Housing values of the Olivetti villas in the Ivrea real estate market.

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Abstract The residential heritage in Ivrea, built during the most successful years of famous Italian company Olivetti, is made up of assets that can be traced back to the Modern Movement of the Twentieth Century. The site "Ivrea, industrial city of the XX Century" was included in the World Heritage List in 2018, which shows the value and originality of the Ivrea experience and recognizes its identity as a city-laboratory.

The aim of this article is to analyse the potential enhancement of the Olivetti villas of Ivrea within their fragile socio-economic context and to check whether their architectural quality and the "Olivetti connotation" is recognized by the real estate market. Furthermore, the energy efficiency upgrade of the residential heritage is investigated in order to understand if and how it is able to enhance the value of the buildings and influence listing prices in Ivrea's real estate market. The influence of some intrinsic and extrinsic characteristics on listing prices was measured by creating a sample of residential units listed on the market and by applying a multiple linear regression model, which was used for both descriptive and predictive purposes.

The results showed that the Ivrea's real estate market can be more positively affected by energy retrofitting, despite the architectural quality of the buildings, which is monetized but with a considerably lower marginal price.

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1 | INTRODUCTION[1]

The impact of the Olivetti Company, founded by Ing. Camillo Olivetti in 1908 to produce typewriters, completely changed the city of Ivrea, making it one of the most important production centres in Northern Italy (Castagnoli, 2014).

The Olivetti Company financed numerous housing facilities, trying to meet the needs of its employees; today, Ivrea's residential heritage linked to the Olivetti Company is a powerful evidence of the architecture of the Modern Movement and the housing policies generated by the industrial events linked to the economic boom of the 1960s (Castagnoli, 2014).

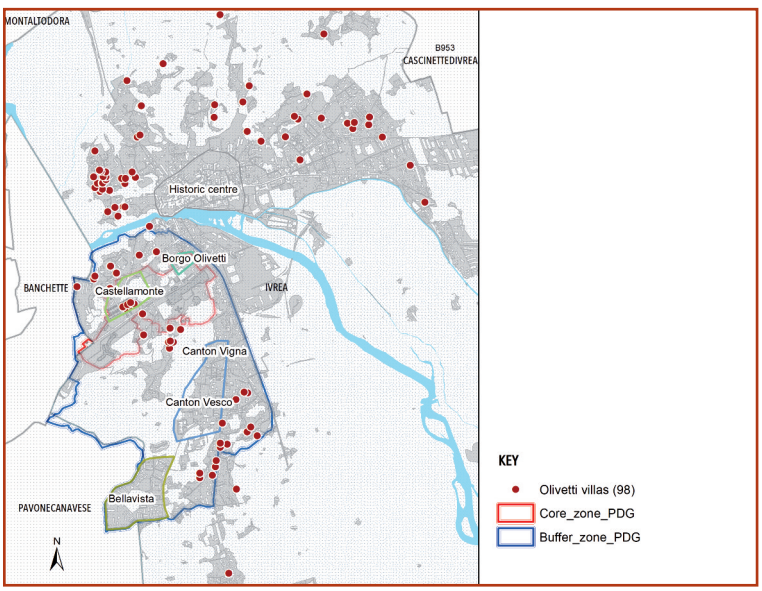

Figure 1 UNESCO areas and Olivetti villas in Ivrea
Source: author's elaboration

Inclusion in the UNESCO heritage listing as the 54th Italian Site represents a significant step for the recognition, at least in part, of the uniqueness of the Olivetti experience, which stands out from the previous company town both because it was realized as an independent industrial village and also for its identity as a city-laboratory (https://www.ivreacittaindustriale.it/).

In some recent cases original functions were preserved to give Olivetti architectures a new chance; this is the case, for example, of the nursery school in Borgo Olivetti, one of the few public buildings in the site.

The main criticisms arise when the object of restoration and reconversion is a private property asset; many of the buildings that were originally used for a social function (such as the nursery school designed by Arch. Ignazio Gardella and Mario Ridolfi in the Canton Vesco neighbourhood) have been bought and converted into offices and premises belonging to companies in the telephony market

1 This article was written as part of the Master's Degree dissertation elaborated by the author (programme in Architecture Heritage Preservation And Enhancement – Politecnico di Torino), supervised by prof. Rocco Curto, Arch. Diana Rolando and Arch. Alice Barreca.

(Vodafone and Telecom Italia, respectively). Even more burdensome is the situation of private housing (especially single-family homes or villas), symbols of great social and economic policies, but which to date are mostly unused or in a state of degradation.

However, many of the architectures linked to the Olivetti Company (Figure 1) now need to be restored and enhanced while considering Ivrea's weakness in the area of socio-economic issues. The current real estate market suffers from low values and a lack of dynamism. Most of the housing properties up for sale show extremely low average prices (compared for example to sales in the metropolitan area of Turin) and in most cases, their energy performance needs improvement.

It can still be said that "there is no real awareness of the cultural value of popular houses" (Ascione, 2012); even if these architectures are the result of extraordinary experiences and products of relevant personalities of the Modern Movement, they obtain very low listing prices in the real estate market of Ivrea. Consequently, this study wants to investigate if and how the historical and cultural value of these assets can influence their economic value.

The purpose of this article is first of all to analyse the potential for enhancement of the Olivetti villas in Ivrea within their fragile socio-economic context and also to check whether or not their architectural quality is recognized by the market. Also this research wants to investigate if and how the energy efficiency upgrade of the residential heritage may correspond to an increase in the listing prices of Ivrea's real estate market.

Therefore, applying a hedonic model to verify the impacts of the villas' intrinsic and extrinsic characteristics on the price determination process.

This research is focused specifically on energy retrofitting, to investigate if an energy class upgrade could also increase the values of the Olivetti buildings and, thus, provide a different opportunity for the economic enhancement of this heritage.

The hedonic model was firstly applied to estimate a possible listing price for an Olivetti villa (Villa Capellaro), which currently is not on the market; subsequently, its value was estimated, supposing an upgrading of the energy class. The results demonstrated that the listing price considerably increased and showed a concrete possibility to enhance this heritage by means of energy retrofit interventions. Currently, this possibility becomes even more real when considering the Ecobonus 110%, a new Italian tax relief scheme consisting of gross tax deductions granted when interventions are carried out to increase the energy efficiency level of existing buildings.

Therefore, public administrations would have the opportunity to create a cohesive and managed asset system; the administration of Ivrea, after the candidacy, needs to implement policies in support of private owners to help them in interventions to safeguard and enhance architectural heritage.

This paper includes the following sections: Section 2 shows the background regarding intervention on industrial and residential modern heritage, energy efficiency in the real estate market and the regulatory framework concerning Ecobonus 110%; Section 3 presents the methodology; Section 4 introduces the case study and Ivrea's socio-economic context; Section 5 illustrates the data sample used for the application of the hedonic model; Section 6 shows the results and one application example ; finally Section 7 is the conclusion.

