007)
log(Dist. to Nearest Public Parking)	-0.03439***	(0.003)	-0.03429***	(0.003)	-0.03440***	(0.003)	-0.03573***	(0.005)
log(Dist. to Nearest Train Station)	0.01697***	(0.003)	0.01484***	(0.004)	0.01726***	(0.004)	0.01543**	(0.006)
Count of Metro Stations 100 m	0.01617*	(0.009)	0.0141	(0.009)	0.01531	(0.009)	0.01095	(0.010)
log(Dist. to 25th April Bridge)	-0.14485***	(0.011)	-0.14463***	(0.012)	-0.14701***	(0.013)	-0.14921***	(0.019)
log(Dist. to Nearest Fitness Amenity)	0.02004***	(0.007)	0.02159***	(0.007)	0.01907**	(0.007)	0.01827*	(0.010)
log(Dist. to Nearest School)	0.00864*	(0.004)	0.00999**	(0.004)	0.00865*	(0.004)	0.00806	(0.006)
log(Dist. to Nearest University)	-0.00208	(0.005)	0.00299	(0.005)	-0.00236	(0.005)	0.00115	(0.008)
log(Dist. to Nearest Health Amenity)	0.02948***	(0.004)	0.02979***	(0.004)	0.02967***	(0.004)	0.02791***	(0.006)
log(Dist. to Nearest Hospital)	0.00696**	(0.003)	0.00630*	(0.003)	0.00644*	(0.003)	0.0047	(0.005)
log(Dist. to Nearest Shopping Center)	-0.00884*	(0.004)	-0.00726	(0.004)	-0.00977*	(0.005)	-0.01139	(0.007)
log(Dist. to Nearest Security Amenity)	-0.00544	(0.005)	-0.00467	(0.005)	-0.0044	(0.006)	-0.00002	(0.008)
log(Dist. to Nearest Fire station)	-0.00014	(0.006)	0.00086	(0.006)	-0.00014	(0.006)	-0.00169	(0.009)
log(Dist. to Nearest Cemetery)	0.05799***	(0.004)	0.05888***	(0.004)	0.05801***	(0.005)	0.05829***	(0.007)
log(Dist. to Freeway)	0.17527*	(0.097)	0.17888*	(0.100)	0.16025	(0.107)	0.15077	(0.151)
log(Dist. to Stadium)	0.26739***	(0.048)	0.28308***	(0.049)	0.26147***	(0.053)	0.27973***	(0.078)
log(Dist. to Stadium)*log(Dist. to Freeway)	-0.04426***	(0.007)	-0.04662***	(0.007)	-0.04328***	(0.007)	-0.04547***	(0.011)
Environmental Amenities								
log(Dist. to Nearest Open Space)	-0.22159***	(0.061)	-0.24350***	(0.063)	-0.22154***	(0.067)	-0.28329***	(0.092)
Count of Open Spaces 50 m	0.03497***	(0.012)	0.02057	(0.014)	0.03163**	(0.013)	0.0141	(0.015)
Count of Open Spaces 200 m	-0.02323***	(0.004)	-0.02282***	(0.005)	-0.02212***	(0.004)	-0.01719***	(0.005)
Count of Open Spaces 500 m	0.00663***	(0.001)	0.00784***	(0.001)	0.00639***	(0.001)	0.00535***	(0.001)
Count of Open Spaces 1000 m	0.00180***	(0.000)	0.00182***	(0.000)	0.00181***	(0.004)	0.00177***	(0.004)
log(PM10 Particulates)	-0.60572***	(0.171)	-0.66647***	(0.173)	-0.62153***	(0.187)	-0.77595***	(0.248)
log(PM10 Particulates)*log(Dist. to Nearest Open Space)	0.05959***	(0.016)	0.06491***	(0.017)	0.05951***	(0.018)	0.07520***	(0.025)
log(PM10 Particulates)*log(Dist. to Freeway)	0.05160***	(0.019)	0.05610***	(0.020)	0.05382**	(0.021)	0.06139**	(0.029)

