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1. Introduction

Our interpretive point of view concerning the value of houses is that this value reflects the quality of urban life. The improvement or decline in the quality of urban life determines benefit or damage to homeowners, since they experience a change in the quality of life, and to landlords, who receive higher or lower rents. So, in our view the value of a house is essentially related to its character of a composite good, which is bought and sold in the housing market as a parcel of characteristics, which determine its market price (among many, Palmquist, 1984, and Cheshire and Sheppard, 1995).

As a consequence, we propose to study the quality of life concerning an urban context through the analysis of the housing market where we observe equilibrium prices concerning purchases and sales of parcels of housing values's determinants. Such determinants are grouped into four distinct categories as follows: i. structural characteristics of the residential unit (such as unit size, distance from the shoreline, qualitative indexes accounting, inter alia, for the building age, the apartment level and the maintenance level); ii. neighborhood demographic characteristics (such as residential density both in the census ward and in the city district in which the property is located, or the number of permanent foreign residents living in the district); iii. plan-related characteristics (such as the presence of residential zones within a given distance from the property, proximity to parks or other green areas, and to common public services), and iv. land cover types. In order to analyze the relationship between housing prices and the aforementioned potential constituent characteristics, we pursue an approach based on a hedonic model in order to figure out the general willingness to pay for a specific commodity among the municipal area of Cagliari (Sardinia).

This paper is organized as follows. In the third section we describe the five measures of the value of houses we adopt in our analysis that is, their estimated value, cadastral value, rent value, value supplied by the National Observatory on Real Estate Market, and sale value. In the following section, we discuss the set of variables that we use as determinants of the value of houses, that is:

i. structural characteristics,
ii. demographic characteristics,
iii. plan-related characteristics,
iv. land cover types.

The fifth section presents the hedonic methodology which we use to investigate the relations between the value of houses and its determinants.

The following section shows the results of the estimates of the hedonic regression models which use the value of houses and covariates in order to analyze if, and to what extent, the value of houses is related to the covariates altogether. Moreover, we compare the results concerning the different measures of the value of houses used as dependent variables in the hedonic regressions. In the concluding section, we discuss, through their hedonic prices, the influence of the determinants found relevant on the value of houses. This influence could be taken into account to define future planning policies to increase the quality of urban life. Exportabilty to other urban contexts and further developments of the research work are discussed as well.

2. Alternative measures of the value of houses

To provide a spatial approach to figure out the real estate market condition is problematic because of both the lack of literature on the topic (Boulay, 2012) and the expected uncertainty that characterizes such kind of analysis. After a general investigation on the national and regional housing market condition, we develop a methodology centered on the appraised market value of a sample of properties located in the main residential zones of the Municipality of Cagliari. The following sub-sections refer to the description of the area of study and the adopted appraisal approach.

2.1. The metropolitan area of Cagliari

Cagliari is the capital and the major city of the second largest island of Italy and of the Mediterranean sea (Sardinia). The island covers a total area of about 24,000 km^2 with an overall population of approximately 1,600,000 people in 2012. As shown in Figure 1, around 150,000 inhabitants reside in the study area and about 250,000 in the surrounding municipalities (ISTAT). An international airport (Elmas) and one of the most important cruise and cargo port of the Mediterranean sea provide the metropolitan area with an efficient transportation infrastructure. This feature, combined with the presence of conspicuous historical/ landscape heritage, makes the city attractive as tourist destination. as confirmed by the annual increase in the number of international travelers (+15.68%) registered in January 2014 by the airport managing company (SOGAER)[1].

FIGURE 1

The economy of the province of Cagliari is based, in order of importance, on trade and services, industry, and agriculture. In 2013, a note of the Bank of Italy reported a significant contraction of the regional GDP (-2.8%) and underlined the awful situation of the construction sector caused by both strong decrease in demand of new residential properties and reduction in public investments, as confirmed by the Sardinian section of the Italian association of building constructors (ANCE Sardegna, 2013), that registered that the sector had hit its worst

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[1] http://www.sogaer.it/it/archivio-news/930-aeroporto-traffico-ancora-in-crescita-nel-2013.html [last accessed: August 1, 2014].

state since the last forty years. As exposed below, this economic condition is fully reflected in the current state of Cagliari's housing market.

2.2. Housing market analysis

The latest report published by the National Observatory on Real Estate Market (OMI, 2013) states that the Italian residential property market is experiencing a period of strong stagnation characterized by a significant decrease in the number of property transactions and by a slight reduction in market prices. The report does not consider specifically the metropolitan area of Cagliari, but contains some interesting observations at the regional level. During the period 2004-2012, Sardinia was the Italian region having both the highest annual percentage change in market prices across the national context (about +7%) and the lowest reduction in average market prices throughout 2012 (approximately -0.5%). This particular housing market condition faces with one of the lowest family income at the national level and generates a serious housing affordability problem whose trend can be appreciated by analyzing the related housing affordability index. This index measures the ratio of the average mortgage rate to the disposable family income. In this specific approach, operated by OMI and based on US National Association of Realtors methodology (OMI, 2013), housing purchase is considered affordable if the calculated index shows a positive value. As a matter of fact, during the last eight years the recorded housing market affordability index decreased from 12% to less than 4%. Such fall is second only to the affordability index decrease registered in Liguria. The authors of the report argue that this specific housing market situation is mainly related to the current growth of tourism flows and the resulting increase in the number of new potential foreign buyers, that is tourists, interested in purchasing holiday homes. More likely, considering the report results and the theory expressed by Shiller (2008) about the US subprime crisis, the potential presence of a housing market bubble can provide an effective explanation of the current market condition.

We study the housing market of the municipality of Cagliari performing an analysis of the estimated market values of a representative sample consisting of 304 apartments spread over 18 distinct market areas. Having regard to the current real estate market stagnation and to the consequent general lack of specific transactional data, to estimate each property's market value, given also the size of the sample, can involve a significant margin of error. For this reason, we use different appraisal approaches and market price references.

For each property, we collect the relative overall gross living area [AREA] and evaluate, in qualitative terms, the potential incidence of the leading quality characteristics in the formation of property prices. As theorized by one of the main references on the subject (Orefice, 2007), these characteristics can be grouped in four categories:

i. localization quality (distance from the city center, efficiency of public transportation service, quality of local services, reputation of the area, proximity to open spaces or other natural features, availability of private or public parking lots for tenants and guests).

ii. position quality (presence and quality of panoramic views, distance from other buildings and structures / daylighting quality, apartment level).

iii. typological quality (building and apartment maintenance level, equipment and mechanical system conditions, building age).

iv. economic productivity: potential risk to re-convert the property investment into cash (marketability risk) and legislative risks. Given the impossibility to access information concerning the property owners, we assess marketability risk as related to the overall gross living area and consider legislative risk almost uniform in a given market area.

TABLE 1

Orefice theorizes three general levels of incidence of the above mentioned categories of quality characteristics, depending on the localization of the market area (Table 1). By means of the market values range published by OMI, we adopt the described quality valuation to appraise, for each house, its market value [OMI_VAL] and rent value [RENT_VAL].

TABLE 2

In addition, we consider another market value definition [EST_VAL] by estimating a linear regression for each market area. For this estimate, we consider a dataset based on a survey concerning residential property sales carried out in 2013. Considering the market price as the dependent variable and the quality of the features as the explanatory variable, we assess the relationship between prices and quality for each market area. Subsequently, we make use of the resulting regression line to define the market value for each of the 304 apartments. Moreover, we appraise the cadastral value [CAD_VALUE] for each single apartment, by means of the on-line evaluation service provided by the Italian Cadastre[2]. Finally, we estimate the list price [SUPP_VAL] by considering a sample of list prices observed during the first semester of 2013 and comparing each property with the nearest detected apartment for sale.

