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The Effects of Environmental Quality on Residential Choice Location

Vincenza Chiarazzo[a]*, Pierluigi Coppola[c], Luigi Dell'Olio[b], Angel Ibeas[b] and Michele Ottomanelli[a]

[a]*Politecnico di Bari, via Orabona 4, Bari, 70125 Italy*
[b]*Universidad de Cantabria, Av.de Los Castros s/n, Santander, 39005 Spain*
[c]*University of Rome "Tor Vergata", Rome, Italy*

Abstract

The aim of this research is to investigate the effects of environmental conditions in a given area on the residential location and the consequences on urban sprawl and accessibility. In particular, the study focuses on the effects of environmental quality and landscaping on property values. To this aim, the paper presents some hedonic Multiple Linear Regression models (MLR) estimating the housing price in metropolitan areas as a function of real-estate, environmental and accessibility variables.
The hedonic models have been estimated using data collected in the province of Taranto (South-Italy) where the biggest steel factory in Europe (namely, ILVA), and one of the most important industrial port in the Mediterranean Sea are located. The set of considered variables were carried out from a location choice survey and hedonic regression estimators are presented to verify to what extent a relationship between the accessibility conditions, environmental context and the dwelling market values does exist. The results indicate that the inclusion, in the model specification, of the environmental variables between zones fit the data significantly better.

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Keywors: Land- Use Transport Interaction (LUTI) models; Hedonic pricing models; air quality

1. Introduction

Consolidated theories on urban economy are based on the trade-off between accessibility and willingness to pay for land acquisition (see for instance Alonso, 1966). As a result, locations with better accessibility to public services,

* Corresponding author. Tel.: +39-080-5963380.
E-mail address: vincenza.chiarazzo@poliba.it

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workplaces, parks, and other opportunities usually have higher real estate values per unit area. In addition to accessibility, other attributes can affect the real estate values in an urban system, for instance the landscape, the built environmental and the air quality. The latter is of particular importance in those cities where the presence of industrial plants does increase the risk of diseases for people due to high pollution levels (Chiarazzo *et al*., 2014).

The aim of this paper is to highlight the role of natural environment quality on the real estate price, estimating a trade-off between dwelling price, air quality and other land-use attributes such as accessibility, and transport related costs. Using the hedonic price modeling approach a dwelling prices function is here estimated for the case study of the Taranto (South of Italy), where one of the biggest steel factory in Europe and a main industrial port is located.

The case study here considered is of particular interest since in the last years residents movements has been observing from zones of the city center, located closely to the industrial plant and to the port, with poor air quality and increasing rates of mortality by cancer disease, towards other zones with lower accessibility and public transport services but with better environmental quality. This phenomenon has originated a drop in real estate price in the city center and a sprawl effect on location of residence and urban functions with unpredictable consequences on the level of service of transport supply system.

The estimated models, integrated into a Land Use/Transport Interaction models (LUTI) modeling architecture could improve the simulation of the urban system feedbacks between accessibility, location choices and real-estate values, both for housing or economic activities (see, for instance, Coppola and Nuzzolo, 2011). In this respect, they constitute useful tools to support investments in urban projects and transport policies.

The paper is developed as follows. In the following section, a state of the art of the models aimed at estimating real estate prices and hedonic models is presented. In the Section 3 the Multiple Linear Regression (MLR) models are estimated using the traditional hedonic regression technique applied to a dataset from the urban area of Taranto (Southern Italy). Then specification and calibrations of the proposed models are presented in Section 4 with the results analysis and discussion. In the final section some conclusions are drawn on the opportunity to take into account the existence of spatial effects when modelling the real estate market as well as on the opportunity to use a given modelling specification to capitalize environmental issue onto the housing market prices.

2. Literature review

Research based on the relationship between transport and real estate values has provided a growing number of case studies. These have been generally supported by the well-known hedonic regression technique formulated by Rosen (1974) to describe how markets function with heterogeneous goods.