Architectural Ambiance								
log(% Buildings built pre 1919)	0.00384***	(0.00056	0.00389***	(0.0005)	0.00384***	(0.0006)	0.00352***	(0.0007)
log(% Buildings built 1919 to 1945)	-0.00193***	(0.00056	-0.00194***	(0.0005)	-0.00202***	(0.0006)	-0.00233***	(0.0008)
log(% Buildings built 1946 to 1960)	0.00213***	(0.00053	0.00207***	(0.0005)	0.00215***	(0.0005)	0.00233***	(0.0007)
log(% Buildings built 1961 to 1970)	0.00156***	(0.00051	0.00141***	(0.0005)	0.00139**	(0.0005)	0.00042	(0.0007)
log(% Buildings built 1981 to 1990)	0.00145***	(0.00055	0.00153***	(0.0005)	0.00155***	(0.0006)	0.00173**	(0.0007)
log(% Buildings built 1991 to 1995)	-0.00014	(0.00061	-0.00006	(0.0006)	-0.00006	(0.0006)	0.00018	(0.0008)
log(% Buildings built 1996 to 2000)	0.00073	(0.00068	0.00058	(0.0006)	0.00068	(0.0007)	0.00066	(0.0009)
log(% Non-Residential Buildings)	0.00228***	(0.00055	0.00211***	(0.0005)	0.00235***	(0.0006)	0.00241***	(0.0007)
log(% Vacant Buildings)	-0.00092	(0.00067	-0.00098	(0.0006)	-0.00097	(0.0007)	-0.00127	(0.0009)
Count of Dilapidated Buildings 1000 m	-0.00076***	(0.00009	-0.00080***	(0.0000)	-0.00076***	(0.0001)	-0.00082***	(0.0001)
log(Average Freguesia Income)	0.17222***	(0.0134)	0.16949***	(0.0140)	0.16883***	(0.0145)	0.14302***	(0.0193)
log(Population Density)	-0.01099***	(0.00332	-0.01177***	(0.0033)	-0.00968***	(0.0036)	-0.00633	(0.0046)
log(% Population w. Superior Education)	0.00191*	(0.00112	0.00220*	(0.0011)	0.0018	(0.0012)	0.00163	(0.0015)
log(% Population under 19)	0.00374**	(0.00146	0.00367**	(0.0014)	0.00340**	(0.0015)	0.00232	(0.0019)
log(% Population over 65)	-0.0038	(0.00246	-0.00413*	(0.0024)	-0.00365	(0.0026)	-0.00245	(0.0033)
Natural Hazard Risk								
High Flood Risk Dummy	-0.05111***	(0.00961	-0.04948***	(0.0098)	-0.05044***	(0.0105)	-0.04298***	(0.0140)
High Seismic Risk Dummy	-0.00837	(0.00728	-0.00803	(0.0073)	-0.00898	(0.0080)	-0.01141	(0.0110)
Views								
log(Dist. to Viewpoint)	0.05990***	(0.02201	0.06036***	(0.0224)	0.06203**	(0.0243)	0.07534**	(0.0342)
log(Elevation)	0.07327**	(0.03315	0.07103**	(0.0339)	0.07645**	(0.0365)	0.09261*	(0.0512)
log(Dist. to Viewpoint)*log(Elevation)	-0.01153**	(0.0055)	-0.01120**	(0.0056)	-0.01210**	(0.0060)	-0.01518*	(0.0085)
Historic amenities								
Protected Zone Dummy	-0.01637*	0.0089)	-0.03114	(0.0231)	-0.01501	(0.0098)	-0.04873	(0.0336)
Protected Zone Dummy*No. of Dilapidated Buildings 1000 m			0.00026*	(0.0001)			0.00035*	(0.0001)
Protected Zone Dummy*No. of Open Spaces 50 m			0.08838**	(0.0361)			0.05343	(0.0413)
Historic Amenity Concentration								
Structural								
log(Area)	0.78416***	(0.008)			0.78202***	(0.0081)		
New Dummy	0.15385***	(0.005)			0.15366***	(0.0056)		
View of Tagus Dummy	0.06065***	(0.008)			0.06055***	(0.0085)		
Pool Dummy	0.12248***	(0.023)			0.12209***	(0.0235)		
Parking Dummy	0.07008***	(0.007)			0.06983***	(0.0073)		
Fireplace Dummy	0.02755**	(0.013)			0.02768**	(0.0129)		
Double Windows Dummy	0.01590***	(0.005)			0.01601***	(0.0055)		
Air Conditioning Dummy	0.14240***	(0.006)			0.13986***	(0.0066)		
Elevator Dummy	0.01577***	(0.005)			0.01535***	(0.0055)		
Accessibility								
log(Dist. to Baixa)	-0.12297***	(0.013)			-0.12243***	(0.0144)		
log(Dist. to Expo)	-0.12135***	(0.014)			-0.12009***	(0.0154)		
log(Dist. to Airport)	0.07273***	(0.014)			0.06885***	(0.0154)		
log(Dist. to Nearest Cultural Amenity)	0.02426***	(0.004)			0.02432***	(0.0050)		
log(Dist. to Nearest Arts Amenity)	-0.01323***	(0.004)			-0.01225**	(0.0050)		
log(Dist. to Nearest Public Parking)	-0.03329***	(0.003)			-0.03329***	(0.0037)		
log(Dist. to Nearest Train Station)	0.01973***	(0.003)			0.01967***	(0.0043)		
Count of Metro Stations 100 m	0.01207	(0.010)			0.01153	(0.0106)		