2 | BACKGROUND

2.1 Industrial and residential modern heritage

Europe

Nowadays, there is a need to redevelop the architectures produced by social policies in support of the lowest social classes realized about 70 years ago, not only to guarantee the well-being of current users but also to include these assets within the real estate market allowing the recognition of their historical value and the architectural quality connected to them.

The first step towards a careful restoration of the Modern Heritage is understanding the reasons that led to the realization of these works, to define the guidelines to maintain its original meaning and allow its conservation.

Today, this aspiration is supported by the international non-profit organisation DO.CO.MO.MO. (Documentation and Conservation of buildings, sites and neighbourhoods of the Modern Movement), which works to safeguard modern architectural heritage in many countries for the purpose of enhancing the world's knowledge of Modern Heritage and has an active role in building restoration technology and material research (Palomares, 2018)

An example of this is the adaptive reuse and conservation of the Van Nelle Factory in Rotterdam, an industrial complex, where the Technological Committee made a referenced recording of the heritage (called "chrono-mapping") including façades and interior spaces to preserve this building as a museum. This process provided the possibility to apply a "climate wall", a second glazed skin, compensating the loss of interior space with smart interior planning (Marieke and Wessel, 2017).

Another evidence of this can be found in the restoration project of housing estate Cité du Lignon (1963-1971) of G. Addor in Geneva, realized between 2008 and 2011, showing that "equilibrium between the conservation of the built object and the subsequent achievable thermal improvement" (Graf and Marino, 2016); the work was organized in four phases and various levels of intervention were proposed to meet current energy standards and give the residents the the choice of how to invest in it. This result was made possible by the collaboration with the Technological Committee of DO.CO.MO.MO, which studies technical construction solutions for modern buildings in order to adapt them to the contemporary climatic environment (Palomares, 2018).

A similar conservative intervention was adopted in the experimental residential settlement Citè Fruges at Pessac through a "critical safeguarding" (Ascione, 2012); thanks to active City Council participation, the site was marked as "zone of architectonic, urban and landscape protection" to make the population aware of current transformations, and some buildings were transformed into museums of the original projects by reconstruction "as it was, where it was". This type of participatory safeguard has allowed for a faster intervention governed by specific flexible site laws and it has proved the importance of administrative backing for project success.

Italy

In 1949 the Italian Parliament approved the draft law proposed by Amintore Fanfani, the Minister of Labour and Welfare, which launched the INA-CASA Plan: this represented the beginning of numerous social housing policies and interventions for workers.
The fourteen years of activity of the Plan led to the implementation of many district interventions such as "La Falchera" in Turin, "via Dessiè" in Milan, some suburbs in Bologna, the "Ridolfi district" in Cerignola and many others spread throughout the Italian territory (Di Biagi, 2010).

Within the Italian panorama, a neighbourhood comparable to Canton Vesco in Ivrea is the experimental QT 8 district, located in the Milanese suburbs. Indeed, both have suffered very similar historical events and are included in the plan to respond to the housing request consequential to World War II. The two districts are characterized by the use of open parcels with the intention to compensate the lack of a real city centre by designing a new urban heart, a central public square around which to develop a series of buildings with public and administrative functions for the two districts(Montanari and Bruno, 2013).
Unfortunately, in both cases, despite the fact that this intervention was considered indispensable by the designers in the zoning process of the modern city, it will never be realized, thus, creating a fundamental gap in the desired self-sufficiency of the two complexes.
La Falchera district, located at the northern edge of the city of Turin, similarly to QT8, can also be assimilated to the residential district of Canton Vesco for its historical events. However, the choices made for these suburbs and those of Ivrea were different; in Ivrea, in line with the Italian and European scene, three housing models (in-line, tower and terraced buildings) were developed, while, on the outskirts of Turin, in respect of the tradition of the place, a single typological solution, three-storey buildings, was used (Di Biagi, 2010).
Unfortunately, also in this case, compared to the initial project, the public services were not realized immediately but only partially built in a second phase, accentuating the sense of marginalization of this area compared to the city centre.
In addition, the initial positive choice to consider local tradition failed when the decision was made to establish large shopping centres that disfigured the landscape of the area, characterized by a stretch of water.
The restoration of public spaces and buildings in the "Ridolfi district" in Cerignola has proposed the recovery of the project idea of Ridolfi and Frankl, allowing the initial idea of green areas to be preserved as the fulcrum of the district and adding services for citizens, wcich were lacking, thus maintaining the original meaning of the neighbourhood while implementing new elements that today are fundamental to preserve the area (http://www.torricelliassociati.it/opere/cerignola.html).

2.2 Energy Efficiency and the Real Estate Market

In recent years, many real estate market studies have sought to detect what would influence the market price of buildings and steer buyers towards their final choices.
Starting from S. Rosen (Rosen, 1974), who , formulated a theory of hedonic prices , as a “spatial equilibrium in which the entire set of implicit prices guides both consumer and producer locational decisions in characteristics space”; this method also allows to clarify the parameters which influence listing prices and consequently customer preference.
As part of these parameters, the Energy Performance Certificate (EPC) certainly occupies a central position, especially following the enactment of the European Directives (Energy Performance of Buildings Directive 2018/844/EU – EPBD and the Energy Efficiency Directive 2012/27/EU) and also considering that in Italy it became mandatory to conclude an act of sale in 2010 and since 2012 this is included in real estate ads.
Given the obligation of this document, it is important today to measure how much it affects real estate prices, especially considering some past studies in which the influence of the EPC was not as strong as expected (Fuerst and McAllister, 2011).
Regarding Italian real estate, initial evidence is provided by the empirical analysis focused on Turin (Fregonara *et al.*, 2014); this study used a hedonic model on a sample of 577 properties to show that interest in energy level was weak, which probably meant that residents could not be encouraged to

invest in energy improvement.
After five years, the same area was considered in a study comparing Barcelona and Turin (Dell'Anna *et al.*, 2019) which has demonstrated that the Italian city is more sensitive to the energy aspect than the Spanish city, for which real estate listing prices are determined by other characteristics unrelated to energy performance; this is probably proof that in some areas interest in energy efficiency is growing.

In addition, a new investigation on a portion of a working-class neighbourhoods in the metropolitan city of Turin (Mecca *et al.*, 2020) considered the increase due to energy class update and turned out that current Italian state financing could make the renovation work advantageous for the owners.

2.3. Ecobonus 110%: regulatory framework[2]

Following the Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, the Italian energy regulatory framework has changed. Moreover, recently, in relation with the Covid-19 epidemic emergency, the new Italian Law "Decreto Rilancio" (Relaunch Decree) has considered the necessity of support policies for the population by increasing from 80% to 110% the rate of detraction for interventions concerning energy efficiency in buildings.

This Law allows owners to get a total refund for the expenses incurred from 1 July 2020 to 31 December 2021 regarding the recovery of the building stock (as Sisma bonus) or energy retrofit of buildings (as Ecobonus), by opting for an advance contribution in the form of a discount from the suppliers of goods or services or, alternatively, for the assignment of the credit corresponding to the deduction due.

The energy retrofit of buildings implies that higher deductions are currently recognized when the intervention involves the common parts of the opaque envelope for more than 25% of the dispersant surface or when these result in the middle class of the envelope in the winter and summer behaviour.