Research about how transport conditions influence real estate prices was started by von Thünen (1826) and later served as a basis for creating a theory about the distribution of land use and rents in urban areas proposed by Alonso (1964), Muth (1969) and Mills (1972). The nucleus of the theory lies in the modelling of certain trade-offs in the choice of location, mainly between the transport costs of getting to the city center and the cost of the space. This tradition has continued to grow through the use of ever more complex models. A systematic review of the various research work carried out can be found in Fujita (1989). The hedonic studies relating real estate prices with transport conditions have complemented the theories on urban economy and tested their hypotheses through multiple case studies (Ibeas and al., 2012).

Many hedonic studies have been concentrated on the relationship between real estate prices and access to rail transport but they have not been conclusive in giving a clear and strong relationship. In fact, some researches (see for instance, Pagliara and Papa, 2011; Debrezion et al. 2007) showed a significant increase of real estate values in the catchments areas of new rail stations; some others found out that the properties located close to the rail stations received negative impacts on the perceived values (Martínez and Viegas, 2009).

Another series of studies have been addressed to the impact caused by Bus Rapid Transit systems on real estate prices (Rodríguez and Mojica, 2009). These studies showed the impact on property values caused by introducing a Bus Rapid Transit (BRT) system in a city and found price increase. The influence of the same BRT system was again examined by Munoz-Raskin (2010) who found that the properties nearest the bus stops had a value 4.5% lower than the rest of the properties in Bogotá. However, they also found that properties located less than 5 min walk away from the stops were valued higher than those located between 5 and 10 min walk away concluding that households were prepared to pay more to be located close to the BRT system. Cervero and Kang (2011) used multilevel hedonic regression to estimate the capitalisation of introducing a new BRT system in Seoul, South Korea and found increases in property values for residents less than 300 m from a stop on the network.

The amenity value provided by urban green spaces, water bodies and good environmental quality is difficult to assess and incorporate into urban planning and development. View of green spaces and proximity to water bodies increase housing price, contributing notably at 7.1% and 13.2%, respectively (Jim, *et al.*, 2006).

Migration is linked to shifts in pollution levels, caused by residents' mobility patterns, and shifts in congestion levels as well as regional differences in housing prices and in the number of varieties of consumption goods (Koland, 2006). There is considerable inequality in the spatial distribution of the local amenities, including accessibility, environmental and social indicators (de Palma et al., 2007).

Verhoef and Nijkamp (2003) have developed an urban general equilibrium model in which the interactions between agglomeration externalities and pollution from commuting showing that seemingly impossible findings from a non-spatial perspective, namely a simultaneous stimulation of agglomeration externalities and a reduction of environmental externalities.

As innovative contribution, this study investigates the impacts of such key environmental elements including effect of big steel factory and the main industrial port that origin pollution and landscaping problems.

3. Empirical study

3.1 The study area

The study area for the empirical analysis is the province of Taranto (see Fig.1). Taranto is a coastal city in Apulia (South Italy) where the biggest steel factory in Europe (namely, ILVA), and one of the most important industrial port in the Mediterranean Sea are located. Apart from city of Taranto, the province includes also other 28 municipalities; ; the most important are Massafra, Palagiano, Mottola, Crispiano, Martina Franca, San Giorgio, Leporano and Pulsano.

The city is connected to the other urban centres by road networks and public transportation services (both bus and rail services). The interurban railway network does not connect the most important households in the study area.

Due to pollutant emissions by the industrial plants located in this area (most notably the ILVA steel plant), Taranto is the most polluted city in Italy and Western Europe. Only 7% of Taranto's pollution is inhabitants-related: 93% is factories-related.

According to 2010 census data, the population is 195,800 but it was around 244,000 thirty years ago and 210,000 ten years ago. Today Taranto is a shrinking city and the spatial distribution of the aggregated asking prices shows how the highest average prices are concentrated in the residential area San Vito-Lama, located to the South of the city, to the opposite area of the industrial zone. This neighbourhood is characterized by a large area with parks and the traffic is not congested as well even if the accessibility of the city centre from these zones is low.

On the other side, the price of real estate in central zone of Taranto is not so high. The areas with the lowest average prices are located in Tamburi district, the nearest neighbourhood to the steel industry ILVA, where the population try to sell their house without succeed. This area has been strongly affected by negative environmental spillovers from industrial development and port activity. Recently many families sold their houses in the city centre and choice to live in houses located along the oriental cost (Leporano and Pulsano).