log(Dist. to 25th April Bridge)	-0.12697***	(0.012)	-0.12899***	(0.0135)
log(Dist. to Nearest Fitness Amenity)	0.02412***	(0.007)		

Historic amenities				
Count of Landmark Church 100m	0.04393	(0.035)	0.04561	(0.0351)
Count of Landmark Church 1000m	-0.03441***	(0.007)	-0.03448***	(0.0074)
Count of Non-Landmark Church 50m	-0.00006	(0.061)	0.0057	(0.0625)
Count of Non-Landmark Church 100m	0.03999**	(0.017)	0.04244**	(0.0180)
Count of Non-Landmark Church 1000m	-0.00110***	(0.0003)	-0.00092**	(0.0003)
Count of Landmark Palace 50m	0.021	(0.041)	0.01606	(0.0408)
Count of Landmark Palace 1000m	-0.00204	(0.005)	-0.00048	(0.0057)
Count of Non-Landmark Palace 50m	0.09237	(0.072)	0.0902	(0.0720)
Count of Non-Landmark Palace 100m	-0.04642	(0.049)	-0.04183	(0.0492)
Count of Non-Landmark Palace 1000m	-0.00162	(0.001)	-0.00178	(0.0011)
Count of Landmark Lithic 50m	-0.08701	(0.063)	-0.08058	(0.0636)
Count of Landmark Lithic 1000m	0.03205***	(0.009)	0.02963***	(0.0096)
Count of Non-Landmark Lithic 50m	0.04198	(0.032)	0.04953	(0.0331)
Count of Non-Landmark Lithic 1000m	0.00623	(0.004)	0.00707*	(0.0041)
Count of Non-Landmark Other 50m	0.05710**	(0.026)	0.05886**	(0.0276)
Count of Non-Landmark Other 100m	-0.04451***	(0.017)	-0.04395**	(0.0176)
Count of Non-Landmark Other 1000m	-0.00087*	(0.0004)	-0.00093*	(0.0004)
Historic Amenity Proximity				
Structural				
log(Area)	0.78391***	(0.008)	0.78173***	(0.0081)
New Dummy	0.15628***	(0.005)	0.15561***	(0.0056)
View of Tagus Dummy	0.06197***	(0.008)	0.06163***	(0.0085)
Pool Dummy	0.12109***	(0.023)	0.12088***	(0.0235)
Parking Dummy	0.07055***	(0.007)	0.07025***	(0.0073)
Fireplace Dummy	0.03045**	(0.013)	0.03001**	(0.0129)
Double Windows Dummy	0.01425**	(0.005)	0.01470***	(0.0055)
Air Conditioning Dummy	0.14336***	(0.006)	0.14100***	(0.0066)
Elevator Dummy	0.01662***	(0.005)	0.01606***	(0.0055)
Accessibility				
log(Dist. to Baixa)	-0.08972***	(0.013)	-0.09032***	(0.0152)
log(Dist. to Expo)	-0.13886***	(0.015)	-0.13774***	(0.0172)
log(Dist. to Airport)	0.06428***	(0.014)	0.06178***	(0.0164)
log(Dist. to Nearest Cultural Amenity)	0.01957***	(0.004)	0.01992***	(0.0051)
log(Dist. to Nearest Arts Amenity)	-0.01231***	(0.004)	-0.01173**	(0.0051)
log(Dist. to Nearest Public Parking)	-0.03449***	(0.003)	-0.03437***	(0.0037)
log(Dist. to Nearest Train Station)	0.01678***	(0.003)	0.01689***	(0.0042)
Count of Metro Stations 100 m	0.01537	(0.009)	0.01449	(0.0097)
log(Dist. to 25th April Bridge)	-0.12350***	(0.012)	-0.12578***	(0.0139)
log(Dist. to Nearest Fitness Amenity)	0.01280*	(0.007)	0.01215	(0.0078)
log(Dist. to Nearest School)	0.00703	(0.004)	0.00711	(0.0051)
log(Dist. to Nearest University)	-0.0014	(0.005)	-0.00175	(0.0056)
log(Dist. to Nearest Health Amenity)	0.03120***	(0.004)	0.03128***	(0.0046)
log(Dist. to Nearest Hospital)	0.00670*	(0.003)	0.00632	(0.0038)
log(Dist. to Nearest Shopping Center)	-0.00449	(0.005)	-0.00557	(0.0054)
log(Dist. to Nearest Security Amenity)	-0.00568	(0.005)	-0.00434	(0.0062)
log(Dist. to Nearest Fire station)	-0.00227	(0.006)	-0.00225	(0.0068)
log(Dist. to Nearest Cemetery)	0.05472***	(0.004)	0.05457***	(0.0052)