Table 2 defines the aforementioned alternative variables used for housing market analysis and reports the obtained mean and standard deviation. As shown, the difference between the two average market values estimated by means of different approaches ([EST_VAL] and [OMI_VAL]) is not important (about 2%) compared to supplemental costs related to ordinary property transactions (i.e. taxes, mortgage fees, realtor's entitlements, etc.). The mean list price [SUPP_VAL] is approximately 10.3 percent higher than the lowest detected mean mar-

[2]Available on the Internet at http://www.agenziaentrate.gov.it/wps/content/Nsilib/Nsi/Home/Servizi+online/serv_terr/senza_reg/Consultazione+rendite+catastali/ [last accessed: August 1, 2014].

ket price [EST_VAL], against a national average of 15.3 percent[3]. The recorded mean Italian cadastral value [CAD_VAL] cannot be considered representative of the real estate market. As a matter of fact, it is more than three times lower than the mean market value ([EST_VAL] and [OMI_VAL]) and, in addition, the average assessed month gross rent [RENT_VAL] presents, in pair with [OMI_VAL], the lowest relative standard deviation among the estimated market values. This issue is related to the use of a general market value reference (the OMI report) for the appraisal process. Finally, the average gross living average area of the sample (109.43 m^2) is consistent with the average gross living area recorded for the provincial capitals of the main Italian islands (103.5 m^2) (OMI).

The general spatial configuration of the housing market in Cagliari is shown in Figure 2. In the Northeastern sectors of the municipality we detect an average unit market value up to 2,000 Euros per square meter (L) and in the Central and Northwestern areas between 2,000 and 2,500 (M). Finally, in the Central and Western parts we observe the highest average unit market value, corresponding to 2,500 Euros per square meter and over (H).

FIGURE 2

3. Factors influencing the value of houses

3.1. Discussion on factors

In the literature (among many, Palmquist, 1984, Cheshire and Sheppard, 1995, Kiel and Zabel, 1999, Zoppi, 2000), a widely accepted classification of factors influencing the value of houses distinguishes those intrinsically belonging to a particular house and those belonging to the house's neighborhood. Palmquist (1984) uses thirty-two variables to define the value of

[3] The reported national average difference refers to the average gap between the first offer price and the related market price, recorded in municipalities with a population ≤ 250,000 inhabitants (source: Bank of Italy Eurosystem Statistics, 2013).

houses in seven United States metropolitan contexts. Twenty-three factors are related to a housing unit, while nine determinants concern the neighborhood where a house is located. Housing unit-related factors include, for example, finished interior area, number of bathrooms, year of construction, etc., while characteristics related to the house's neighborhood are drawn from the census data with reference to the census tract where the house is located, e.g., median age of residents, percentage of workers that has a blue/white collar job, population classified as non-white, and so on. Cheshire and Sheppard (1995) use a similar approach to the definition of the set of factors, but they add characteristics related to the zoning rules established by municipal Masterplans and urban land uses, such as industrial land, land for new residential developments, open space for leisure.

Characteristics of housing units and of the neighborhoods where houses are located could possibly be either positive aspects or negative aspects. Since the characteristics of neighborhoods where houses are located are locally intrinsically non-excludable and non-rivalrous they can be considered public amenities or public negative aspects. The more the quantity of a public bad, the less the value of houses in the neighborhood, and vice-versa. Under this perspective, Zoppi (2000) analyzes the quantitative negative impact of widespread illegal building activity on the value of houses in the metropolitan area of Cagliari (Italy) by considering illegal buildings as a public bad, that is, a negative characteristic of the neighborhood where a house is located.

In the light of the papers quoted above and of many others which deal with the issue of the determinants of the value of houses, in this paper we use the following taxonomy of the characteristics of houses:

i. structural characteristics of the residential unit;
ii. neighborhood demographic characteristics;
iii. plan-related characteristics;

iv. land cover types.

Structural characteristics of houses are collected through interviews to real estate agencies, landlords, renters and homeowners, and through direct observation. Surely, more reliable estimates could have been obtained, had more precise and standardized databases, such as the American Housing Survey, been available, which is not the case for Italy.

We consider structural characteristics of the residential unit as follows.

i. Finished interior area is a characteristic of a house dependent on the prevailing architectural building typologies in a given urban region, which in turn is strictly linked to the way urban planning has been historically implemented. Where urban planning has projected intensive building activity, that is, zones characterized by high densities of resident population, architectural typologies generally consist of tall buildings with several stories. In these cases, houses have small interior areas. Moreover, there is limited space for parking since up to the 1980s, when this was explicitly forbidden, what had been originally projected as parking areas were often sold as shopping areas. On the other hand, in the zones characterized by extensive residential urbanization, densities are lower and houses are located in one, two or three-story buildings. In these cases finished interior area is larger and buildings usually have large parking areas in their courtyards. A question that is widely recognized in the literature, with reference to finished interior floor area, concerns the functional behavior of the value of houses with respect to finished interior area. Palmquist (1984, 397) observes that: "one characteristic requires special attention. It would be anticipated that the number of square feet of living space would not simply have a linear effect on price. As the number of square feet increases, construction costs do not increase proportionally since such items as wall area do not typically increase proportionally. Appraisers have long known that price per square foot varies with the size of the house." As a consequence, in our discussion it could be expected that the value of houses is negatively correlated to finished interior area, since we express it as the value per unit of finished interior area.[4]

ii. Two quality factors related to typology and position represent two intrinsic features of the property. Typological quality regards the physical characteristics of the house and, in most aspects (i.e. maintenance level and quality of construction), can be improved by property owners. Depending on the buyer's willingness to pay, the value added or lost by carrying or not carrying out these improvements may not worth the related cost. For example, to renovate an apartment by providing high-end quality finishes can be a cost-rewarding operation in a prestigious district. In a less qualified market area, where potential buyers usually are not interested in supporting the marginal cost of this improvement, the same process has a more limited influence on the value of the apartment. Considering the state of the regional housing market and the multifaceted Italian taste in design and materials, sellers are used to sell the property "as it is" avoiding the risk of supporting additional costs without meeting the expectations of potential buyers. Conversely, position quality cannot be improved by property owners and has a significant influence in price formation, especially for residential units located in multistory buildings. In these cases, features like "presence and quality of panoramic views" or "daylighting quality" can differ significantly according to the apartment level.

iii. Finally, we include the distance from the seashore. In the case of Sardinia, an island which coincides with an administrative region of Italy, the distance from the coast is of particular importance, since the so-called "coastal strip" (CS) is defined in article 19 of the Planning Implementation Code (PIC) of the Regional Landscape Plan of Sardinia (RLP, approved by the Regional Government of Sardinia in 2006) as a "strategic re-

[4] In the first part of Palmquist's citation "price" is the price a house is offered for sale. In this paper, we consider the value of houses per unit of finished interior area.

source, vital for the achievement of sustainable development in Sardinia, that requires integrated planning and management." Under article 20 of the PIC, as a general rule, new development of land and transformation of current land uses are not allowed in the CS. Some exceptions to the general rule are allowed, provided that municipalities and developers abide by regulations and procedures given by the PIC. Due to these particular restrictions in force in the CS, it was believed that the amount of municipal land area included in the CS could be a relevant impact factor on the ability of cities and towns to spend funds allocated for public services and infrastructure (Zoppi and Lai, 2013). So, a proximity-to-coast effect could be expected, since coastal land is demanded for future development. If land-taking processes related to tourism development are forbidden, it seems very possible that land take will occur in the proximity of the CS or in the parts of the CS where exceptions are allowed. This argument is discussed with reference to a different spatial context, by Dewi et al. (2013), who found that the establishment of protected areas (CS-like areas) in Asian and African tropical forestry regions determines an increased exploitation of the marginal lands just outside the protected areas. If a proximity-to coast effect does occur, the value of houses will increase as distance from the coast diminishes.