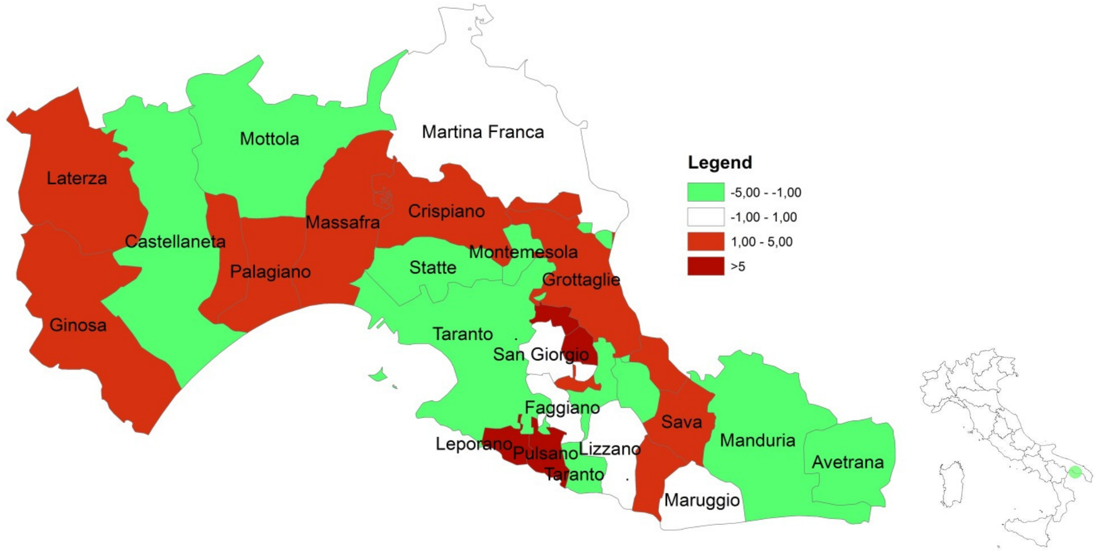

Fig. 1. Net migration of the Municipality of Taranto in percentage, between 2001 and 2013 (Elaboration on ISTAT data)

3.2 Data collection

A survey has been designed to understand the impact of built environment, air quality on the households' location choices as well as on dwellings prices.

The surveys were carried on in seven high schools of Taranto for families' students. The household sample comes from a cross sectional database obtained from various on-line real estate platforms. The data were collected by ad hoc surveys on October 2012 and contains information about asking prices and other structural characteristics for 512 properties located in the metropolitan area.

At first, a qualitative methodology of focus groups has been used for designing the survey for residents. The focus group has been important and crucial to perform a pilot survey, evaluate the results and redesign the final version of the survey. This included two different sections:

1. One for a family representative;
2. One for all the members of the family (over 12 years old).

The remaining part of the survey, characterization of each family member and preference about location choice remain the same as in the pilot survey. The variables that have been taken into account are the following ones:

- quality of life
- services congestion
- public order (safety)
- presence of public transportation
- noise
- air quality
- accessibility