The decree identifies three driving types of intervention:
- thermal insulation, which involves more than 25% of the dispersant surface of the building or the unit (if it is independent);
- replacement of existing winter air conditioning systems with centralized systems, for independent units or common parts in buildings;
- anti-seismic interventions.

Additional intervention types are considered in this law, but they are bound to the previous types to obtain the detractions; these include other energy class upgrading works, the installation of photovoltaic solar systems connected to electricity or the addition of electrical vehicle charging stations.

The detraction request can be made by residents, natural persons, public housing associations (e.g. IACP) or other non-profit associations; the detraction could consist in a refund of the expenses subdivided in five years or in a discount on the consideration due, whose amount does not exceed the consideration itself, anticipated by the supplier of goods and services related to soft interventions. The supplier recovers the contribution in the form of a tax credit equal to the deduction, with the right to subsequent assignment of that claim to other persons, including credit institutions and other financial intermediaries.

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3 | METHODOLOGICAL APPROACH

Data collection and preliminary analyses

This study has been driven by an inductive process that involves the construction of a random homogeneous data sample extracted from the total population data, its subsequent analysis through the comprehension of its elements and the calculation of the summary indicators with the aim to extend the results to the entire population.
Therefore, the sample size has to set at least one of the following conditions:

$$k > 1 \text{ or } (n + 1)\,k > 1 \text{ or } n\,k > n + 3$$

Where k is the number of observations and n is the number of independent variables in a regression model (Simonotti, 2006).
Please consider that the use of a quantitative model implicitly requires the use of quantitative variables expressed in technical or economic measures; on the other hand, qualitative variables will need to be measured in a dichotomous way or via scoring scales. This last step will suffer from a certain degree of operator subjectivity in the attribution of values and will result in a loss of quality content in favour of a higher level of synthesis (Simonotti, 2006).

In order to best describe and synthesize the sample to be analysed, it is necessary to elaborate some descriptive statistics; through the techniques proper to this discipline it will be possible to report the most significant aspects of the data collected (Corain, 2012).
After having appropriately removed anomalies from the sample, it is necessary to evaluate the correlation between variables. The term correlation refers to the link between two variables that can assume different levels of intensity; moreover, a strong relationship between these implies the presence of co-variability, *i.e.* the tendency to oscillate negatively or positively together. To apply a linear regression model, it is therefore important to identify correlated variables, as these could compromise the validity of the model.
The possible linearity relationship between two variables can be obtained by means of the Pearson's correlation test, defined as their covariance divided by the product of the respective standard deviations; the variables were expressed in interval scales, *i.e.* measured on a range of values in order of rank.

Hedonic model

The OLS "Ordinary Least Squares" method is determined by the following mathematical function:

$$Y = \alpha_k + \sum_{i=1}^{n} \alpha i X_{ik} + \ldots + \sum_{i=1}^{n} \beta i\, Z_{im} + \varepsilon \qquad (1)$$

where: Y stands for the dependent variable, αk stands for the model intercept, X_{ik}, with k=1, and Zim, with m=1 are the independent variables (property characteristics), αi and βi represent the hedonic weights assigned to each variable, *i.e.* the contribution given by each single characteristic level to the price value, and ε represents the error term.

After the application of the OLS method, it is necessary to validate the regression model both in terms of the statistical significance level and the absence of collinearity between variables.

The resulting hedonic model is not only for descriptive purposes, but it is also intended as a predictive tool for property evaluation. To construct the sample, were used the offer prices and the characteristics of the real estate units located in the municipality of Ivrea and nearby cities.

Predicted value and analysis of residuals

The independence of the residuals implies certain concepts; one is that every predicted value has no bias in its residual value. An example of this is that certain values of the regression output have a bias toward positive residuals or negative residuals. This generally shows up as a curve or wave form in a plot of the residual (y) versus a predicted value (x).

A second independence concept is a time correlation of the residuals. In this case the residuals may have a bias toward being more positive or more negative at some period during data collection. This is commonly found when a process start-up performance is not like the standard running performance producing a series of high or low residual values. Autocorrelated data, primarily in y but sometimes in x values as well, can also impact residual independence. This autocorrelation is found when sequential data points are not independent because the next data point is always close to the value of the prior data point, as we can find in the stock market.

4 | CASE STUDY

4.1. Olivetti Residential Heritage In Ivrea[3]

The Olivetti residential heritage in the UNESCO site is very extensive; it consists of 83% of the assets (98% of which are private) even if only 59% of it is populated (Piano di Gestione, 2017).

The first residential projects related to the Olivetti company history can be found in an area adjacent to the production plants, consequently named Borgo Olivetti social housing. The types initially proposed for this complex refer to the model of the traditional single-family house with a vegetable garden designed to facilitate the self-production of food. Subsequently, the typological studies, commissioned by the company to Luigi Figini and Gino Pollini, will lead to the construction of a building organized on three levels to accommodate 24 families.

Within the Core Zone, along the west side of the axis of via Jervis, the Castellamonte district was later built. The initial project, also by the architects Figini and Pollini, would have provided for a social mix, outlined by the different building types that would have been placed within the area.

Although the initial idea was only partially implemented, the “Houses for employees with large families” were initially built, conceived by the same designers of the district in a rationalist style, to which were added the “Houses for Executives” (1948), the “Building with 4 homes” (1951) and “House with 18 flats” (1954) commissioned to the architects Marcello Nizzoli and Giuseppe Mario Oliveri, who used this design experience to implement housing studies in Ivrea.

During the seventies, the iconic “Western Residential Unit” was added to the complex, the design of which was entrusted to Roberto Gabetti and Aimaro Isola; the building is characterized by a semi-circular plan (with a radius of about 70 meters) and it houses simplex and duplex apartments designed to accommodate Olivetti employees temporarily residing in Ivrea.

The Via Torino road axis, one of the main routes of the city of Ivrea, hosts the districts of Canton Vigna, Canton Vesco and Bellavista, which offer a large catalogue of residential types within the Buffer Zone.

The Canton Vigna complex constitutes the first Ina-Casa construction site opened by the Olivetti company between 1950 and 1953; the area consists of three blocks (respectively named A, B and C) with three and four floors above ground arranged in an open courtyard. The courtyard was initially

3 https://www.ivreacittaindustriale.it/

conceived as a play area for children, to provide a more human environment to the three buildings in a rationalist style.

Figure 2 Views from Canton Vesco. *Source: Paolo Mazzo's photos*

Immediately adjacent to Canton Vigna is the Canton Vesco district (Figure 2), also designed, like the previous one, by the hands of E. Devoti, L. Figini and L. Piccinato, as part of the Ivrea Town Plan of 1942. In 1958, after numerous requests by the inhabitants, the complex was expanded thanks to the INA-CASA Plan and the Istituto Case Popolari (IACP, Public Housing Association), providing for the inclusion of a kindergarten and an elementary school. The huge demand for housing prompted the Olivetti company to establish a further appendix east of Canton Vesco, in the area still called La Sacca until today.