Neighborhood demographic characteristics are drawn from the most recent demographic survey made available by the municipality of Cagliari. We consider the following characteristics.

i. Population density, whose correlation with demand for new houses, which could possibly put in evidence a positive agglomeration effect, is underlined by several studies (Sklenicka, 2013; Guiling et al., 2009; Forster, 2006).

ii. Population size and the presence of permanent foreign residents, mostly coming from underdeveloped countries, are the other factors we include as determinants of the value of houses. The value of houses is expected to be positively correlated to the presence of foreign residents, whose presence, everything else being equal, is expected to increase the demand for houses, while there is no prior expectation related to the effect of population size, since concentration could cause a negative effect in terms of possible shortage of public services and infrastructure due to overcrowding, but also positive impact, since excess demand for houses could raise their market value.

Plan-related characteristics are the features of the neighborhood where a house is located which are related to the zoning rules of the city Masterplan. We class them into the following categories, identified in the zoning rules through acronyms in parentheses:

- historic center zone ("A" zone);
- residential completion zone ("B" zone);
- residential expansion zone ("C" zone);
- enterprise zone ("EZ" zone);
- parks (open-space leisure areas, "S3" and recreational "G" zone);
- mixed use zone (industrial and service areas, "IS" zone).

The surveyed houses are located either in the historic center zone or in the residential completion zone, where steady residential development has taken place. Houses in the completion zone are more recent, affordable and, at least to some extent, constructed through social housing projects so their value is expected to be lower, everything else being equal.

The categories of the areas related to the zoning rules can be described as follows.

i. The historic center zone is a single, dense and central area in the urban fabric; it dates from the Middle Ages and hosts buildings important for cultural, artistic and historic reasons. Specific rules apply to this area, in order to avoid an increase in built volume, preserve the facades and control the building uses. The peculiarity of the historic center zone is that it is not a residential zone. Rather, it is a mixed-use zone, which entails public services, commercial and residential uses. The peculiarity of the historic center zone is that it is not a residential zone. Rather, it is a mixed-use zone, which entails public services, commercial and residential uses.

ii. The “B” zones are built-up areas which consist mainly of dense residential blocks. A partially-built area is generally considered to belong to a “B” zone when its area is smaller than 5,000 square meters and more than a 30 percent of the volume has already been built. As a general rule, on a single building lot belonging to a B zone, building is limited to 3 cubic meters per square meter of plot size.

iii. The “C” zones are either non-developed or partially developed parts of the city (where less than 30 percent of the volume has already been built) bound to be residential are-as. Restrictions on built volume are far stricter than those imposed in the B zones and equal to 1.5 cubic meters per square meter of plot size. Furthermore, in order to obtain a building permission, a plan must be approved by the local municipality. This plan must indicate the spatial distribution of the building lots, as well as a portion of the ar-ea which has to be handed over to the municipality, in order to build public services and infrastructure. The size of this area depends on the estimate of the number of the future residents, which is estimated on the basis of the amount of the housing volume, therefore on the ratio of maximum volume to the area of the lot.

iv. The “EZ” zones are either non-developed or partially developed parts of the city where an integration of different functions (residential buildings, public facilities and recrea-tional areas) is required. For each EZ zone, the city Masterplan sets specific rules on the combination of functions. For instance, in an EZ zone important for environmental reasons a maximum of 35 percent of the area is available for housing areas, and a 0 percent for public facilities, while a 65 percent has to be reserved for recreational are-as. A stronger residential EZ is characterized by a 93 percent - 7 percent - 0 percent combination. An EZ zone located in spoiled city outskirts is characterized by a 70 percent - 30 percent - 0 percent combination.

TABLE 3

There is no prior expectation on the effect of plan-related characteristics on the value of houses except with reference to the presence of parks in a house's neighborhood, which should increase the house's market value.

The last characteristic is related to land cover. The land cover map of Cagliari was drawn from the 2008 land cover maps of Sardinia made available in 2008 by the Sardinian regional administration[5], whose nomenclature is based on that of the inventory of land cover carried out in the frame of the European programme COoRdination de l'INformation sur l'Environnement (CORINE).

We consider artificial (urban fabric) surfaces of the neighborhood where a house is located. There is no prior expectation on the effect of this characteristic on the value of houses, since a higher level of urbanization can, to some extent, raise environmental and social quality of urban contexts, but it could be related to the negative impact of services' and infrastructure's overcrowding as well.

Finally, we consider a spatially-lagged dependent variable as a covariate related to the spatial autocorrelation of the dependent variable. This question is discussed in the following paragraph.

[5] The 1:25,000 "New Land Use Map of the Region of Sardinia - 2008 Edition" is actually a land cover maps that covers the whole island. Data were obtained mainly from photo-interpretation of aerial photographs, satellite images, and orthoimages, but other vector data sets (e.g., regional digital cartography) were also used, together with on-site surveys. The maps' minimum mapping unit (Longley et al., 2001, 151) equals 0.5 ha in urban areas and 0.75 ha in rural areas. Both maps can be freely downloaded from http://www.sardegnageoportale.it/index.php?xsl=1598&s=141401&v=2&c= 8831&t= [last accessed: August 1, 2014].

Table 3 shows the variables which describe factors related to the value of houses and their descriptive statistics.

3.1.1. Autocorrelation-related spatially-lagged dependent variable

If the value of a variable defined with reference to a spatial unit, such as a point where a house is located, is correlated to the values it takes in the closest units, the variable is characterized by spatial autocorrelation.

Spatial autocorrelation of the dependent variable in spatial regressions produces biases in the model's estimates. This issue can be addressed by adding a spatially-lagged dependent variable to the set of covariates (Anselin, 1988; 2003).

The presence of spatial autocorrelation of the dependent variable of a model, that is the values of houses described in the previous section is detected through the Moran's test (Moran, 1950; Anselin, 1988).

The Moran's test concerning the spatial autocorrelation of a variable X which takes values over a finite number of spatial units i, i = 1, …, N, is based on a statistic I defined as follows:

$$I = \frac{N}{S}\frac{\sum_{ij} W_{ij}(X_i - \boldsymbol{X})(X_j - \boldsymbol{X})}{\sum_i (X_i - \boldsymbol{X})}, \quad (1)$$

where j = 1, …, N, X is the mean of the components of vector X, Wij is equal to 1 if spatial unit i is spatially-related to spatial unit j, 0 otherwise, and S is equal to $\sum_i \sum_j W_{ij}$. The test assumes that i is normally distributed with a zero mean in case no spatial autocorrelation occurs, which is the null hypothesis of the Moran's test. If the p-value of the test is lower than 5-10%, a spatially-lagged dependent variable should be added to the set of the covariates in order to make the model unbiased, since it is very possible that the values of the dependent variable are spatially autocorrelated. The spatially-lagged dependent variable, named AUTOCORR in Table 3, is defined as follows (Anselin, 1988; 2003):

$$AUTOCORR_i = \sum_j W_{ij}, \quad (2)$$

where i, j = 1, …, N.

The application of the procedure described so far to our study implies the implementation of the Moran's test. We implement a set of Moran's tests using GeoDa[6] by assuming, alternatively, that Wij of (1) is equal to 1 if the distance between house i and house j is less than 500 meters. The reason we choose this distance is that the p-values of the Moran's test for the alternative dependent variables described in the previous section show a peak at 500 meters, so spatial autocorrelation maximizes its significance at 500 meters.

Table 3 shows the results of the Moran's tests at different distances. Descriptive statistics of AUTOCORR are shown in Table 2.