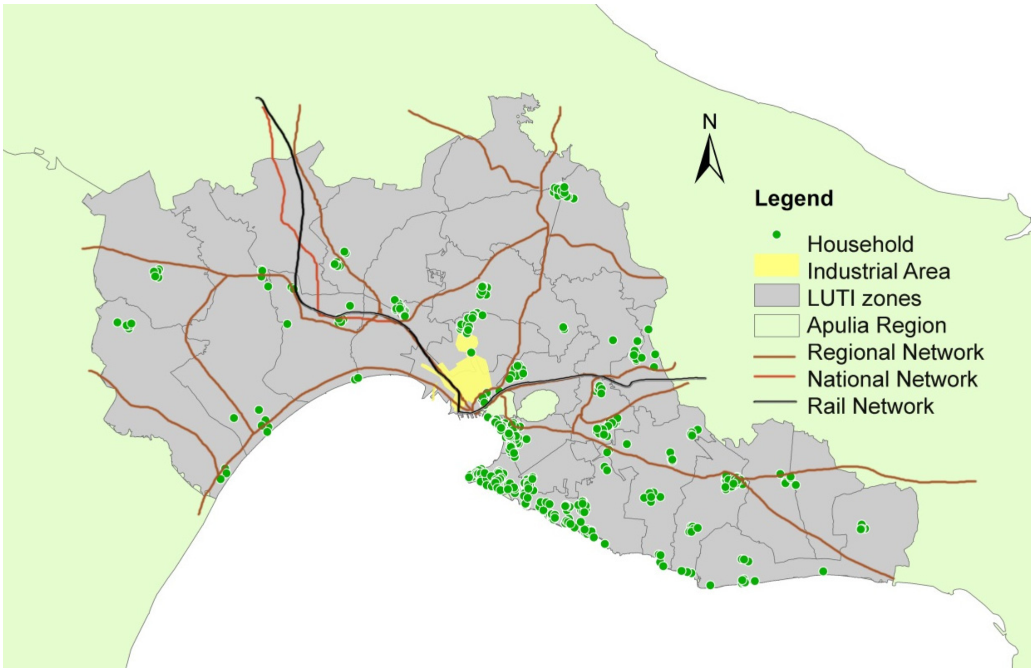

Fig. 2 Location of sampled household, industrial area and environmental monitoring in the study area.

The questionnaire were distributed in seven high schools of Taranto for families' students. More than 1000 observations have been gathered thanks to the 380 households survey successfully completed.

The availability of the address of each observation in the sample allowed the data to be geo-coded into a GIS. Variables relating to the environment and the accessibility of the residential location of each household were cross-matched with other socio-demographic zonal characteristics available from the Census.

After a first statistical correlation analysis, the following variables contained in the database have shown to be significant (see Table 1):

- LN(P) is the natural logarithm of the property asking price.
- PRESTIGE is a dummy variable equal to 1 if the area where the property is located is prestigious.
- ROOMS is the number of bedrooms at the property.
- BATH is the number of bathrooms at the property.
- TE is a dummy variable taking a value of 1 if the property has a terrace.
- GAR is a dummy variable taking a value of 1 if the property has a garage.
- GA is a dummy variable taking a value of 1 if the property has a garden.
- LTI is the number of internal lines bus serving the zone.
- TRAIN is a dummy variable taking a value of 1 if the property is less than 500 m from a suburban train station.
- ILVA is the distance in kilometres to reach the industrial centre from the property using the road network.
- AIRQ is value of air quality' s perception which it measures from 1(i.e. very poor quality) to 10 (i.e. very good quality air) by city users considering the area where their property is located
- NOISE is value of noise' s perception which it measures from 1(i.e. very high level of noise) to 10 (i.e. very low level of noise) by city users considering the area where their property is located

Table 1. Descriptive statistics of the variables contained in the residential property data base (Data Istat Census 2001).

Variable	Minimum	Maximum	Mean	Std. Deviation	*Measurement unit*
LN(P)	10,0432	13,7642	11,8154	0,6402	Ln (price €)
PRESTIGE	0	1	0,5127	0,5011	-
ROOMS	1	10	4,0508	1,8748	No. of rooms
BATH	0	6	1,5851	0,7797	No. of bathrooms
TE	0	1	0,1898	0,3925	-
GA	0	1	0,3796	0,4858	-
GAR	0	1	0,4637	0,5443	-
LTI	0	5	1,7279	1,8959	No. of internal lines
TRAIN	0	1	0,3757	0,4848	-
ILVA	1	55	20,6065	13,4082	Km
AIRQ	1	10	6,4976	1,1346	-
NOISE	1	10	5,8531	1,0805	-

The most relevant variables, according to the aim of this study, are ROOMS, BATH, GAR, GA, TE, those which refer to transport conditions (LTI and TRAIN) and to environmental quality (ILVA; NOISE and AIRQ).