The southern area of Via Torino includes the Bellavista district, built between the fifties and sixties, also the result of Ina-Casa funding.

The design, entrusted to Luigi Piccinato in 1957, included large green areas and low-density buildings within the complex; at the centre are the church, schools and service buildings for the neighbourhood.

The panorama of services offered by the Olivetti company provided also the Ufficio Consulenza Case Dipendenti (Employee Homes Office, UCCD), which was established in 1948 and suppressed in 1969, due to corporate changes. The key figure of this institution is the architect Emilio Aventino Tarpino, director of the Office, who would go on to design more than three hundred buildings around Ivrea and Piedmont.

Supporting the UCCD, and also coordinated by the Social Services Management, there were other departments: the Direzione Centrale Relazioni Interne (Central Internal Relations Department, DCRI) and the Servizio Relazioni Interne (Internal Relations Service, SRI), which carried out coordination and support activities for internal correspondence. There was also a Costs and Estimates Office.

Olivetti's Historical Archive features a large collection of letters and documents belonging to Arch. Tarpino, useful for understanding the dynamics involved in the construction of the residences.

The architectures attributable to the Employee Homes Consultancy Office (UCCD) include different types shaped according to the needs of the user and those of the Olivetti company: single-family and semi-detached villas, small condominiums that can accommodate a few families and tower houses. For Adriano Olivetti, establishing this body was a further opportunity to experiment and acquire new knowledge; in 1958, a competition was launched for the best designers of the time to further expand the UCCD architecture catalogue (Figure 3).

Figure 3 Some UCCD houses. *Source: Paolo Mazzo's photos*

In addition to designing houses, UCCD's main functions included customer mediation and interaction; to start with, applicants would have to fill out a questionnaire entitled "Come vuole la casa" ("How would you like your house to be?"), indicating their housing needs. After implementing a project design, Tarpino himself would draw up a contract document that was submitted to the major local companies. Finally, after having chosen the best bidder, the project would be carried out under the architect's step-by-step supervision (Olmo *et al.*, 2018).
No aesthetic limit was placed on design, so much so that Tarpino developed a real catalogue of architectures varying from double-roof buildings like Casa Barberis, more akin to local traditions but with an eye to Modern styles, to the latest, almost brutalist episodes like Casa Sidro. Tarpino's intention was therefore to propose a style that could be appreciated by customers while merging the new forms with local materials, while at the same time being attentive to details and elegant modernity.

4.2. The Socio-Economic Context and Real Estate Market of Ivrea

The trend of Ivrea's resident population (Figure 4) confirms that Olivetti had a concrete impact on the area; the largest percentage increases can be traced back to the 1930s and 1960s (+28.8% and +35.2%, respectively) corresponding to the company's main growth periods.
Today, the demographic trend tends toward a progressive decline with slight percentage movements that recorded a decrease (4%) in the decade 2008-2018, probably due in part to a regressive population structure.
The latest available data on population distribution for three age groups shows Ivrea's lower percentage of young people compared to the metropolitan city of Turin and the Piedmont Region, shows the (11.3% versus 12.8% and 12.6%). Conversely, population ageing within the Municipality of Ivrea (256.2) was significantly higher in 2018 than the values recorded in the Metropolitan City of Turin (195.7). Similarly, in the same year, the data on average population age show a higher figure in the municipality of Ivrea (48.4 years) compared to both the Metropolitan City of Turin and the Piedmont region (46.1 and 46.3 years, respectively) (Istat, 2018).

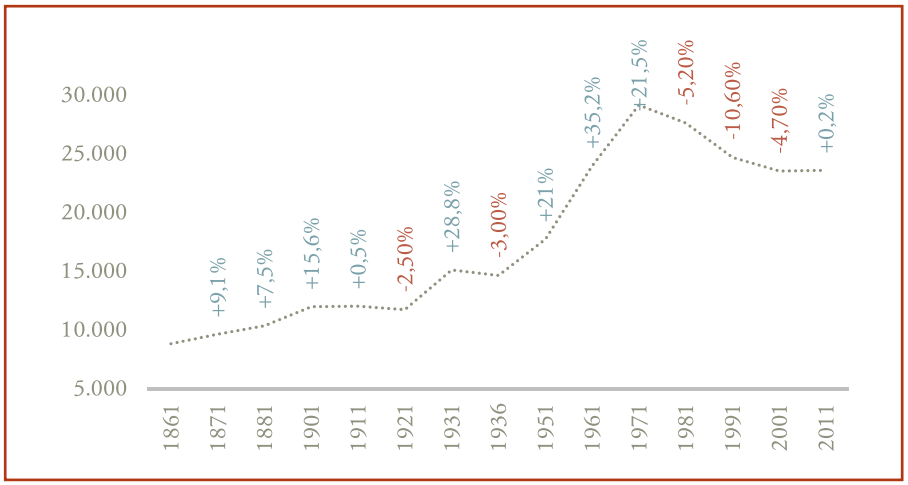

Figure 4 Population trend based on censuses from 1861 to 2011.
Source: Author's elaboration on Tuttaitalia.it data

The Olivetti residential heritage offers numerous opportunities from an architectural point of view, as a "city-laboratory", and in terms of the current use of residential buildings.

Indeed, 2011 census data (8mila Census, 2011) illustrate how potentiality could have increased over the twenty-year period 1991-2011, going from a value of 12.2% to 30.8%, with a 152-percentage change. This parameter is particularly significant because it also takes into account buildings unsuitable for residential use which are falling down, in a state of collapse or in a similar condition, pointing to the need for enhancing (and using) the buildings in question.

The under-utilization of homes is another significant indicator, which is 16% higher than the regional and Italian average. The degree of overcrowding and the number of square meters per occupant (equal to 47.2 square meters in Ivrea against 40.2 square meters on average in Italy) suggest that there are new and different perspectives for a greater exploitation of the buildings present in the area today. In the last 5 years, the Ivrea real estate market recorded a decrease of 22.3% in the listing prices of residential properties.

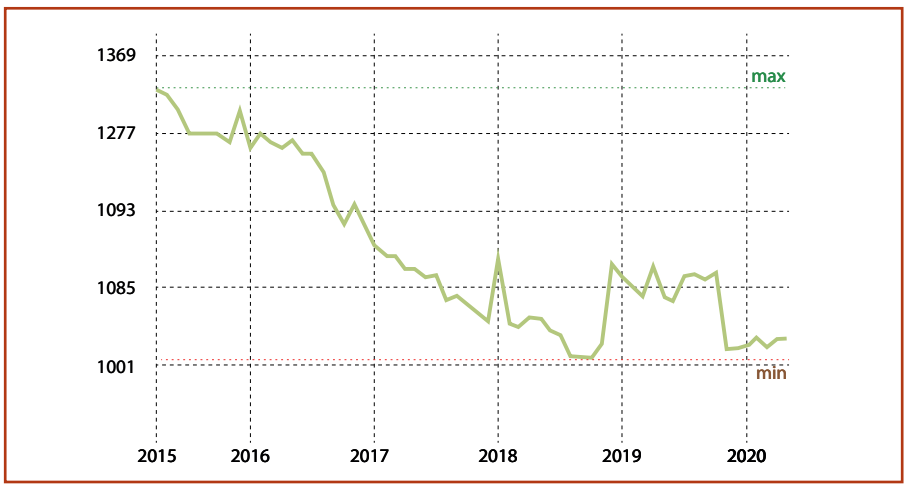

Figure 5 Trends in listing prices per square meter required in Ivrea for residential properties.
Source: author's elaboration on Immobiliare.it data

As can be seen from the graph (Figure 5), the maximum bid price per square meter was reached in April 2015 (1328 €/sqm); on the other hand, the minimum is 1010 €/sqm, reached in October 2018. This value has subsequently increased during 2019, maybe influenced by the UNESCO site, but in 2020 there is still a stabilization of the requested prices around 1000 €/m^2.

