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How Much Does Location Determine the Market Value of a Building According to a Multiple Econometric Analysis? †

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Abstract: Multi-parametric valuation techniques, in real estate valuation, are particularly useful to understand and define all the factors that contribute to the determination of market prices. Even though a plethora of building features influence the way prices are formed, location is certainly among the most influential. As such, the goal of this research is the analysis of position and neighbourhood in the process of market value estimation for a building. Particular attention is given to the comparison of location characteristics versus construction characteristics by means of a multi-parametric econometric analysis.

Keywords: market value assessment; buildings; location; multiple regression; econometric analysis

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1. Introduction

Multi-parametric assessment methods are particularly interesting in property valuation [1] since they are able to define all the factors that contribute to the determination of market prices, while also identifying the marginal influence that each factor has on the price [2]. In this context, we distinguish construction and positional factors. Among the *construction characteristics*, there are, for instance, features like the dimension of the building, the floor level, the state of maintenance, the presence of installations, domotics, balconies, gardens, or parking spaces. On the other hand, *location characteristics* refer to the position in a central/semi-central/suburban area of a city, the proximity to commercial facilities and services, the access to public transport, as well as the neighbourhood quality. Such positional factors are also defined as fixed effects, since a property, apart from its construction characteristics, cannot be considered separately from the positional context in which it is placed [3]. Such fixed effects may have both a positive [4] or a negative [5] influence on prices depending on the market segment considered.

In this study, the scope is to examine the impact that fixed effects produce on prices in comparison to construction characteristics, by means of a multi-parametric econometric analysis [6,7].

An econometric market value assessment application, in fact, is able to determine the relationship that links some features describing the property (the independent variables) and its market value (the dependent variable) [8].

2. Materials and Methods

Presented in Figure 1, the methodological strategy is aimed at producing a reliable hedonic pricing model that includes both construction and location regressors. The methodological approach is as follows:

- In Phase 1, the independent variables for the econometric model are defined (construction and location characteristics), given the market value as the dependent variable.

- In Phase 2 a Random Forest (RF) feature importance analysis is carried out to test the significance of the regressors on the output.
- In Phase 3, the econometric model is produced, and the multiple regression is built as in Equation (1):

$$Y = \beta_a + \beta_b X_b + \beta_c X_c + \ldots + \beta_k X_k + \ldots + \beta_K X_K + \xi, \quad (1)$$

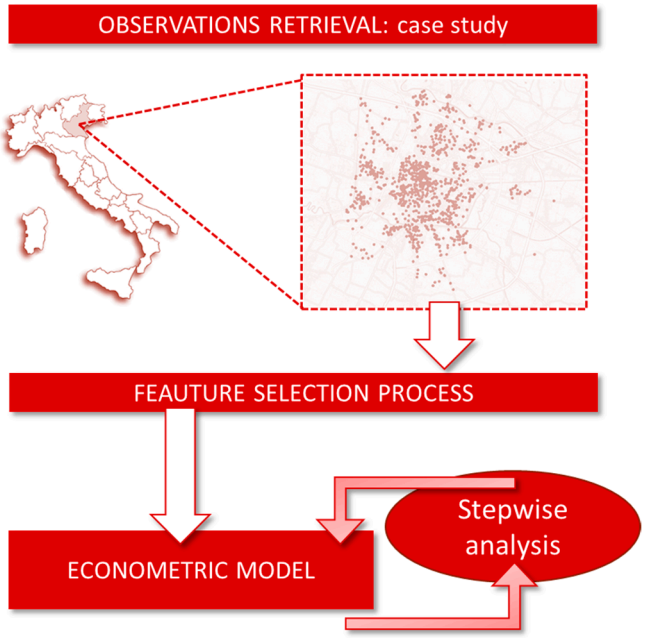


Figure 1. Methodological flow-chart.

In the equation above, Y is the market price, X_k are the buildings characteristics, β_a is the constant, β_k are the coefficients, ξ is the error.

3. Results

3.1. Case Study

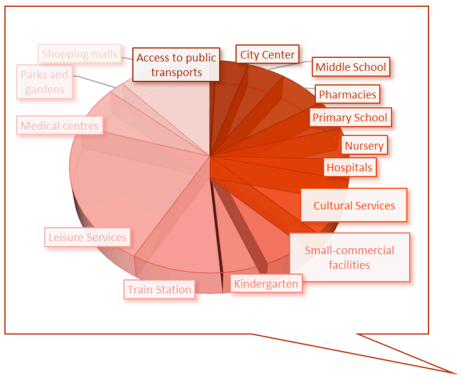
Padova (a city in North-Eastern Italy) is chosen to be an exemplary case study, and the consulted information is from the first half of 2023.

The observations collected to produce the forecasting model are limited to residential buildings in Padova, including new and existing apartments, detached houses, villas, lofts, or terraces located in central, semi-central, and suburban areas.

Particular attention is given to the selection of the location and construction characteristics of each property that need to be collected. The observations recorded describe 1518 buildings, with an average market value of 2150 EUR /m².