LTI, as described earlier, represents the interaction between the presence of a bus stop at least 500m away and the number which service that bus stop. This variable represents an indicator of bus services supply availability to each of the properties. TRAIN variable represents an accumulated opportunities measure of accessibility to railway services (Handy and Niemeir, 1997). It has been assumed that all the properties located at less than 500 m from the railway station in the study area have access to the train mode.

Differently and in addition to traditional studies, we focused our attention on environmental related variables too. From this view at first we consider among the others, the environmental variable "ILVA", that represents the distance between the steel industrial plant ILVA and the property. The distance is measured in kilometres considering the route length from the property using the road network.

Moreover other relevant variables were carried out from the location choice surveys in the study area: "AIRQ" that represents the perception of air quality by city users considering the area where their property is located and "NOISE", where a high value corresponds to a positive perception of the sound (low sound level). These two parameters are calculated as average values at zonal level.

3.3 MLR model estimates

From the spatial point of view, the research focused on the Province of Taranto considering two specific models (Chiarazzo *et al*., 2014): the first model (MRL1) considers the zones of the province (excluding Taranto), the second one (MRL2) considers the zones belongings to the municipality of Taranto only.

The MLR1 and MLR2 were therefore specified as in Eqs. (1) and (2) respectively:

$$\mathrm{Ln}(\widehat{\mathrm{P}}_{\mathrm{i}}) = \beta_0 + \beta_1\,\mathrm{PRESTIGE} + \beta_2\mathrm{ROOMS} + \beta_3\mathrm{BATH} + \beta_3\mathrm{GA} + \beta_4\mathrm{GAR} + \beta_5\mathrm{TE} + \beta_6\mathrm{TRAIN} + \beta_7\mathrm{ILVA} + \beta_6\mathrm{NOISE} + \varepsilon_i \quad (1)$$

$$\mathrm{Ln}(\widehat{\mathrm{P}}_{\mathrm{i}}) = \beta_0 + \beta_1\,\mathrm{PRESTIGE} + \beta_2\mathrm{ROOMS} + \beta_3\mathrm{BATH} + \beta_4\mathrm{GAR} + \beta_5\mathrm{LTI} + \beta_6\mathrm{TRAIN} + \beta_7\mathrm{AIRQ} + \varepsilon_i \quad (2)$$

In these models all the estimated parameters showed theoretically correct signs (see Table 2). The best first hedonic model (MLR1) was estimated with the nine independent variables of database and considering the towns located at the first ring around Taranto (i.e. Leporano, Statte, San Giorgio, Crispiano, Mottola, Massafra, etc.).

Among the variables related to the property's structural conditions, which had a positive effect on property values, the presence of an additional bathroom, the presence of a garage, garden, and terrace implied an increase in the value. TRAIN variable, which had a positive sign, implying that people who live near a train station perceive it as an opportunity to reach the Taranto's CBD.

The ILVA variable had a negative correct sign: the closer the zones are located to the ILVA district the the greater the real estate values. This can be interpreted and explained as a positive value of accessibility to workplaces for municipalities of the province. In fact, the ILVA industrial area is close also to Taranto CBD, so people living in other municipalities of the Province prefer zones closer to Taranto and to the ILVA district, since most of the workplaces of the whole province are here located.

Air quality (AIRQ) has resulted to be not significant for the municipality of the province (excluding Taranto), since here environmental pollutants emission is not perceived as a problem. Finally, the MLR1 includes also a variable related to the level of noise (NOISE) variable. This resulted significant and positive as expected: the greater the value of NOISE variable (i.e. the lower the level of noise in the zone) the greater the perceived real estate values.

Table 2 Estimated parameters of the MLR models: province municipalities excluding Taranto (MLR1) and Taranto municipality only (MLR2)

	MLR1		MLR2	
Variable	Parameter	t-ratio	Parameter	t-ratio
Constant	10,4953	81,0643	9,9925	48,0461
PRESTIGE	0,4287	9,2697	0,4896	11,1395
ROOM	0,1257	8,5242	0,2113	11,3103
BAG	0,1685	5,2215	0,1008	2,2071
TE	0,1374	2,5963	-	-
PA	0,0966	2,1915	0,1431	2,6917
GIA	0,1858	3,6662	-	-
LTI	-	-	0,0782	1,9633
TRAIN	0,1972	3,7381	-0,1788	-1,9202
ILVA	-0,0064	-2,7317	-	-
NOISE	0,0496	2,4438	-	-
AIRQ	-	-	0,06399	2,0309
R^2	0,6234		0,8332	
R^2_{adj}	0,6131		0,8271	
N	337		197	

MLR2 was specified and estimated considering only the observations related to households residing in the municipality of Taranto (see Table 2).