In line with the national panorama, the city of Ivrea has suffered the effects of the real estate market crisis of recent years, which has led to a decrease in property values throughout Italy.

The statistical report on the Piedmont real estate market, published by the Real Estate Market Observatory-OMI (https://www.agenziaentrate.gov.it/portale/schede/fabbricatiterreni/omi/pubblicazioni/statistiche-trimestrali/archivio-statistiche/archivio-note-inglese) in June 2019, shows to what extent the Normalized Transactions Number (NTN) registers positive percentage changes throughout the region, with the exception of the Ivrea area, where in 2018 there was a 3.9% decrease of the aforementioned value and a Market Intensity Index (IMI) lower than 0.06%.

5 | DATA

The data collection of real estate listings is the result of a sampling process started in December 2018 and ended in February 2020, by means of the Immobiliare.it portal (https://www.immobiliare.it).[4]

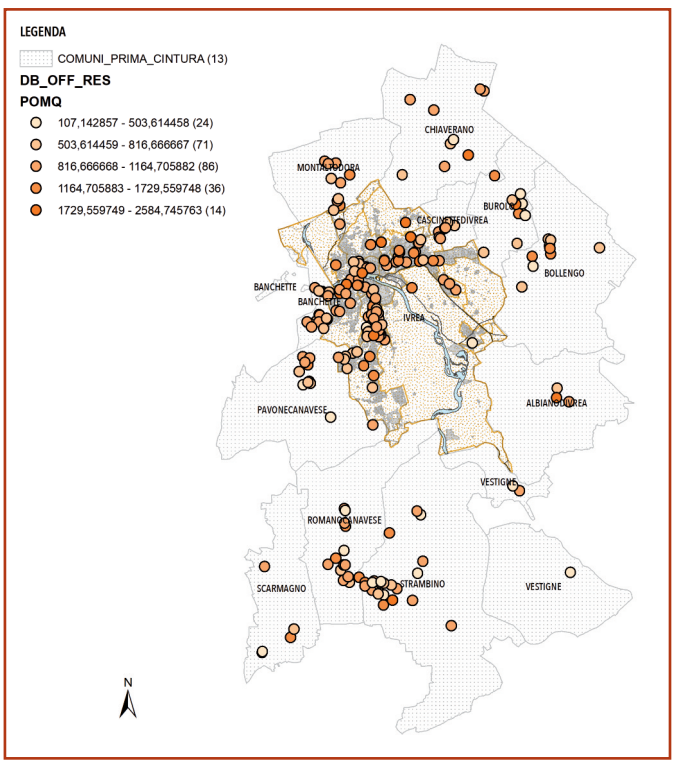

Figure 6 Spatial distribution of listings (Euro/m^2) in Ivrea and neighbouring municipalities. *Source: author's elaboration*

It is important to note that all analyses have been carried out on the listing prices of the real estate market and not actual market prices; this type of sources provides often uneven and contradictory data, as the real values are determined after the bargaining phase between buyers and sellers.

The data sample consists of 251 residential property listings (Figure 6), including prices, and more than 20 variables related to the key features. The data collection was focused on villas and apartments located in Ivrea and in the municipalities of its first belt.

Figure 6 shows how lower listing prices gather also near the Core and Buffer Zone, while there are only some cases involving higher price levels located near the centres of the municipalities; there are no specific spatial clusters, as all the price levels are located all over the area.

4 Founded in 2007, Immobiliare.it portal is a research and real estate listings and boasts 55 million visits per month with 1.2 million ads.

In order not to falsify the results, 11 cases related to farmhouses were removed, from the sample, as these are not homogeneous with respect to the system of buildings analysed by this research.

Table 1 shows the descriptive statistics of the data sample.

Variable	Mean (€/mq)	St. Dev. (€/mq)	Levels	Freq
Listing Price (€)	**137976**	**100205**		
Size (sqm)	**151**	**94**		
City	1070.12	454.25	Ivrea	0.38
	869.23	340.61	Cascinette d'Ivrea	0.04
	795.9	474.39	Burolo	0.04
	919.13	308.81	Montalto Dora	0.04
	850.79	369.98	Romano Canavese	0.07
	864.85	418.51	Scarmagno	0.02
	912.12	481.46	Strambino	0.12
	773.83	314.81	Pavone Canavese	0.07
	832.51	242.52	Banchette	0.09
	798.24	398.72	Bollengo	0.05
	1008.42	469.61	Chiaverano	0.04
	554.34	319.75	Vestignè	0.02
	1315.62	870.75	Albiano d'Ivrea	0.01
Building category	739.08	347.43	Economical	0.26
	926.84	352.59	Medium	0.5
	1296.93	498.73	Classy	0.19
Unit status	1200.04	455.12	Renovated	0.33
	861.96	343.02	Partially renovated	0.51
	653.64	353.3	Not renovated	0.15
Energy Performance Certificate (EPC) level			A and over	0.3
			B	0.1
			C	0.4
			D	0.9
			E	0.11
			F	0.14
			G	0.19
			N/A	0.39
Olivettian connotation	913.08	944.24	Yes	0.9
	548.35	418.46	No	0.91
Panoramic view	1049.69	903.54	Yes	0.26
	507.81	394.92	No	0.74
Architectural quality	817.62	794.99	Low	0,56
	350.34	471.7	High	0.44
Distance from the center of Ivrea between 1 and 2 km	1134.92	501.21	< 1 km	0.08
	1191.06	444.5	between 1 and 2 km	0.12
	981.46	456.39	between 2 and 3 km	0.14
	855.53	390.75	> 3 km	0.67

Table 1 Descriptive statistics of dataset features and levels. *Source: Author's elaboration*

Among the features already presented (Figure 7), it is important to focus on three variables describing the phenomena of interest in this analysis: the Energy Performance Certificate (EPC) level, the "Olivetti connotation" and the "Architectural quality" of the buildings.

The latter is specified on two levels:
Architectural Quality (Q_ARCH) is set to 0 for buildings lacking any noteworthy design features, such as finishes, details and additions;
Architectural Quality (Q_ARCH) is set to 1 for architectural artefacts based on a well-known Olivetti project, or with targeted design and finishes, valuable materials and a particular architectural style.
Olivetti connotation is set to 0, for buildings that do not belong to the Olivetti residential housing.
Olivetti connotation is set to 1 for assets that were planned and realized during the UCCD era, or by authors connected to the Olivetti Company.
Another noteworthy variable is the 7 levels of the EPC label, in accordance with actual enactments; level "D" is the most frequent condition, but there is also a high number of buildings that do not have a class yet.