log(Dist. to Freeway)	0.07342	(0.100)	0.06409	(0.1089)
log(Dist. to Stadium)	0.19501***	(0.049)	0.19203***	(0.0539)
log(Dist. to Stadium)*log(Dist. to Freeway)	-0.03321***	(0.007)	-0.03271***	(0.0080)
Environmental Amenities				
log(Dist. to Nearest Open Space)	-0.21159***	(0.064)	-0.21200***	(0.0695)
Count of Open Spaces 50 m	0.03147**	(0.012)	0.02911**	(0.0131)
Count of Open Spaces 200 m	-0.02544***	(0.004)	-0.02407***	(0.0046)
Count of Open Spaces 500 m	0.00623***	(0.001)	0.00608***	(0.0017)
Count of Open Spaces 1000 m	0.00183***	(0.000)	0.00184***	(0.0004)
log(PM10 Particulates)	-0.59421***	(0.173)	-0.60905***	(0.1875)
log(PM10 Particulates)*log(Dist. to Nearest Open Space)	0.05780***	(0.017)	0.05784***	(0.0193)

[redacted]

73 623.86 Tm0 g()]T448 5140 1 EMC /P <<MCID 322>>BDC q270BDC q 0 9 56.66450C5 reW* nBT/F2 9 Tf1 0 0 1 268.61704 reW