3.2. Spatial analysis of factors

For each of the 304 apartments in the sample, the value of nearly all of the characteristics listed in Table 3 (except for AREA, Q_POS and Q_TYP, which were assessed, for each apartment, by means of on-site surveys) was calculated by performing some kind of GIS-based analysis, as none of them were available "off the shelf". This also meant that various data (both geographic and non- geographic) were collated from different sources (accounted for in Table 3) and, in some cases, also pre-processed. In most cases, GIS-based analyses consisting of combinations of buffering and basic geoprocessing operations were performed. This made it possible to develop a geographic dataset, to calculate the value of each characteristics for each apartment, and to analyze their spatial distributions.

FIGURE 3

The spatial distribution of four of the potential determinants of market prices is shown in Fig. 3, as follows.

[6] Version 1.4.6. Available on the Internet at https://geodacenter.asu.edu [last accessed: August 1, 2014].

i. In the top-left map (AREA), larger and paler points show the localization of apartments taking the highest values of the finished interior area, by using the zoning scheme of the municipal land-use plan of Cagliari as a background.
ii. In the top-right map (PARKS), larger and paler points correspond to apartments surrounded by larger amounts of open-space leisure areas; this map shows a clear spatial clustering of the values, with the central part of the city (also comprising the historic district) taking low values, albeit not the lowest, as these form three distinct clusters around the central part (two to the West and one to the North-East).
iii. Similarly, the bottom-left map demonstrates that the factor FOR_2012 is spatially clustered, meaning that permanent foreign residents mostly live in the central districts.
iv. Finally, the bottom-right map shows the distribution of the variable DISCOAST, accounting for the distance of each apartment from the shoreline.

4. The hedonic methodology

The hedonic methodology considers quality of urban life as a phenomenon embedded into the value of houses through their characteristics. According to the hedonic approach, a house is a parcel of goods. This means that a person who buys a house, buys a basket of amenities (Thaler and Rosen 1976; Dickens 1984; Gegax et al., 1991). What is paid is the arithmetic sum of what the buyer is willing to pay for each of the amenities or is willing to accept as a refund for each of the negative aspects contained in the basket (King, 1976). If we consider this methodology on the supply side, the vendor sells a bundle of goods and is willing to accept a price that is equal to the arithmetic sum of the values of each contained amenities or negative aspects (a negative price in case of a bad). Assuming the housing market to be in equilibrium, that is, assuming that the market of each amenity or bad is balanced, the price of each amenity or bad represents an equilibrium price between willingness to pay (demand side) and willingness to accept (supply side). Each determinant can be sold just as a component of the bundle of goods contained in the housing unit and its price cannot be observed directly from the housing market; however, it can be estimated as a component of the housing price through direct observation of the housing market. This quasi-market price is called a hedonic price and the function which expresses the housing price as dependent on the quantities of the amenities or negative aspects contained in the basket containing the housing unit is called a hedonic function (Ridker and Henning, 1967; Brown and Rosen, 1982; Cropper and Oates, 1992).

The basket of goods a person buys in the housing market can contain not only amenities, but also undesired characteristics. The higher the quantity of negative aspects, the lower the housing price. In other words, the basket paid for by the buyer contains some undesirable characteristics, which decreases his/her willingness to pay.

Hedonic functions have the following form:

$$WTP = h\,(A,B) \qquad (3)$$
$$WTA = g\,(A,B),$$

where: WTP is the total willingness to pay for a house (demand side) and WTA is the total willingness to accept a payment for a house (supply side); A is a vector of amenities or negative aspects that are included in the housing unit; B is a vector of characteristics of the neighborhood where the housing unit is located. WTP is the hedonic demand and WTA is the hedonic supply function. If the housing market is in equilibrium, the observed price of a house is equal to the willingness to pay for that house (demand side) and to the willingness to accept for that house (supply side). In the same way, the marginal willingness to pay (MWTP) for each amenity or bad contained in that house is equal to the marginal willingness to accept (MWTA). This equilibrium price is the hedonic price of that amenity or bad. Notation Hpi indicates the hedonic price of amenity or disamenity i, i= 1, …, n.

In model (3), there are two hedonic functions, one for the demand side and one for the supply side. The estimation of these two functions implies the availability of data on willingness to pay (buyers) and willingness to accept (sellers). Data on the supply side must be collected by directly interviewing sellers, which is a very cumbersome task. Blomqvist and Worley (1981) have suggested assuming the supply of characteristics as perfectly inelastic at any location. In this case, only one of the two equations of model (3) must be estimated. Palmquist (1984; 1991), Blockstael et al. (1991), and Graves (1991) have studied a modification of model (3) which reduces the number of equations to be estimated by taking data on the housing market transactions instead of willingness to pay. The dependent variable in the hedonic function is the market price of houses which expresses an attained equilibrium between demand and supply. Utilizing data regarding the housing market instead of data on willingness to pay and willingness to accept reduces the hedonic function to a function, P, which expresses the equilibrium of the housing market as follows:

$$P = f(A,B). \tag{4}$$

If a change in the required quantity of an amenity or bad does occur, the value of the change can be calculated by multiplying the hedonic price of the amenity or bad by the quantity change.

TABLE 4

TABLE 5

TABLE 6

The hedonic function operationalizes equations (4) with the form:

$$PRICE = \beta_0+\beta_1\ HUNIT+\beta_2\ DEMOG+\beta_3\ PLANREL+\beta_4\ LANDCOV+\beta_5\ AUTOCORR+\varepsilon, \quad (5)$$

where the dependent variable, PRICE, is one of the five alternative measures of the value of houses defined in the third section (see Table 2), HUNIT, DEMOG, PLANREL and LANDCOV are the vectors of characteristics of a house (HUNIT), and of a house's neighborhood (demographic, DEMOG; plan-related, PLANREL; artificial land cover, LANDCOV), discussed in the fourth section (see Table 3), and AUTOCORR is the spatially-lagged dependent variables defined through the procedure described in paragraph 4.1.1 (see Table 3).

5. Results

We estimate the five linear multiple regressions indicated in (5), using the five alternative dependent variables discussed in the third section. Results are shown in Tables 4-8. Table 4 shows that results concerning the cadastral value of houses are almost completely non-significant. Moreover, the goodness of fit of the regression is lower than in the other four cases, since adjusted R-squared is less than 10 percent. So, we can conclude that cadastral values, which are the values property taxes are based upon, do not represent effectively the value of houses, as it was expected. This outcome indicates that a comprehensive and equity-oriented reform of cadastral values and related property taxes is needed, and that an effective analysis of the factors influencing the value of houses cannot be related to the actual cadasters'.

TABLE 7

TABLE 8

The results of the other four regression models are reasonably consistent with each other (see Tables 5-8 and the synthesis shown in Table 9).

The coefficients of the variables related to the structural characteristics of houses are almost always significant (p-values less than 5 percent) and show the expected sign. The only case three out of four of them are not significant (p-values greater than 10 percent) is the model where the dependent variable is the average list price recorded from other apartments for sale (SUPP_VAL). Distance from the coast is always significant and presents the expected sign, so we can conclude that proximity to the seashore is one of the most important factors which influences the value of houses in the municipality of Cagliari.

Among the variables related to the demographic characteristics of the neighborhood where a house is located, density is significant just in two cases (EST_VAL and SUPP_VAL), and it shows the negative sign, which implies no agglomeration effect. A negative sign does occur in the other two models, which use OMI_VAL or RENT_VAL as dependent variables, but the estimate of the coefficient is not significant (p-value higher than 10 percent). The coefficients of the variables related to the presence of permanent foreign residents (FOR_2012) and to population size (RES_2012) are always significant. The sign of FOR_2012 is consistent with expectation, while the RES_2012's sign is negative, which indicates that the higher the concentration of residents in the neighborhood where a house is located the lower the quality of the urban environment, possibly due to shortage of public services and infrastructure.

