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The impact of Energy Performance Certificate level on house listing prices. First evidence from Italian real estate

The recent dispositions related to the energy performance of buildings, launched by the European Directives 2002/91/EC and 2010/31/EU, turned attention to the Energy Performance Certificate (EPC).
The aim of this study is to investigate the economic effects of the recent Italian statutory provisions related to energy performance of buildings on listing behaviour. With this aim an hedonic regression analysis is performed, in order to measure the impact of EPC level on listing prices. The study, based on a set of more than 500 housing property asset collected in 2012 from real estate advertisements websites, is focused on the Turin real estate market as a case study. Furthermore this paper contributes to the early limited literature on implication of the impact of EPC level on Italian housing market, representing one of the first systematic evidence about the energy certifications in the housing listing prices.

1. Introduction

The impact of energy performance of buildings on house prices is related to recent European Directives. Particularly, the European Performance of Buildings Directive 2002/91/EC introduced the Energy Performance Certificate (EPC), to measure energy performance of buildings. According to Article 7 of the Directive 2002/91/EC "Member States shall ensure that, when buildings are constructed, sold or rented out, an energy performance certificate is made available to the owner or by the owner to the prospective buyer or tenant, as the case might be. The validity of the certificate shall not exceed 10 years". Furthermore, in order to reinforce the European regulation in housing market, the European Directive 2010/31/EU (EPBD Recast) requires mandatory energy performance certificate for all buildings within the European Union. The Article 12 defines that "Members States shall require [...] the energy performance indicator of the energy performance certificate of the building or the building unit, as applicable, is stated in the advertisements in commercial media."

According to the Directives 2002/91/EC and 2010/31/EU "the energy performance of buildings should be calculated on the basis of a methodology, which may be differentiated at national and regional level, that includes, in addition to thermal characteristics, other factors that play an increasingly important role such as heating and air-conditioning installations, application of energy from renewable sources, passive heating and cooling elements, shading, indoor air-quality, adequate natural light and design of the building […]".

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Since European Member States can autonomously implement EPC standards, each government defines properly EPC levels. Most of European countries are still on a halfway towards the energy efficiency achievement and, therefore, it is necessary to assess the highly diverse settings of the different contexts (Andaloro et. al., 2010), as well as to adopt a multidisciplinary approach in the early design stage (Fregonara *et al.*, 2013).

In Italy, the European Directive 2002/91/CE has been adopted by the Legislative Decree 19 August 2005 n. 192 which defines 7 EPC levels, where "A" is the highest and "G" the lowest.

Then, the Legislative Decree 3 March 2011 n. 28 made the Energy Performance Certificate (EPC) a mandatory requirement for apartments to be sold (or rental) since 1st January 2012, so that apartments placed on the real estate market must necessarily have an EPC that does not exceed ten years.

Furthermore, it is important to underline that, according to the Ministerial Decree 22 November 2012 – which modifies the Ministerial Decree 26 June 2009 (guideline for energy certification of buildings) and abrogates the Paragraph 9 Attached A – , the owners can self-certificate that their apartments can be assigned to the lowest EPC level "G".

In Italy, the European Directive 2010/31/EU has been recently adopted by the Law 3 August 2013 n. 90 that, modifying the Legislative Decree 19 August 2005 n. 192, introduces a new methodology for the calculation of the energy performance of buildings to be adopted at national level.

Although the EPC has been introduced in Italy in 2005 it has become a mandatory requirement in apartment deeds of sale only since 2010 and in house sale advertisements only since 2012.

So, considering the fact that in Italy the information related to the EPC level could be considered reliable only after the Legislative Decree n.28/2011 regulations, the impact of energy performance of buildings on house prices can be observed starting from 2012.

In order to analyse the first effects of the recent statutory provisions related to energy performance of buildings on the Italian residential real estate market, the present study wants to analyse whether real estate agencies consider the EPC level just as a mandatory requirement or as a significant aspect able to influence the house price. Since the EPC level is the only property characteristic whose publication on advertisements is mandatory by law, we decided to measure its impact on listing prices, considering apartments put up for sale in 2012 on real estate advertisements websites.