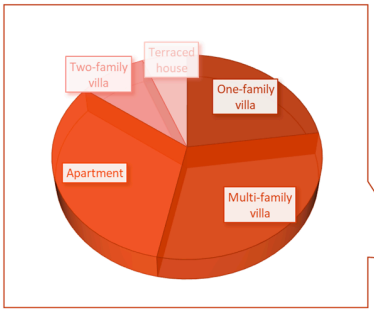
3.2. Feauture Selection

A feature importance and a consequent feature selection analysis is performed with the Random Forest (RF) regressor to calculate the importance coefficients that link the regressors to the market price. Such coefficients are summarized in Figures 2 and 3.



	Straight line distance	Actual travel distance by car	Travel time by car	Travel time on foot	Travel time by public transport	N. of POI in 400 m ring buffer	N. of POI in a 1 km ring buffer	TOTAL
Unit of measure	Km	Km	minutes	minutes	minutes	number	number	%
Access to public transports	0.263%	0.000%	0.083%	0.046%	0.062%	0.146%	0.130%	1%
City Center	0.573%	2.832%	0.287%	0.281%	0.181%	0.001%	0.000%	4%
Middle School	0.603%	1.004%	0.412%	1.587%	1.052%	0.082%	0.066%	5%
Pharmacies	1.487%	0.017%	0.218%	1.037%	2.028%	0.427%	1.004%	6%
Primary School	0.526%	0.016%	0.261%	0.936%	0.623%	0.482%	1.832%	5%
Nursery	1.721%	0.523%	0.272%	0.648%	1.087%	0.034%	0.624%	5%
Hospitals	1.598%	0.238%	0.515%	0.357%	0.180%	0.059%	0.138%	3%
Cultural Services	1.153%	0.020%	0.273%	1.892%	0.600%	0.577%	4.005%	9%
Small-commercial facilities	2.597%	0.643%	0.418%	0.686%	2.321%	0.027%	0.074%	7%
Kindergarten	0.831%	0.041%	2.092%	0.661%	1.014%	0.037%	0.072%	5%
Train Station	0.945%	1.883%	0.715%	2.153%	3.929%	0.000%	0.035%	10%
Leisure Services	6.148%	0.000%	0.165%	2.276%	1.388%	4.237%	7.207%	21%
Medical centres	0.605%	0.003%	1.534%	0.118%	0.534%	0.420%	3.403%	7%
Parks and gardens	0.746%	0.025%	0.324%	0.294%	0.352%	0.056%	0.151%	2%
Shopping malls	3.133%	1.560%	0.456%	1.143%	1.131%	0.008%	4.314%	12%
								100%

Figure 2. Random Forest importance coefficients: positional features.



Feature	Unit of measure	RF coefficient
Energy performance	energy class	9.36%
Maintenance	new/good/poor	4.33%
Area	sqm	44.53%
Number of rooms	number	40.34%
Park spaces	yes or no	0.25%
Garden areas	yes or no	0.18%
Number of baths	number	0.12%
Cellaro or basement	yes or no	0.04%
Terrace or balcony	yes or no	0.14%
Building type	yes or no	0.13%
Plants and installations	number	0.59%
		100.00%

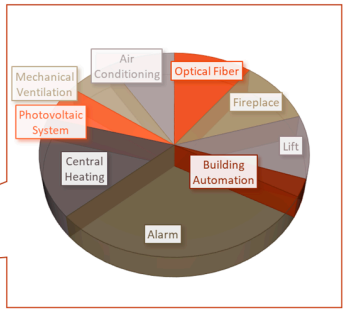
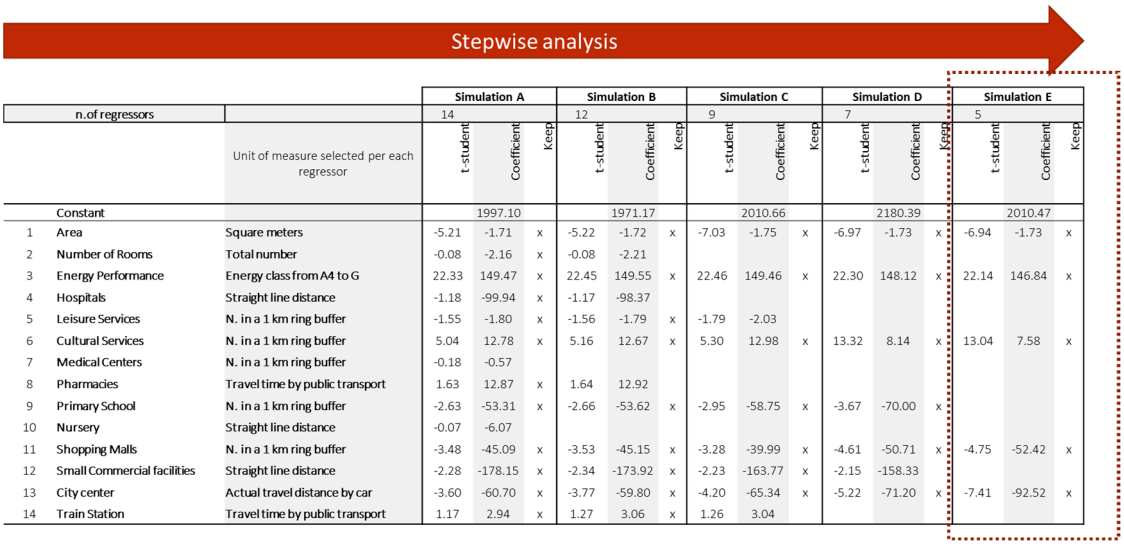