Plan-related variables do not show significant estimates only in the case of the historic center zone (A_Zone). The coefficients of PL_ZONE, B_Zone, C_Zone, EZ_ZONE, MIXUSE and PARKS are always significant. The value of houses located in the historic center is higher than that of the houses located in the completion areas (dummy variable PL_ZONE), and the presence of either residential completion areas, or residential expansion areas, or enterprise zone areas, or mixed-use areas in the neighborhood of a house implies a negative marginal effect on the value of the house, which could be explained by the uncertainty which characterizes the future residential and public services and infrastructure lay-out of these almost-not-yet-urbanized areas.

TABLE 9

As it was expected, the variable related to presence of public parks in the neighborhood of a house (PARKS) is always positively correlated to the value of houses, and significant in three out of four cases. Nothing can be stated with reference to the plan-related variable A_ZONE, which has a negative and significant effect on the variable related to the market value of houses (OMI_VAL), while in the other three cases the effect is negative, but not significant, which indicates that houses closer to the historic center are comparatively less valuable, which may possibly be explained by observing that historic areas of the city of Cagliari are often characterized by old urban fabric with lots of obsolescent buildings, roads and public areas, which could make the location of houses less attractive, everything else being equal.

Finally, the land cover-related variable (LC_URB) is never significant, while the spatially-lagged dependent variable is always positively and significantly correlated to the four dependent variables, as it was expected.

We have also estimated the log-linear specifications of the five regression models discusses in this paper, which gave results similar to those proposed in this section, even though with a slight lower goodness of fit.

6. Discussion and conclusion

In terms of policy planning concerning the housing market it can be observed that a reduction in size through the division of large apartments (greater than 120 square meters) in two or more residential units could increase the value of houses, since the variable AREA decreases.

The reason is that smaller housing units produce a higher sale price per square meter and allow for effective functional recovery of apartments, whose living area otherwise would be not appropriate for current needs. The variable Q_POS has a significant relationship with the dependent variable EST_VAL, but it should not be effectively targeted for housing policies.

Some aspects of Q_POS, such as the presence of panoramic views, are related to other independent variables such as DISCOAST or PARKS; the variable has a dramatic spatial variability, since the city of Cagliari spreads across numerous hills. Moreover, even with reference to the same building, for any residential unit that overlooks the sea or has an excellent sun exposure, it is possible to identify a wide gradient of position quality levels depending on the apartment level and exposition. In addition, position quality usually has its highest influence in price formation in case of high-quality districts, where it is highly likely that it works as a specific market segment determinant. For these reasons, Q_POS must be considered as a factor that generates a general market appreciation of position quality.

The variable Q_TYP shows a significant correlation with EST_VAL as well, and produces an increase in the value of residential properties. As stated above, some features of typological quality of houses (i.e. building and apartment maintenance level, quality of construction, equipment and mechanical system conditions) can be improved by landlords and homeowners depending on their cost-effectiveness or personal needs related to the use value. In order to increase cost-effectiveness margin, policies that focus on improving the quality of neighboring urban spaces, with particular reference to green and transportation facilities, can lead landlords and homeowners to renovate private and common parts of their building. Such kind of public investment can possibly have a direct impact on the local community by both encouraging private development and improving citizens' quality of life.

In the rest of this concluding remarks we use GIS to comment and discuss policy implications of our results through some spatial representations. Such GIS-based representations are easily reproducible with reference to other urban areas, provided that the value of the characteristics here analysed are available, and they allow for a pretty straightforward spatial interpretation of the results.

We started by simulating a "what-if" scenario by building upon the results of the linear multiple regression that uses EST_VAL as the dependent variable, and more precisely upon coefficient presented in Table 5: for each apartment, we estimated the magnitude of the impact on the variable EST_VAL, that is the percent change that would occur if a single explanatory variable (among those that are generally significant, as shown is Table 9, and that can be driven in some way by means of appropriate policies, that is, the area of the house, AREA, the distance from the coast, DISCOAST, and the endowment of recreational areas (PARKS) had increased by a given quantity – that is, ten percentiles in that variable's distribution.

Figure 4 presents the results of this process: the greatest change in market price is produced by implementing policies that increase the variable PARKS, as EST_VAL could increase up to 6.61 percent if the value of this characteristic increased by ten percentiles (Figure 4, center); as the map shows, the market price would increase unevenly across the city, as both the lowest and the highest variations are strongly clustered. Policies affecting either the characteristic AREA or the characteristic DISCOAST would produce a consistent decrease in market prices, but not as significant (in quantitative terms) and not as spatially clustered as that produced by varying the value of PARKS.

Such spatial representations provide decision makers with clear indications on which are the "best" possible areas that policies should target in order to affect market prices.

The results obtained with reference to Cagliari's urban area allow generalization for two reasons. On the one hand, no similar empirical studies have been implemented to analyze the determinants of the value of houses in other Italian conurbations by means of the hedonic approach. This is most likely due to the scarce availability of data to implement this evaluation.

On the other hand, it is not possible to compare the situation of the urban area of Cagliari to a situation in which a more flexible, participatory, faster and bottom-up planning process was implemented. This kind of situation would have probably encouraged people to lobby in favor of effective planning policies concerning the housing market, since the established planning process has been developed quite homogeneously in all of Italy, and counter-examples are very rare.

FIGURE 4

Secondly, empirical results give credit to the view that there would be benefits for the public providing utilities concurrent with development. This finding is relevant in Florida, which has enacted concurrency rules that require this as a condition of development approval; no development with inadequate infrastructure may be allowed (Auerhahn, 1988). This is a controversial policy, since it can slow development or raise development costs.

Rigid separation between right to build and property right allows the Italian cities to determine how much developers must pay to compensate the local communities for the increased pressure on the existing public infrastructure and services.

This is different from the approach in the United States, where the question is addressed on a case-by-case basis. There, some local governments levy “impact fees.” These are very similar to the building permit fees levied in Italy, since they are based on estimates of the public costs of providing needed public facilities per dwelling unit to be constructed (Lillydahl et al., 1988; Nicholas, Nelson 1988; Nicholas et al., 1991).

Urban fringe development, for example, frequently utilizes septic tanks without adequate public utilities. At some point in the future, the public extends public water and sewerage, paying for it in one of several ways: using general tax revenues, special assessments of benefited properties, user charges, or some combination of these. The Boston Zoning Code establishes that the developer's submission of a project to the city must include an evaluation of the Proposed Project's impact on the capacity and adequacy of existing water, sewerage, energy, and electrical utility systems, and the need reasonably attributable to the Proposed Project for additional systems facilities (Boston Redevelopment Authority, 1991).

The City of Boston and the developer must be aware of the cost of urban transformation, but there is no established sum the developer must pay to build new public infrastructure and services. This is left to the free negotiation between the city and the applicant.

French legislation gives cities the task of establishing the contribution developers must pay to obtain their building permits, adopting an approach that lies between the Italian and the United States ones. When a plan d'occupation des sols is approved by a city, payments to obtain building licenses cannot be revised and are deterministically established. However, in this case, there is plenty of room for free negotiation (République Française, 1983).

Moreover, in light of the empirical results relating to the determinants of the value of houses, it would be interesting to explore if, and to what degree, planning policies aimed at qualitative improvements of houses would develop in a United States or French context had local developers be discouraged due to very high development costs.

This empirical work defines and implements a research methodology and design to evaluate the monetary value of the characteristics of houses as determinants of the value of houses. This research methodology and design offers powerful tools to define city fiscal policies which could successfully deal with value generated by urban residential expansion. This is implemented through an analysis of the housing market, through direct observation of human behavior. The more reliable the information, the more effective policy decisions can be in order to convey part of the generated value to the financial resources of the cities.

Regarding this issue, a sound institutional framework is necessary to allow the cities to implement zoning regulations and fiscal policies to deal with the determinants of the value of houses. This would be based on negotiation with developers, landlords, homeowners, and local communities, along with detailed and standardized territorial information systems and databases regarding the housing market.