It is assumed that the listing behaviour can play a primary role in the Italian real estate market framework, because in Italy transaction prices are not easily usable because of the difficult procedures to assess and collect data from deeds of sale. Furthermore, it must be taken into account that in Italy market analysis must face the issue of transparency: the lack of transparency limits analysis and makes it difficult to obtain statistically significant samples of effective sale prices. For this reason analysis must use listing prices with all the limitations that these represent (Curto *et al.*, 2012).

Since listing prices and apartments characteristics are the initial, fundamental information that sellers and buyers (and analysts) can take in consideration during a first preliminary analysis, real estate advertisements can be considered the first step of a house transaction (Robertson and Doig, 2010; Semeraro and Fregonara, 2013).

When putting an apartment up for sale, real estate agencies publish information deemed relevant to potential sellers on web advertisements by emphasizing some characteristics while omitting some others. Therefore it is interesting to understand their perception on EPC level and its potential influence on listing prices.

So the aim of this study is to investigate the economic effects of the recent statutory provisions related to energy performance of buildings on listing behaviour in the Italian residential real estate market, focusing on the Turin real estate market as a case study.

With this aim, the study performed an hedonic analysis explaining listing prices in advertisements, by using EPC levels and house characteristics as regressors, in order to measure the impact of EPC level on listing prices and its relationship with the other house characteristics promoted by real estate agencies on real estate advertisements websites.

Furthermore this paper wants to offer one of the first systematic evidence about the energy certifications in the housing listing prices, contributing to the early limited literature on implication of EPC levels in Italian housing market (Fabbri *et al.*, 2011), which has thus far addressed the existing buildings (Magrini *et al.*, 2012) and calculation methodologies for energy classification (Ballarini and Corrado, 2009; Tronchin and Fabbri, 2010; Tronchin and Fabbri, 2012).

Although several international studies are recently focusing on the impact of energy performance of buildings on house prices, in Italy the research on that topic seems rather new.

The article is structured in the following sections: Section 2 describes the scientific background regarding the impact of EPC levels on house listing prices; Section 3 presents the methodology; Section 4 presents data used for the application; Section 5 presents the descriptive statistics and Section 6 illustrates the results; finally, Section 7 concludes.

2. The background

In the last decade, several studies investigated the economic effects of Energy Performance Ratings (EPR) on the real estate market. Prices are fundamental elements of market since they provide the information basis for the allocation of resources. Research on price effects is, therefore, central to identifying the effectiveness of energy policy intervention. However, it is clear that the information provision role of energy levels may not be operating as expected (Fuerst and McAllister, 2011c).

To our knowledge, the real estate literature on EPR is mainly addressed to demonstrate the impact on market value and rent value, leaving out important features of purchasing process such as the impact on listing price (Horowitz, 1992)

and the role of energy labels in real estate advertisements. Aune (Aune, 2012) analyses the visibility of energy on web housing advertisements and provides insight into the challenges of energy performance visible in the marketing process. Aune analyses that energy is only visible as comfort and convenience and are omitted as calculation possibilities.

Several researches argue that buildings with higher energy performance improve buildings' attractiveness for occupiers and decrease risk for investors (Eichholtz *et al.*, 2010; Brounen and Kok, 2011); in the meanwhile, several empirical researches finds no evidence of a significant relationship between energy performance and capital value, and, furthermore, that energy level is not yet having the effects on market value and rent value that would be expected (Fuerst and McAllister, 2011c).

Further, to our knowledge, the empirical literature on impact of energy level is mainly addressed in the commercial property market; generally speaking it is possible to observe a lack of interest on Italian property market as far as concern the residential sector -which represents the focus of this paper -. Note that the effective impact of energy level on the market is different by Country.

For example, regarding energy effects on U.S. commercial real estate, a number of studies have looked at the effect of Energy Star level and LEED certificate[1] on the sale prices of office buildings (Wiley *et al.*, 2010; Pivo, 2010), and rental premium of office buildings (Reichardt *et al.*, 2012). These studies tested that the presence of an high energy level has a significantly positive effect on both rental rates and sale prices of commercial office buildings. Fuerst and McAllister (Fuerst and McAllister, 2011b) suggests that office buildings with Energy Star and LEED produces an additive effect with rental premium (9%) lower than sale price premium (28-29%), and also there is a rental premium of 5% for LEED certification and 4% for Energy Star certification for U.S. commercial assets; there is price premium of 25% for LEED-certified buildings and 26% for Energy Star (Fuerst and McAllister, 2011a).