In MLR2 the parameter LTI related to the transport conditions showed positive signs if the buildings were located at least 500 meters away from a bus stop and train station, showing a higher real estate values. The exception was the TRAIN variable which had a negative sign implying that properties nearest to the train station had a lower value in the city of Taranto. This issue can be explained assuming that railway infrastructures usually imply a series of negative impacts such as noise, lower landscaping and environmental quality (Armstrong and Rodríguez, 2006).

MLR2 includes AIRQ showing that residents in Taranto do not prefer living near to the industrial area, due to pollutant emissions The parameter of the environmental variables AIRQ has positive sign, indicating that an increase of perceived air quality implies an increase in real estate values. This is valid for the zone of the municipality of

Taranto where pollution is perceived as a dangerous problem, contrary to what we found for the rest of the province where the accessibility to workplace (see MRL1) is predominant.

MLR2 returns more significant results than MLR1. In fact, MLR2 shows a higher value of both R^2 and R^2_{adj} and it better explains the influence of environmental polluters thanks to air quality, while MLR1 presents the ILVA and noise parameters.

4. Conclusions

This study discovers that the relationship between house value and pollution problem is important and relevant, considering the location of the properties. The work described in this article specifies the role of quality of environment considering the real estate price, accessibility and other local land-use attributes. The proposed models were estimated using data collected in the province of Taranto and were compared to determine which of them presented the best fit end the explicative variables.

The estimated models were useful in highlighting how different transport characteristics as well the environmental quality affect the prices of real estate properties. In these models all the considered variables had theoretically correct signs and were significant according to the t-test at a 95% confidence level. The models had a good fit in both the value of R^2 and R^2_{adj}.

Among the variables related to the environmental conditions, which had a positive effect on property values, air quality and noise parameters implied an increase in value, as well as among the variables related to the property's structural conditions, the presence of an additional bathroom, the presence of a garage, a garden, a terrace implied an increase in value.

Most of the parameters related to the transport conditions had signs which agreed with the hypothesis that improved transport conditions resulted in increased real estate values. The parameters of the bus accessibility indicators LTI indicate that each additional nearby public transport line can imply an additional increase in property values. However, this result should be interpreted with care because the city of Taranto is the one served by the best public transport.

In this sense, the assumption that better public transport services supply raise property values could be reversed: in fact the inner city areas have more public transport services due to the travel demand to that area from all the other zones of the city (Felsenstein et al., 2010).

Thus in the case study of Taranto, the LTI variable, as a measure of accessibility to bus transport, is three times larger than the Province of Taranto.

The TRAIN variable representing accessibility using suburban railway transport, presented a different sign parameter in agreement with previous research (Ibeas *at al.*, 2012). This can be justified considering that railway infrastructures imply diseconomies related to noise and a lower landscaping and environmental quality in the city of Taranto, in this case had negative sign. On the contrary, where the TRAIN variable had positive sign imply that people who live near a train station perceive it as an opportunity to reach the Taranto's CBD or use railways to commute for work or study purposes towards other cities (MLR1).

Air quality is an important parameter for residents living in Taranto (MLR2) and it is not significant for residents of the metropolitan area (MLR1). Conversely, the distance from ILVA industrial district is significant for people living in the province (MLR1) and not for people living in Taranto (MLR2) In other terms, there is a trade-off among air quality and accessibility to workplaces (i.e. the industrial district) that is strictly related to the spatial location within the study area and which can strongly affect dwelling values. Further development of this research will be addressed to the analysis such trade-off in order to investigate a possible equilibrium between distance from steel plant and air quality.

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