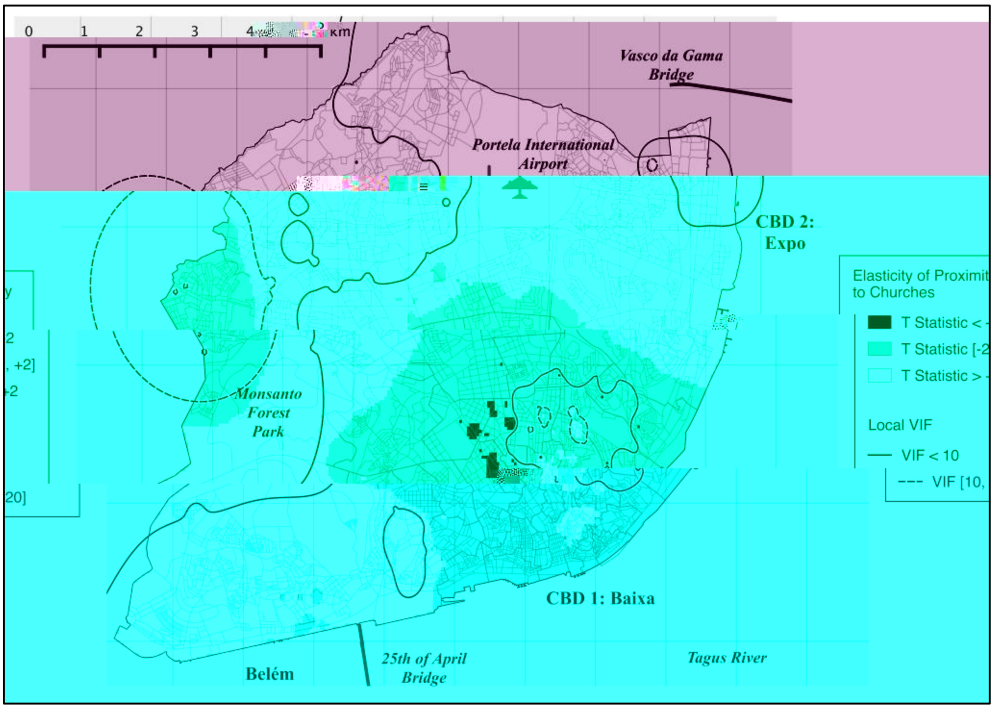
Table A8. **GWR Diagnostics**

	Optimal Bandwidth	SSE	Moran's I (Residuals)	AIC	R^2	Rho Err.
Monument Proximity						
OLS	-	639.8	0.0508***	-714.30	0.5885	-
SEM	-	613.6	-0.0039	-1087	-	0.5869***
GWR	982	587.4	0.0032**	-1441	0.6163	-
Landmark, Non-Landmarks, World Heritage Proximity						
OLS	-	637.5	0.0475***	-753.76	0.5900	-
SEM	-	613.5	-0.0034	-1090.9	-	0.5709***
GWR	982	587	0.0029*	-1441	0.6164	-
Historic Amenity Proximity						
OLS	-	636.9	0.0462***	-762.75	0.5903	-
SEM	-	613.5	-0.0036	-1090.1	-	0.5697***
GWR	982	586.9	0.0024	-1436	0.6163	-

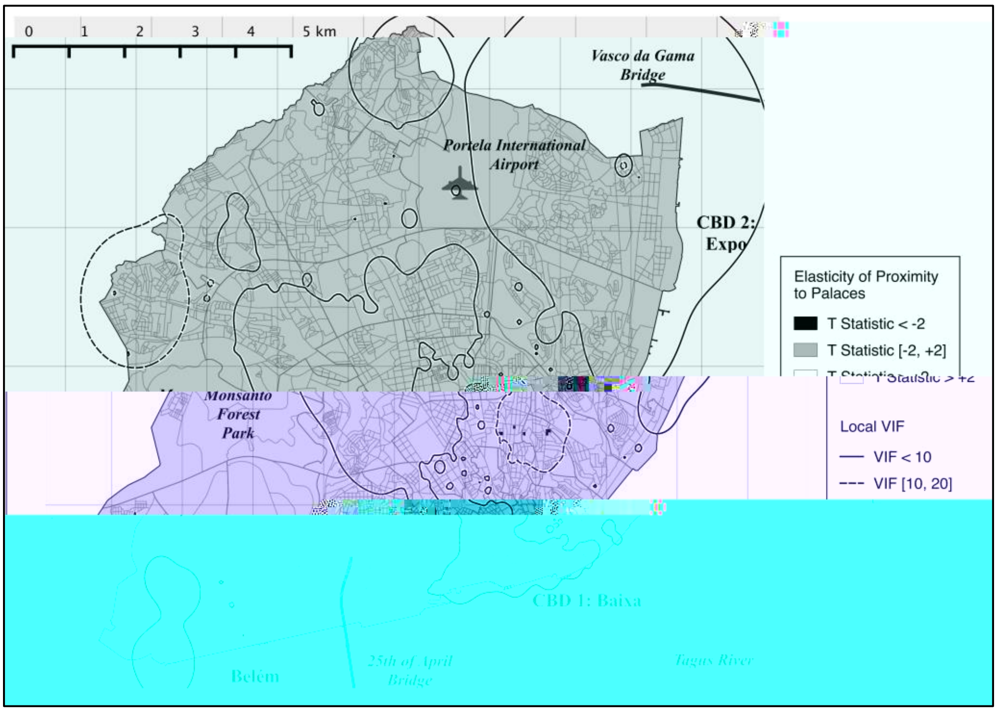
Notes: ****Significance at 1 p.c. level;* ***Significance at 5 p.c. level;* **Significance at 10 p.c. level.*