Recent evidence shows that the US energy levels are effective as a marketing device in commercial real estate. When it comes to Europe real estate, evidence on the evaluation of energy levels is various.

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[1] LEED® - Leadership in Energy and Environmental Design - is a registered trade mark and a brand name. It's part of a keen commercial mindset at USGBC, who have attracted over 6,500 paying members bringing in over $24 million a year.
The USGBC, says that LEED was created to:
- define "green building" by establishing a common standard of measurement;
- promote integrated, whole-building design practices;
- recognize environmental leadership in the building industry;
- stimulate green competition;
- raise consumer awareness of green building benefits;
- transform the building market.

(For more details see http://www.usgbc.org and http://www.gbcitalia.org/page/show/leed-leadership-in-energy-and-environmental-design).

For Europe, several studies provide that buildings designated as "inefficient" have rental levels and translation prices lower as compared to energy efficient buildings.

Rents and prices of office properties with "green" levels and "non-green" levels are compared and analysed by advice and consulting companies, like for example Troostwijk Real Estate (https://www.troostwijkauctions.com/uk/commercial-real-estate/92-393/), which often highlight a positive relation between energy efficiency and value.

Eichholtz *et al.* (Eichholtz *et al.*, 2010) shows that buildings with an Energy Star level (indicating that a building belongs to the top 25 percent of the most energy-efficient buildings) have rents that are two to three percent higher as compared to regular office buildings. Transaction prices for energy-efficient office buildings are higher by 13-16%.

Kok and Jennen (Kok and Jennen, 2012) provides that buildings with an EU energy performance certificate "D" or worse have rental levels 6.5 percent lower as compared to energy efficient buildings with energy level "A", "B" or "C".

Furthermore a real estate report made in 2012 by an important Dutch company (DTZ Zadelhoff of the international DTZ group) shows how energy levels are positively correlated with buildings value, considering an appraisal of 150 offices in the Netherlands.

In contrast, for commercial real estate Fuerst and McAllister (Fuerst and McAllister, 2011c) tests a UK subset of BREEAM-rated[2] assets for significant price effects but a statistical significant effect is only confirmed for equivalent yields; furthermore, there is no evidence the EPC level had any effect on market rent and market value with only minor effects of EPC level on equivalent yields. Rodrigues *et al.* (Rodrigues *et al.*, 2012) shows that in the UK commercial market there is a little or no premium being paid for energy efficient buildings. Regarding eco-classing effects on residential real estate, for the Netherlands Brounen and Kok (Brounen and Kok, 2011) analyzes the relationship between EPC level and sale price for 18.190 residential sale prices compared to apartments rated G; it is estimated a

[2] BREEAM stands for the BRE Environmental Assessment Method, and was invented by BRE, a building research organization funded mainly by the government. Based in the UK this organization seeks to provide relevant research and information to the building industry, about what kind of methods would best support environmental protection and sustainable development. According to the BREEAM website (www.breeam.org), 'BREEAM assesses the performance of buildings in the following areas:
Management: overall management policy, commissioning site management and procedural issues.
Energy use: operational energy and carbon dioxide (CO2) issues.
Health and well-being: indoor and external issues affecting health and well-being.
Pollution: air and water pollution issues.
Transport: transport-related CO2 and location-related factors.
Land use: greenfield and brownfield sites.
Ecology: ecological value conservation and enhancement of the site.
Materials: environmental implication of building materials, including life-cycle impacts.
Water: consumption and water efficiency.

premium of 12%, 7% and 4% for A, B and C, respectively.

In contrast, several studies suggest that people not yet show willingness to pay more rent or value for energy efficient buildings. For Germany, Amecke (Amecke, 2012) analyses in how far EPCs have helped purchasing of owner-occupied apartments in Germany to incorporate energy efficiency in their purchasing decisions and finds that the effectiveness of EPCs is limited.

For UK, Rodrigues *et al.* (Rodrigues *et al.*, 2012) shows that in the UK residential market there is an apparent premium being paid by willing buyers. It might be caused by the level of education and awareness of buyers or because of enthusiastic to be part of a "green movement"; otherwise, it might be linked to the house owners capacity to directly transmit the benefits in their pockets.

By analyzing the Italian context, recent studies present verification and control systems on the EPC developed at regional level, in order to check the compilation of the buildings' energy certificates and to analyze the most frequent incoherencies connected with them (Marinosci and Morini, 2014).