6 | RESULTS

6.1 Preliminary Analyses

Based on the total sample, a correlation analysis was carried out between the variables to examine a possible situation of co-variability between the different property characteristics. Using the opensource Gretl (http://gretl.sourceforge.net) software, was outlined the variable correlation matrix (Figure 8) and graphically represented the degree of co-variance between them.

DC	villa	prop_type	class_ed	verde	p_all	mq	cl_mq	n_locali	n_bagni	status_u	riscald	APE	p_autobox	prezzo	prezzomq	arch_oli	location	panor	qarch	X
1	-0,2336	-0,2340	-0,0075	-0,0422	0,1566	-0,2125	-0,2061	-0,0258	-0,1639	-0,0812	-0,1598	-0,1474	0,2775	-0,0045	0,2617	0,0096	0,4212	-0,1247	0,2451	DC
	1	0,9495	0,3114	0,4511	-0,4215	0,5744	0,6396	0,4500	0,4577	0,0114	0,5052	-0,0643	-0,0671	0,5249	0,0451	-0,1269	-0,1994	0,4224	0,0535	villa
		1	0,3293	0,414	-0,3989	0,6163	0,6338	0,4445	0,4327	0,0516	0,4669	-0,0496	-0,0556	0,5623	0,0485	-0,1120	-0,1545	0,4027	0,0711	prop_type
			1	0,2401	-0,2809	0,4354	0,4635	0,3667	0,4613	0,3776	0,3174	0,1640	0,1738	0,6500	0,4332	-0,2187	-0,0465	0,3335	0,0560	class_ed
				1	-0,2323	0,3586	0,4249	0,2522	0,2598	0,0152	0,3072	-0,0903	0,1834	0,3758	0,1216	0,0858	-0,0623	0,2480	0,2602	verde
					1	-0,2942	-0,3361	-0,1488	-0,2180	-0,1258	-0,4961	-0,1733	0,0238	-0,3021	-0,1899	0,2397	0,1177	-0,2350	0,0928	p_all
						1	0,8677	0,6955	0,5898	0,0249	0,4060	-0,0156	0,1337	0,6930	-0,1129	-0,1531	-0,1879	0,4509	0,0419	mq
							1	0,6990	0,6629	0,0238	0,4625	-0,0229	0,1371	0,6670	-0,0488	-0,1868	-0,2461	0,4434	0,0205	cl_mq
								1	0,5571	0,0685	0,3092	0,160	0,1727	0,5325	0,0082	-0,0735	-0,0998	0,3370	0,0832	n_locali
									1	0,1719	0,3359	0,0449	0,2564	0,6089	0,1165	-0,0575	-0,1288	0,4014	0,0801	n_bagni
										1	0,0761	0,2560	0,134	0,2860	0,4494	-0,146	0,0380	0,0751	0,0265	status_u
											1	0,0886	-0,041	0,3735	0,1206	-0,1477	-0,1842	0,2571	0,0268	riscald
												1	-0,231	0,1201	0,2720	-0,0434	-0,133	-0,0266	-0,146	APE
													1	0,2784	0,3135	0,3244	0,4319	0,0345	0,4334	p_autobox
														1	0,5586	-0,148	-0,0000	0,5152	0,2274	prezzo
															1	-0,0225	0,2206	0,1465	0,2291	prezzomq
																1	0,2175	-0,0633	0,6924	arch_oli
																	1	-0,0271	0,3240	location
																		1	0,1706	panor
																			1	qarch

Figure 7 Pearson's correlations. *Source: author's elaboration*

The matrix has high correlation values between all parameters that outline the horizontal aspect of the properties; in fact, the variables "number of rooms" and "number of bathrooms", are closely related to the size, and, for this reason, they will be excluded from the regression model.. Similarly, the villa, type and building classification variables are correlated, but since they have a value lower than 0.5, was decided to analyse them within the regression model anyway.

Subsequently, was tested the Moran's Index value (Moran's I= 0.078), which confirmed the probable absence of spatial autocorrelation (Goodchild, 1986) (Figure 8).

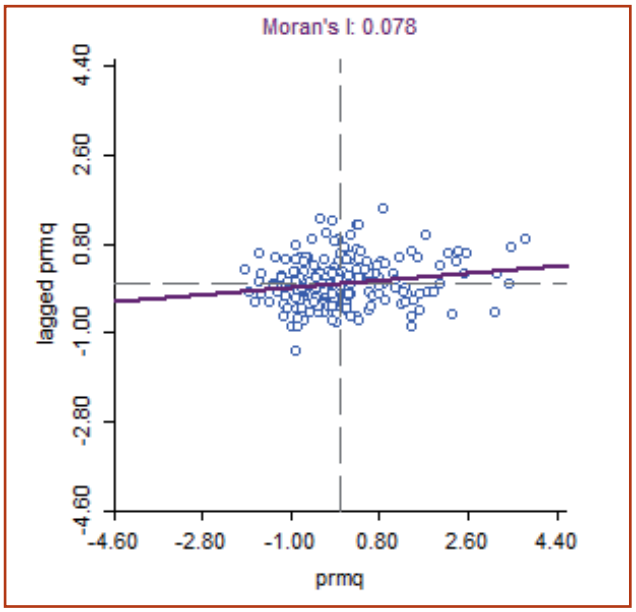

Figure 8 Moran's Index Scatterplot. *Source: Author's elaboration*

6.2 Regression Analysis

The regression method used is defined as backward stepwise, *i.e.* selecting the variables that will be used in the model by eliminating in successive steps all those that are not statistically significant.
A first regression model was applied with the listing price (Euro) as a dependent variable and the 22 features previously considered in the correlation analysis as explanatory variables.

The stepwise process reduced the 22 explanatory variables to 9. Subsequently, the goodness of the model was verified by testing the presence of heteroscedasticity, multicollinearity and the spatial dependence of variables. The outputs of the final Ordinary Least Squares (OLS) model are shown in Table 2.

Variable	Coefficient	Std. Err.	t value	p-value	
const	-6624,45	10715,1	-0,6182	0,5371	
Distance from the center of Ivrea < 1 km	34700,0	12646,5	2,744	0,0066	***
Villa	27029,6	9171,99	2,947	0,0036	***
Building Category - Classy level	84783,5	10445,1	8,117	3,60e-014	***
Size	436,466	479,386	9,105	5,92e-017	***
Unit status - partially renovated	30181,1	10103,4	2,987	0,0031	***
Unit status - renovated	52264,6	10929,3	4,782	3,21e-06	***
EPC - A	64348,0	24360,1	2,642	0,0089	***
Panoramic view	35949,4	9270,58	3,878	0,0001	***
Architectural quality - High level	18226,4	7493,90	2,432	0,0158	**

Table 2 OLS Regression model outputs. *Source: Author's elaboration*

The results in Table 2 show that the model can explain 75% of the variability (R^2 = 0.747) of the price formation process. The Fisher's F value is less than the theoretical reference to the degrees freedom of the system and the value of the variance increase (VIF) of 3.95, which is lower than 4, thus ensuring the absence of collinearity between variables.
The signs of the implicit marginal prices are consistent with the phenomenon to which they refer. In particular, building category (Classy Level) has the biggest marginal price and Size the smallest.
It is important to note that with respect to the initial model, the variable concerning "Olivetti connotation" was discarded within the regression: this suggests that the Olivetti connotation of buildings is not monetized within the Ivrea market.