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FIGURES

Municipality	Population
Assemini	26607
Cagliari	**149.575**
Capoterra	23189
Decimomannu	7954
Elmas	9064
Maracalagonis	7592
Monserrato	20178
Quartu Sant'Elena	69443
Quartucciu	12947
Selargius	28643
Sestu	20044
Settimo San Pietro	6577
Sinnai	16852
Uta	8007
Metropolitan area	**406,672**

Figure 1. Distribution (left) and extension (right) of the metropolitan area of Cagliari (source: ISTAT 2012).

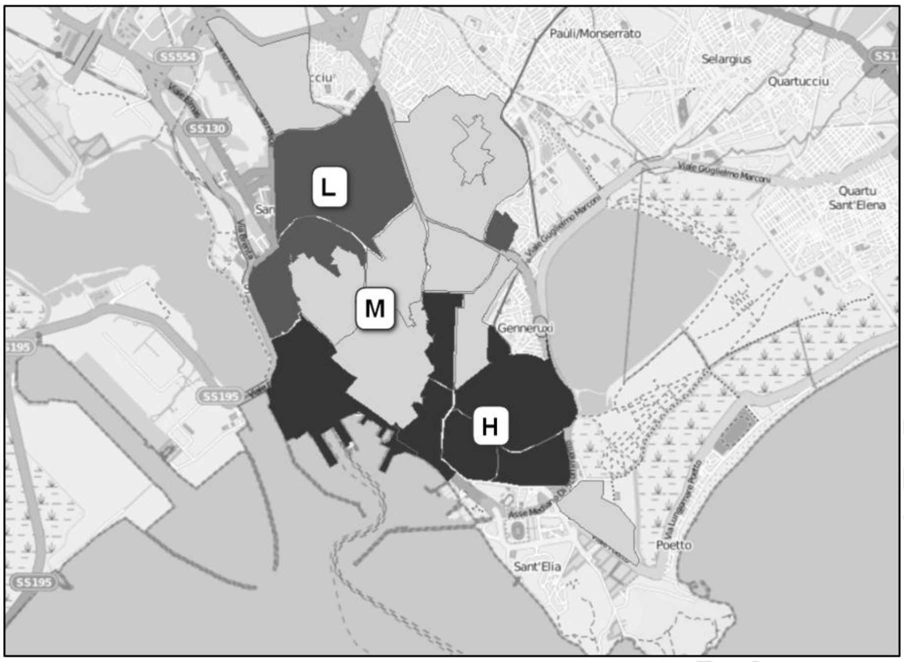

Figure 2. Average market value ranges detected in the study area.

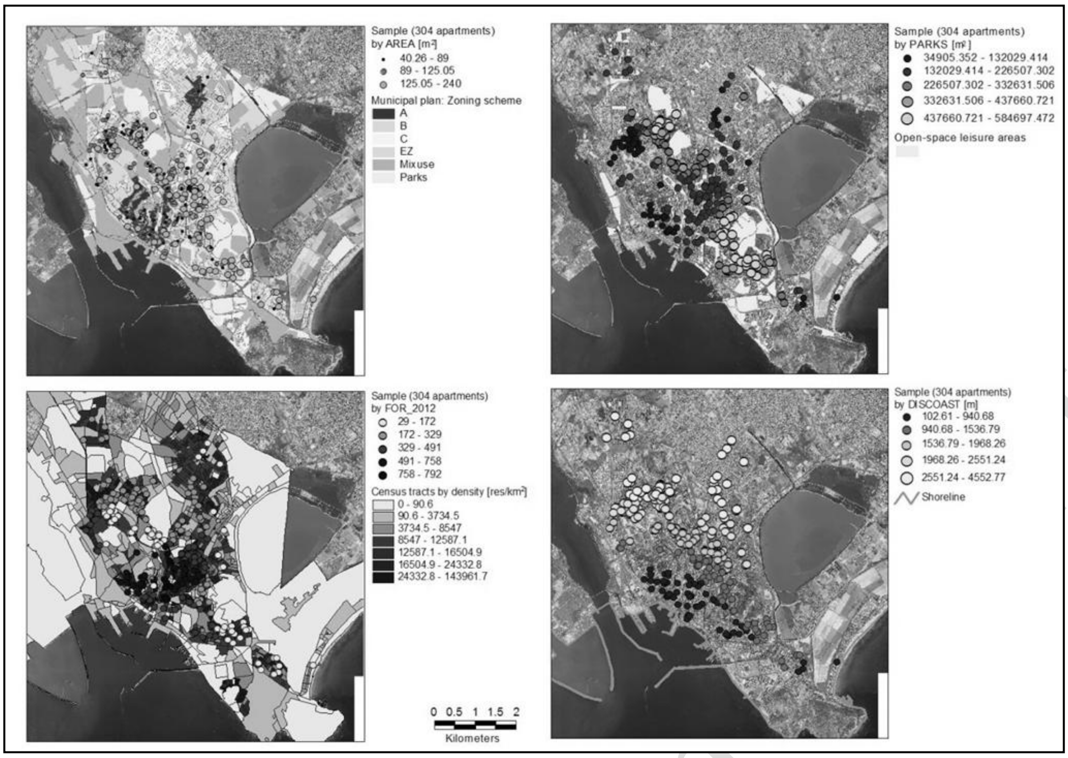

Figure 3. Spatial distribution of some of the characteristics of houses. Top-left: larger and paler points show the localization of apartments taking the highest values of the finished interior area. Top-right: larger and paler points correspond to apartments surrounded by larger amounts of open-space leisure areas. Bottom-left: distribution of variable FOR_2012 (spatially clustered). Bottom-right: distribution of variable DISCOAST (distance of each apartment from the shoreline).

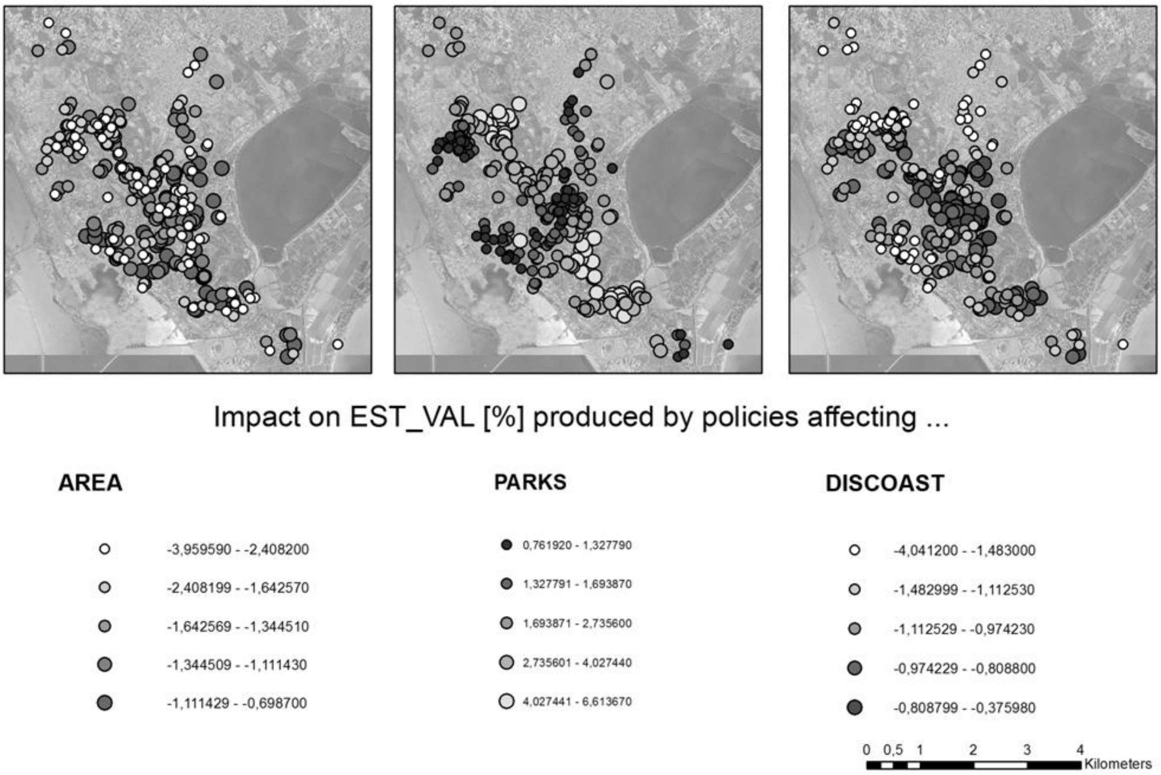

Figure 4. Spatial representation of policy implications: impact on market prices (percent change) stemming from policies that increase an apartment interior finished area (left); or the amount of open-space leisure areas (center); or the distance from the shoreline (right) (all quantiles).