Figure A2. GWR Spatial Variation

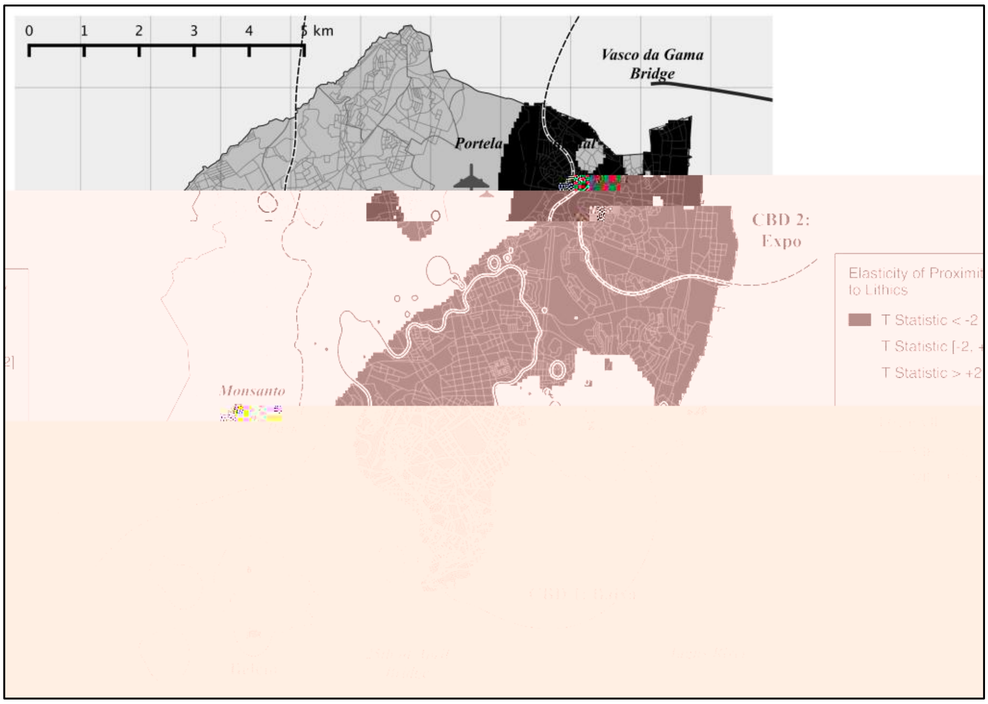
Panel A: All Churches



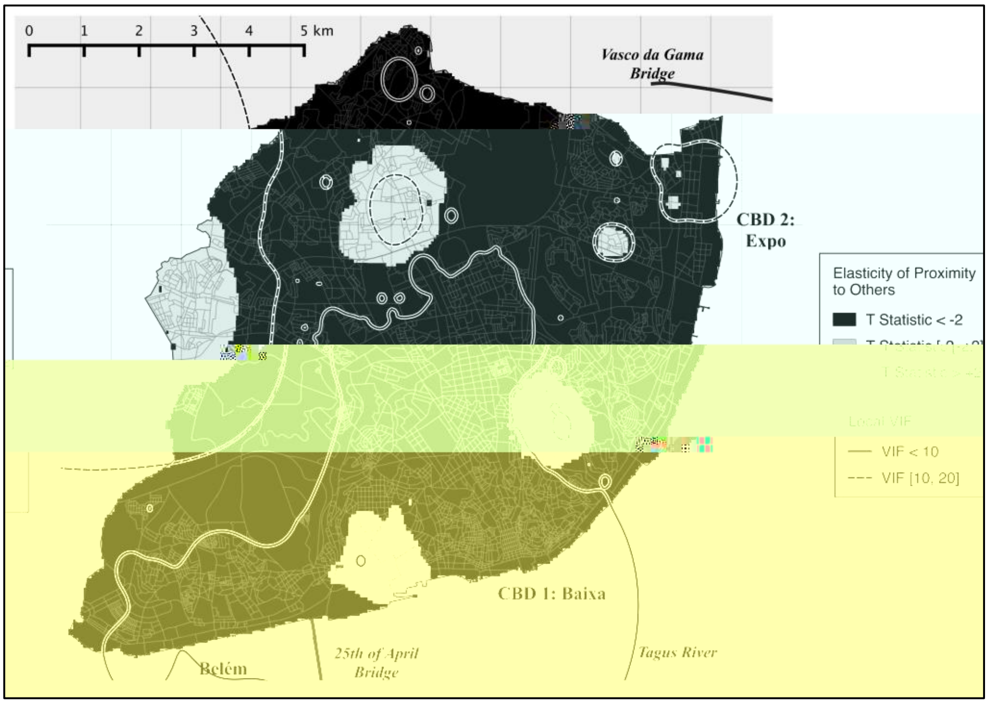
Panel B: All Palaces



Panel C: All Lithic



Panel D: All Others



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