Figure 3. Random Forest importance coefficients: construction features.

3.3. Hedonic Pricing Model

A stepwise analysis is carried out as described in Figure 4 to identify the best regression equation. Simulation "E" leads to the final equation, which is summarized in Equation (2): The R-square is 79.21%, and all the regressors satisfy the significance test with a p-value < 0.05.

$$\text{Unitary Price} = 2010.47 - (1.73 \times \text{Area}) + (146.84 \times \text{Energy Performance}) + (7.58 \times \text{Cultural Services}) - (52.42 \times \text{Shopping Malls}) - (92.52 \times \text{City Centre}) \quad (2)$$



			Simulation A			Simulation B			Simulation C			Simulation D			Simulation E		
n.of regressors			14			12			9			7			5		
		Unit of measure selected per each regressor	t-student	Coefficient	Keep	t-student	Coefficient	Keep	t-student	Coefficient	Keep	t-student	Coefficient	Keep	t-student	Coefficient	Keep
	Constant			1997.10			1971.17			2010.66			2180.39			2010.47	
1	Area	Square meters	-5.21	-1.71	x	-5.22	-1.72	x	-7.03	-1.75	x	-6.97	-1.73	x	-6.94	-1.73	x
2	Number of Rooms	Total number	-0.08	-2.16	x	-0.08	-2.21										
3	Energy Performance	Energy class from A4 to G	22.33	149.47	x	22.45	149.55	x	22.46	149.46	x	22.30	148.12	x	22.14	146.84	x
4	Hospitals	Straight line distance	-1.18	-99.94	x	-1.17	-98.37										
5	Leisure Services	N. in a 1 km ring buffer	-1.55	-1.80	x	-1.56	-1.79	x	-1.79	-2.03							
6	Cultural Services	N. in a 1 km ring buffer	5.04	12.78	x	5.16	12.67	x	5.30	12.98	x	13.32	8.14	x	13.04	7.58	x
7	Medical Centers	N. in a 1 km ring buffer	-0.18	-0.57													
8	Pharmacies	Travel time by public transport	1.63	12.87	x	1.64	12.92										
9	Primary School	N. in a 1 km ring buffer	-2.63	-53.31	x	-2.66	-53.62	x	-2.95	-58.75	x	-3.67	-70.00	x			
10	Nursery	Straight line distance	-0.07	-6.07													
11	Shopping Malls	N. in a 1 km ring buffer	-3.48	-45.09	x	-3.53	-45.15	x	-3.28	-39.99	x	-4.61	-50.71	x	-4.75	-52.42	x
12	Small Commercial facilities	Straight line distance	-2.28	-178.15	x	-2.34	-173.92	x	-2.23	-163.77	x	-2.15	-158.33				
13	City center	Actual travel distance by car	-3.60	-60.70	x	-3.77	-59.80	x	-4.20	-65.34	x	-5.22	-71.20	x	-7.41	-92.52	x
14	Train Station	Travel time by public transport	1.17	2.94	x	1.27	3.06	x	1.26	3.04							

Figure 4. Regression stepwise analysis.

4. Discussion and Conclusions

The Random Forest analysis and the hedonic pricing model developed indicate that the most influential factors among the construction features are the area of the premises, the number of rooms, the energy performance level, and the maintenance conditions. As far as the building typologies are concerned, the most appreciated ones are apartments and multi-family villas. Among the location characteristics, the most impactful factors are access to a train station and proximity to commercial, cultural, and leisure services, as well as to medical centres.

The hedonic pricing model points out that greater proximity to the city centre produces greater market values (the higher the distance, the lower the price). The number of cultural services increases the market value of a building, producing a higher quality neighbourhood, and, also, the higher the energy performance of a building, the higher the market price.

In conclusion, this study has developed a unified procedure to understand processes affecting demand preferences and price formation mechanisms in a specific Italian real estate market, i.e., the city of Padova. In further development of this line of research, the approach could be expanded to other cities in Italy, and also applied at different times, so as to produce a diachronic comparison spread out over the territory that is able to map the willingness to pay for certain features of buildings.

Supplementary Materials: The presentation materials can be downloaded at: https://www.mdpi.com/article/10.3390/IOCBD2023-16868/s1.

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