TABLES

Quality characteristic category	**Incidence among central market areas**	**Incidence among intermediate market areas**	**Incidence among suburban market areas**
Localization quality	from 5% to 10%	from 10% to 30%	from 15% to 35%
Position quality	from 15% to 25%	from 10% to 20%	from 10% to 25%
Typological quality	from 15% to 30%	from 20% to 25%	from 5% to 20%
Economic productivity	from 25% to 35%	from 10% to 25%	from 10% to 20%
Overall incidence	**from 60% to 100%**	**from 50% to 100%**	**from 40% to 100%**

Table 1. General incidence of quality characteristic categories among central, intermediate and sub-urban market areas.

Variable	Definition	Mean	St.dev.
EST_VAL	Market value (€/m^2) estimated through regression analysis (source: 2013 direct survey)	2,279.77	404.02
CAD_VAL	Cadastral Assessed Value (€/m^2) (source: 2013 cadastral register of the city of Cagliari)	714.64	294.76
OMI_VAL	Market value (€/m^2) estimated through average market values range (source: OMI)	2,325.56	220.75
RENT_VAL	Rent value (€/m^2 for month) estimated through average rent values range (source: OMI)	7.84	0.62
SUPP_VAL	Average list price (€/m^2) recorded from other apartments for sale (source: 2013 direct survey)	2,515.00	308.59

Table 2. Definition of alternative variables used for housing market analysis.

Variable	Definition	Mean	St.dev.
	Characteristics of housing units, vector HUNIT in (5)		
AREA	Finished interior area (m^2) (source: 2012 direct survey)	109.43	34.89
Q_POS	Position quality (presence and quality of panoramic views, distance from other buildings and structures / daylighting quality, apartment level).	4.52	1.84
Q_TYP	Typological quality (building and apartment maintenance level, quality of construction, equipment and mechanical system conditions, building age).	4.19	1.41
DISCOAST	Distance from the coastline (m) (source: Spatial Dataset of the Regional Geographic Information System of Sardinia[7])	1788.15	877.80
	Demographic characteristics of the neighborhood where a house is located, vector DEMOG in (5)		
DENSITY	Population density in the Census tract (residents/km^2) (source: 2001 National Survey of the Italian National Institute of Statistics concerning population and houses)	21704.12	10632.79
FOR_2012	Permanent foreign residents in the neighborhood (foreign residents) (source: 2012 Survey of the Municipality of Cagliari)	354.17	203.23
RES_2012	Residents in the neighborhood (residents) (source: 2012 Survey of the Municipality of Cagliari)	7645.28	2978.05
	Plan-related characteristics of the neighborhood where a house is located, vector PLANREL in (5)		
PL_ZONE	Dummy, location in a residential completion area (source: Masterplan of the City of Cagliari, available on the Internet at: http://www.comune.cagliari.it/portale/it/puc.wp [last accessed: August 1, 2014])	0.12	0.33
A_ZONE	Area of the "A" zone in a buffer of 150 m around the location of a house (m^2) (source: Masterplan of the City of Cagliari, available on the Internet at: http://www.comune.cagliari.it/portale/it/puc.wp [last accessed: August 1, 2014])	4753.14	11935.82
B_ZONE	Area of the "B" zone in a buffer of 150 m around the location of a house (m^2) (source: Masterplan of the City of Cagliari, available on the Internet at: http://www.comune.cagliari.it/portale/it/puc.wp [last accessed: August 1, 2014])	33033.85	14514.09
C_ZONE	Area of the "C" zone in a buffer of 150 m around the location of a house (m^2) (source: Masterplan of the City of Cagliari, available on the Internet at: http://www.comune.cagliari.it/portale/it/puc.wp [last accessed: August 1, 2014])	400.78	2262.48
EZ_ZONE	Area of the "EZ" zone in a buffer of 150 m around the location of a house (m^2) (source: Masterplan of the City of Cagliari, available on the Internet at: http://www.comune.cagliari.it/portale/it/puc.wp [last accessed: August 1, 2014])	678.98	3287.24
MIXUSE	Percent area of the "IS" zone in a buffer of 150 m around the location of a house (percent) (source: Masterplan of the City of Cagliari, available on the Internet at: http://www.comune.cagliari.it/portale/it/puc.wp [last accessed: August 1, 2014])	12.66	11.78
PARKS	Area of the "S3"and recreational "G" zones in a buffer of 800 m around the location of a house (m^2) (source: Masterplan of the City of Cagliari, available on the Internet at: http://www.comune.cagliari.it/portale/it/puc.wp [last accessed: August 1, 2014])	24.17	13.68
	Artificial land cover of the neighborhood where a house is located, variable LANDCOV in (5)		
LC_URB	Artificial surfaces, urban fabric in 2008 (m^2) (source: CORINE Land Cover Map of Sardinia – 2008 Edition, level 2, code 1.1)	64577.89	9560.18
	Spatially-lagged dependent variables (see paragraph 4.1.1)		
CAD_LAG	Spatially-lagged dependent variable, spatial lags of variables reported in Table 2, CAD_VAL	706.25	132.22
EST_LAG	Spatially-lagged dependent variable, spatial lags of variables reported in Table 2, EST_VAL	2261.10	327.11
OMI_LAG	Spatially-lagged dependent variable, spatial lags of variables reported in Table 2, OMI_VAL	2313.08	264.05
RENT_LAG	Spatially-lagged dependent variable, spatial lags of variables reported in Table 2, RENT_VAL	7.79	0.78
SUPP_LAG	Spatially-lagged dependent variable, spatial lags of variables reported in Table 2, SUPP_VAL	2497.37	346.92

Table 3. Definition of characteristics of houses and of neighborhoods where houses area located, and descriptive statistics.

[7] Available on the Internet from the Regional Geoportal, at: http://www.sardegnageoportale.it/index.html [last accessed: August 1, 2014].

Variable	Coefficient	Stand.error	t-statistic	Hypothesis test: coefficient=0
Constant	542.2240	203.9922	2.658	0.0083
AREA	0.4507	0.4957	0.909	0.3640
Q_POS	7.8002	9.0757	0.859	0.3908
Q_TYP	13.5892	11.9822	1.134	0.2577
DISCOAST	-0.0371	0.0297	-1.248	0.2130
DENSITY	-0.0021	0.0017	-1.270	0.2052
FOR_2012	0.1165	0.1406	0.829	0.4077
RES_2012	-0.0037	0.0086	-0.433	0.6651
PL_ZONE	-200.8341	147.2615	-1.364	0.1737
A_ZONE	-0.0035	0.0045	-0.784	0.4337
B_ZONE	-0.0050	0.0030	-1.687	0.0927
C_ZONE	-0.0018	0.0089	-0.206	0.8370
EZ_ZONE	0.0076	0.0057	1.325	0.1863
MIXUSE	-2.2312	1.9821	-1.126	0.2612
PARKS	8.80E-05	0.0001	0.588	0.5572
LC_URB	0.0016	0.0022	0.713	0.4763
CAD_LAG	0.3395	0.1458	2.329	0.0205
Adjusted R-squared= 0.0900				

Table 4. OLS results, dependent variable CAD_VAL: the regression model includes the covariates of Table 3.