Similarly, the Architectural Quality of buildings is not a particularly significant parameter within the formation mechanism of the real estate sale prices.
In contrast, a high Energy Performance Certificate (EPC) coefficient shows how significant this factor is when evaluating a property.

6.3 Application of themodel: Prediction of Energy Class Upgrade

The model was not only applied to describe marginal prices, but also to estimate the listing price of Villa Capellaro, an Olivetti villa in the Core Zone currently not on the market.
For this purpose, the marginal coefficients resulted from the hedonic model were used to firstly estimate the singular villa's features. Subsequently, they were used to estimate a possible listing price in the current maintenance condition, while a second estimation was hypothesized to calculate a possible upgrade after an energy retrofit intervention.

This villa was commissioned by Natale Capellaro, engineer and Director Responsible for the Projects Office in Olivetti Company, and designed by Marcello Nizzoli and Gian Mario Oliveri in 1955.
The features of this asset made it an excellent example to explain what is intended in this research for an high quality architectural level: the eccentric volumetric composition, the aesthetic placement of the retaining wall and the employment of materials attributable to Modern Movement are noticeable elements of this architecture; facades are made of stone and plaster and the roof is slightly sloped almost comparable to a flat roof.

The villa is arranged on two levels: the basement, with a surface of 64.3 m^2, includes the heating rooms, a cellar and the garage; the ground floor, with an area of 208.7 m^2, is divided into three zones dedicated to kitchen, living room and three bedrooms.
In the preparatory phase of the present research, a series of data and information, including all the interventions made on the assets, were collected and registered in a catalogue (containing detailed sheets for each Olivetti villa in Ivrea).
Furthermore, the plot of land of Villa Capellaro was exploited to obtain beautiful contrasts in the landscape to made it more interesting giving different views on the Ivrea Morainic Amphitheatre: for this reason the "Panoramic View" value was set equal to 1.

Even if Villa Capellaro stands in the Core Zone, this property is 3 kilometers far from the city center. Therefore it is not possible to add a marginal price for its location because the model monetized only the distance from the centre of Ivrea shorter than 1 kilometer.
Considering the year of construction of the building and the materials used, a relatively low energy class has been assumed for example (F), because the real EPC label is not known.
Assuming the intrinsic characteristics of the villa in its current condition and the related marginal prices, the unitary listing price could be 1.582 Euro/m^2, for a total price of 330.346 Euro.

Variables	Value	Marginal price (€)	Marginal price[5] (€/mq)
Distance from the centre < 1 km	>3km (=0)	0	0
Villa	yes (=1)	27.029	129.5
Building category	Classy (=1)	84.783	406.2
Size (m2)	272	118.592	436
Unit status	Renovated (=1)	52.264	250.4
Unit status	Partially renovated (=0)	0	0
EPC label A	F (=0)	0	0
Panoramic View	yes (=1)	35.949	172.3
Architectural Quality	yes (=1)	18.226	87.33
Constant	-	-6.624	-24.35
Estimation		**Total price (€)**	**Total price (€/mq)**
Listing price evaluation (EPC label F)		330.219 Euro	1582.9

Table 3 Characteristics of Villa Capellaro and marginal prices related to the property features in the current condition. *Source: Author's own work*

Table 3 shows how the single coefficients affect the listing price: the greatest is associable to the "Building Category" which is 406.2 Euro/mq (25% of the total price), in contrast to "Architectural Quality" which reveal the lower coefficient with an incidence of 87.33 Euro/mq (6% of the total price). The "Unit status - Renovated" counts 250.4 Euro/mq (15% of the toal price), followed from the "Panoramic view" with a coefficient of 172.3 Euro/mq (11% of the total price). Noteworthy is also the coefficient for "Villa" equal to 129.5 Euro/mq (8% of the total price) Subsequently, guessing an energy retrofit intervention on the villa, and an EPC label increasing from G to A, the simulation registers a substantial increase of the value also in this case, which would lead to the total coverage of the improvement interventions (Table 4).

Variables	Value	Marginal price (€)	Marginal price (€/mq)
Distance from the centre < 1 km	>3km (=0)	0	0
Villa	yes (=1)	27.029	129.5
Building category	Classy (=1)	84.783	406.2
Size (m2)	272	118.592	436
Unit status	Renovated (=1)	52.264	250.4
Unit status	Partially renovated (=0)	0	0
EPC label A	A (=1)	64.438	306.7
Panoramic View	yes (=1)	35.949	172.3
Architectural Quality	yes (=1)	18.226	87.33
Constant	-	-6.624	-24.35
Estimation		Total price (€)	Total price (€/mq)
Listing price evaluation (EPC label F)		394.567 Euro	1582.9
Estimation		**Total price (€)**	**Total price (€/mq)**
Listing price evaluation (EPC label A)		394.567 Euro	1881.2
Difference between estimated listing prices (with EPC F label and with EPC label A)		+19%	308.3

Table 4 Characteristics of Villa Capellaro and marginal prices related to the property features in with energy retrofit intervention hypothesis (EPC=A). *Source: Author's own work*

5 Calculated on heated areas (ground floor) excluding service spaces.

For the simulation presented in Table 4 was guessed a soft retrofit intervention including the following: replacing the windows and replacing the heating system supposing an unitary cost of 300 Euro/m^2.

Considering the retrofit unitary cost, the marginal price of the "Listing Price Evaluation (EPC label A)" could cover the entire cost of the intervention with an increase of +6.7 Euro/m^2 of the total price.

In spite of it would be necessary an harder retrofit intervention to get the best energy performance, for example including the improvement of the building envelope and roof, the example shown in Table 4 confirms how this methodology could therefore be useful also for owners in the pre-evaluation phase of retrofit interventions, to estimate their property value, to compare construction costs with the increased value of the asset and evaluate the convenience of the energy retrofit intervention, also in relation to having access to the tax break "Ecobonus 110%". By using the Ecobonus 110%, regardless of the cost of the intervention, if energy improvement interventions are included, the owner may not have to pay anything. In fact, the Ecobonus allows to discharge from taxes the entire amount of costs relating to energy retrofit interventions, but, above all, it gives the possibility of transferring the tax deduction to other subjects.

In particular, in the case of Villa Capellaro, it would be interesting for the owner to transfer the tax credit to a construction company. In this way, if the overall costs of the intervention (including VAT, professional charges, safety charges and risk variables) were within the limits imposed by law, they would be fully borne by the construction company. Alternatively, if the cost of the works were higher than the ceilings, the owner might have to pay only the difference and, also in this case, get a big advantage from the operation.

On the other hand, this methodological approach could suggest to the Municipality of Ivrea and the UNESCO committee which interventions should be promoted to enhance the Olivetti residential heritage in Ivrea.

7 | CONCLUSIONS

The inclusion in the World Heritage List has ideally started a process of enhancement of the modern heritage of Ivrea and acknowledgment of its unique value. Although this has been a particularly significant step, today there is an urgent need not only to value this heritage as "monument", but to implement its actual reuse with new functions for non-residential assets, and interventions aimed also at improving the energy performance for the housing stock. These interventions are fundamental to make the Olivetti housing stock more usable and more attractive to potential buyers and investors.

The aim of this article is to analyse the potential for enhancement of the Olivetti villas of Ivrea in the fragile socio-economic context in which they are located and to check whether their architectural quality is recognized by the market. It was also investigated if and how the energy performance label upgrade of the residential heritage may correspond to the enhancement of the buildings' value and listing prices in the Ivrea real estate market.

By applying an OLS regression model on a sample of 251 property listings, it was possible to assess how and how much some intrinsic and extrinsic building characteristics affected the price formation process.

Results show that the variable with the higher marginal coefficient is the Energy Performance Certificate (EPC) label (+64,348.00 Euro) which, though generally perceived only as a simple mandatory document, in the regression model emerged as a determining variable and a meaningful factor that can influence listings prices.

Similarly, above the housing unit feature, the conservation status of the unit has a significative and positive coefficients (Refurbished=+52.264,6 Euro, and Partially refurbished= +30181,1 Euro).
As regards the building features, the building type "villa" has a positive coefficient (+ 27.029,6 Euro), while the variable referring to the Architecture quality (high level) results also positive (+18,226.00 Euro) with a lower coefficient.
On the other hand, the "Olivetti connotation" of buildings is noteworthy, as this indicates that the historical and cultural value of Olivetti's housing is not recognized by the real estate market.
To conclude, the marginal price of "architecture quality" that is lower than the "EPC label" one suggests that the Ivrea real estate market is formed by a type of demand that is more sensitive to energy concerns rather than modern architectural quality.
The model applied was useful not only to describe the Ivrea real estate market, but also to demonstrate that the energy retrofit could raise the listing prices of this assets: especially with the simulation of Villa Capellaro, through the model it was possible to estimate its possible listing price at its current conservation status level and, assuming an upgrade of the energy class, its new listing price that could increase by 19%.Therefore, the possibilities of enhancement of these buildings can be related to energy retrofit interventions that, in the event of using tax breaks would be cost-effective and could offer an opportunity to re-evaluate these properties.
By having access to Ecobonus, lower-income population could improve the hygrothermal well-being of their house at no cost; in this way, Municipalities have the sole task to manage the intervention, supporting private owners, investors and construction companies with specific policies, thus ensuring the protection of the assets.
Considering this, the energy retrofitting of modern residential heritage is a real opportunity both for owners and for the UNESCO Site because, thanks to the incentives, the full coverage of any intervention's costs would be guaranteed and the Olivetti heritage enhanced.
Further research could overcome some limits of the present study. For example, considering a wider sample of listings prices, the hedonic model could be improved to yield new results regarding its application on private buildings which could benefit from Ecobonus 110%; at the same time, the approach to energy retrofit may deserve a deeper analysis on the cost of the interventions.

To conclude, assuming that citizens are increasingly aware of energy savings issues, also thanks to the de-carbonization programs carried out by the European Union (Net-zero 2050), and assuming that the attention on the modern heritage of Ivrea will be guaranteed by the visibility of the UNESCO site, in the near future also the Olivetti residential assets will hopefully get the right attention and their value will be recognized in the real estate market.

References

Ascione P. (2012) Conoscere e riqualificare il patrimonio architettonico del Novecento: esperienze e metodologie. Techne. 250-61.

Castagnoli A. (2014) Across borders and beyond boundaries: How the Olivetti Company became a multinational, Business History. 1281-1311.

Corain L. (2011) Elementi di Statistica Descrittiva, Corso di Laurea in Ingegneria Civile Facoltà di Ingegneria, Università di Padova.

Curto R., Barreca A., Rolando D. (2017) An innovative methodological and operational approach to developing Management Plans for UNESCO World Heritage Sites: a Geographic Information System for "Ivrea, industrial city of the 20th century". Aestimum 71

Dell'Anna F., Bravi M., Marmolejo-Duarte C., Bottero M. C., Chen A. (2019) EPC Green Premium in Two Different European Climate Zones: A Comparative Study between Barcelona and Turin. Sustainability.

Di Biagi P. (a cura di) (2010) La grande ricostruzione - il piano Ina-Casa e l'Italia degli anni '50. Roma. Donizelli Editore.

Dossier di candidatura (2017) Ivrea Città Industriale del XX secolo.

Fregonara E., Rolando D., Semeraro P., Vella M. (2014) The impact of Energy Performance Certificate level on house listing prices. First evidence from Italian real estate. Aestimum. 143-163.

Fuerst F., McAllister P. (2011, c). The impact of Energy Performance Certificates on the rental and capital values of commercial property assets. Energy Policy 39(10), 6608-6614.

M. F. Goodchild, 'Spatial Autocorrelation. Concepts and Techniques in Modern Geography 47', p. 56, 1986

Graf F. and Marino G. (2016) Building Environment and Interior Comfort in 20th-Century Architecture : Understanding Issues and Developing Conservation Strategies / Les Dispositifs du confort dans l'architecture du XXe siècle : connaissance et stratégies de sauvegarde. Lausanne, Presses polytechniques et universitaires romandes.

Kuipers, Marieke, Wessel de Jonge. (2017) Designing From Heritage: Strategies for Conservation and Conversion. TU Delft.

Mecca U., Moglia G., Piantanida P., Prizzon F., Rebaudengo M., Vottari A. (2020) How Energy Retrofit Maintenance Affects Residential Buildings Market Value?. Sustainability.

Montanari G., Bruno A. (2013) Architettura e città nel Novecento - i movimenti e i protagonisti. Roma. Carocci Editore.

Palomares Figueres M. T. (2018) DOCOMOMO. Arquitectura moderna y patrimonio. Loggia (31). 8-21.

Piano di Gestione (2017) Ivrea Città Industriale del XX secolo.

Rosen S. (1974) Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. The Journal of Political Economy (Vol. 82, n. 1). 34-55.

Simonotti M. (2006) Metodi di stima immobiliare - applicazione agli standard internazionali. Palermo. Dario Flaccovio Editore.

Ivrea Città Industriale del XX Secolo. Available online: https://www.ivreacittaindustriale.it/. (September 2020)

MAAM Ivrea. Museo Virtuale dell'Architettura Moderna. Available online: http://www.mamivrea.it/. (September 2020)

Superbonus 110%. Agenzia delle Entrate. Available online: https://www.agenziaentrate.gov.it/portale/superbonus-110%25. (September 2020).