Variable	Coefficient	Stand.error	t-statistic	Hypothesis test: coefficient=0
Constant	1549.8007	224.0705	6.917	0.0000
AREA	-2.8768	0.4852	-5.929	0.0000
Q_POS	71.3490	8.9995	7.928	0.0000
Q_TYP	43.0423	11.8714	3.626	0.0003
DISCOAST	-0.0822	0.0305	-2.696	0.0074
DENSITY	-0.0048	0.0017	-2.903	0.0040
FOR_2012	0.3796	0.1425	2.663	0.0082
RES_2012	-0.0164	0.0086	-1.912	0.0569
PL_ZONE	-237.8951	146.9027	-1.619	0.1065
A_ZONE	-0.0060	0.0045	-1.348	0.1787
B_ZONE	-0.0059	0.0030	-1.990	0.0475
C_ZONE	-0.0179	0.0088	-2.039	0.0423
EZ_ZONE	-0.0088	0.0056	-1.557	0.1205
MIXUSE	-5.7069	1.9711	-2.895	0.0041
PARKS	0.0002	0.0001	1.524	0.1287
LC_URB	-0.0002	0.0022	-0.081	0.9357
EST_LAG	0.4775	0.0630	7.577	0.0000
Adjusted R-squared= 0.5208				

Table 5. OLS results, dependent variable EST_VAL: the regression model includes the covariates of Table 3.

Variable	Coefficient	Stand.error	t-statistic	Hypothesis test: coefficient=0
Constant	1941.9215	110.8157	17.524	0.0000
AREA	-0.4112	0.2190	-1.878	0.0614
Q_POS	21.5585	4.0668	5.301	0.0000
Q_TYP	1.9950	5.3698	0.372	0.7105
DISCOAST	-0.0838	0.0140	-5.986	0.0000
DENSITY	-0.0009	0.0008	-1.168	0.2436
FOR_2012	0.1709	0.0633	2.698	0.0074
RES_2012	-0.0190	0.0039	-4.934	0.0000
PL_ZONE	-171.1874	66.2100	-2.586	0.0102
A_ZONE	-0.0034	0.0020	-1.679	0.0943
B_ZONE	-0.0025	0.0013	-1.861	0.0637
C_ZONE	-0.0077	0.0040	-1.936	0.0538
EZ_ZONE	-0.0066	0.0026	-2.603	0.0097
MIXUSE	-3.7663	0.8908	-4.228	0.0000
PARKS	0.0003	.67E-04	4.638	0.0000
LC_URB	-0.0006	0.0010	-0.637	0.5245
OMI_LAG	0.3096	0.0353	8.780	0.0000
Adjusted R-squared= 0.6725				

Table 6. OLS results, dependent variable OMI_VAL: the regression model includes the covariates of Table 3.

Variable	Coefficient	Stand.error	t-statistic	Hypothesis test: coefficient=0
Constant	7.2509	0.3599	20.148	0.0000
AREA	-0.0017	0.0007	-2.492	0.0133
Q_POS	0.0852	0.0129	6.618	0.0000
Q_TYP	0.0138	0.0170	0.814	0.4163
DISCOAST	-0.0002	4.31E-05	-4.187	0.0000
DENSITY	-2.91E-07	2.38E-06	-0.122	0.9029
FOR_2012	0.0005	0.0002	2.680	0.0078
RES_2012	-8.04E-05	1.22E-05	-6.591	0.0000
PL_ZONE	-0.5894	0.2092	-2.817	0.0052
A_ZONE	-4.33E-06	6.36E-06	-0.681	0.4965
B_ZONE	-1.01E-05	4.24E-06	-2.385	0.0177
C_ZONE	-3.22E-05	1.26E-05	-2.558	0.0111
EZ_ZONE	-2.52E-05	8.06E-06	-3.131	0.0019
MIXUSE	-0.0089	0.0028	-3.149	0.0018
PARKS	7.25E-07	2.09E-07	3.479	0.0006
LC_URB	-4.73E-06	3.10E-06	-1.523	0.1289
RENT_LAG	0.2300	0.0347	6.629	0.0000
Adjusted R-squared= 0.5810				

Table 7. OLS results, dependent variable RENT_VAL: the regression model includes the covariates of Table 3.

Variable	Coefficient	Stand.error	t-statistic	Hypothesis test: coefficient=0
Constant	1851.8704	131.5397	14.078	0.0000
AREA	0.3880	0.2667	1.454	0.1469
Q_POS	-2.3448	4.9547	-0.473	0.6364
Q_TYP	-2.0876	6.5567	-0.318	0.7504
DISCOAST	-0.0849	0.0179	-4.738	0.0000
DENSITY	-0.0019	0.0009	-2.052	0.0411
FOR_2012	0.2017	0.0775	2.602	0.0098
RES_2012	-0.0191	0.0047	-4.078	0.0001
PL_ZONE	-128.3240	80.6387	-1.591	0.1126
A_ZONE	-0.0026	0.0025	-1.072	0.2844
B_ZONE	-0.0046	0.0016	-2.805	0.0054
C_ZONE	-0.0080	0.0048	-1.652	0.0997
EZ_ZONE	-0.0092	0.0031	-2.966	0.0033
MIXUSE	-5.0426	1.0845	-4.650	0.0000
PARKS	0.0006	.88E-04	6.936	0.0000
LC_URB	-0.0011	0.0012	-0.891	0.3736
SUPP_LAG	0.4332	0.0383	11.319	0.0000
Adjusted R-squared= 0.7514				

Table 8. OLS results, dependent variable SUPP_VAL: the regression model includes the covariates of Table 3.

Covariate	Dependent variable							
	EST_VAL		*OMI_VAL*		*RENT_VAL*		*SUPP_VAL*	
	Sign (+/-)	*Significance (5%-10%-NO)*	*Sign (+/-)*	*Significance (5%-10%-NO)*	*Sign (+/-)*	*Significance (5%-10%-NO)*	*Sign (+/-)*	*Significance (5%-10%-NO)*
AREA	-	5%	-	10%	-	5%	+	NO
Q_POS	+	5%	+	5%	+	5%	-	NO
Q_TYP	+	5%	+	NO	+	NO	+	NO
DISCOAST	-	5%	-	5%	-	5%	-	5%
DENSITY	-	5%	-	NO	-	NO	-	5%
FOR_2012	+	5%	+	5%	+	5%	+	5%
RES_2012	-	10%	-	5%	-	5%	-	5%
PL_ZONE	-	10%	-	5%	-	5%	-	NO
A_ZONE	-	NO	-	10%	-	NO	-	NO
B_ZONE	-	5%	-	10%	-	5%	-	5%
C_ZONE	-	5%	-	10%	-	5%	-	10%
EZ_ZONE	-	NO	-	5%	-	5%	-	5%
MIXUSE	-	5%	-	5%	-	5%	-	5%
PARKS	+	NO	+	5%	+	5%	+	5%
LC_URB	-	NO	-	NO	-	NO	-	NO
EST_LAG	+	5%						
OMI_LAG			+	5%				
RENT_LAG					+	5%		
SUPP_LAG							+	5%

Table 9. Synthesis of regression models' estimates: sign and significance. If a coefficient's estimate is not significant either at 5% or at 10%, then we put a "NO" in the significance column.