Furthermore Morri and Soffietti (Morri and Soffietti 2013) present the results of a web-based survey conducted on a sample of more than 2.400 people among real estate operators. One of the most interesting outputs is that in Italy the multinational corporations prefer to buy or to rent buildings certified as "energy efficient": more than the 88% of the sample affirms to consider the LEED certification an important tool able to guarantee buildings sustainability and, as a consequence, the real estate investments. In contrast, according to the evidence from the everyday experience of the Turin Real Estate Market Observatory, agents' perception of the importance of EPC level in selling a house is rather weak.

3. The methodology

The study focuses on the agents' perception of the EPC level contribution to price. Since the EPC level is the only property characteristic whose publication on advertisements is mandatory by law, its publication on web advertisements is not a sign of their perception that high EPC levels could attract buyers or influence a house value. As a consequence in order to measure whether and how much agents take EPC level into account in selling a house, we use a traditional hedonic approach to assess the EPC level contribution on listing price. We include in the hedonic model the main characteristics published in web advertisements, which are used from sellers to attract potential buyers. Before introducing the hedonic regression model we spend some words on the listing behaviour of agents in Italy. Real estate agents estimate the property value and agree with the seller to define the list price. Afterwards, the seller commits to sell the property at the established price. Agents place a public advertisements, where the property is described, and some of its characteristics are listed.

The house attributes included in our analysis concerns location, building structural characteristics and apartment characteristics that can be deduced by web advertisements.

In order to measure the explanatory power of EPC level, we explained listing prices using only the EPC levels and computed the coefficient of determination. Further, we perform two standard regression analysis. Firstly, we specify the following log-linear regression model (1):

$$\log LP = \alpha + \beta x + \varepsilon \quad (1)$$

where log LP is the logarithm of the listing price, x is a vector of house characteristics published on web advertisements, α is the intercept, β is the vector of the characteristics coefficients.

Secondly, we explained LP using the vector x of house characteristics in equation (2), including the EPC level variable, in that:

$$\log LP = \alpha + \beta x + \gamma EPC + \varepsilon \quad (2)$$

Where -as above- log LP is the logarithm of the listing price, x is a vector of house characteristics published on web advertisements, α is the intercept, β is the vector of the characteristics coefficients and γ is the EPC level coefficient

By comparison between the fit of the two models, we measure the EPC level contribution to explain listing price variation. As usual, we used dummy variables to specify nominal and ordinal characteristics levels, included EPC levels.

Summing up, the two steps of analysis performed identify the characteristics taken into account by the agents in listing price and isolate the EPC level effects on listing prices.

4. Data

We focus on the Turin real estate market as a case study. To perform empirical analysis, we based the study on a sample of 577 property listings, published in 2012 on one of the main Italian real estate advertisements websites. The sample belongs to a database property of the Turin Real Estate Market Observatory (TREMO). TREMO was founded in 2000 to collect real estate data and to analyse the Turin real estate market, according to an agreement among the Politecnico di Torino, the Turin Municipality and the Chamber of Commerce of the Province of Turin (Curto and Fregonara, 2002).

Advertisements are marketing tools which convey a small part of the total characteristics of an apartment placed on the market. Although information released on advertisements can vary, there are some basic characteristics which are commonly published. Inquired characteristics for this study are always used by real estate agencies to place an apartment on sale.

For each sampled apartment put up for sale we collected the following characteristics:

- Listing Price (LP), measured in Euro per square meter ;
- Energy Performance Certificate (EPC) level: the EPC levels are the following

7: "A", "B", "C", "D", "E", "F" and "G", where "A" is the highest and "G" is the lowest;
- Size, measured as marketable square metres;
- Apartment condition, measured by means of 4 levels ("to be completely renovated", "to be partially renovated", "good" and "refurbished");[3]
- Building quality, measured by means of 5 levels ("council housing", "economical", "medium-level", "distinguished" and "classy");[4]
- Location, i.e. the Microzone.

Since a deep analysis of the spatial component of prices is out of the aim of the present work, we choose to use a geographical segmentation based on 40 market areas, called Turin City Cadastral Microzones (Microzone Catastali della Città di Torino), defined according to the Italian DPR 138/98 and the Regulation issued by the Ministry of Finance (Figure 1). These market areas are homogeneous market-wise but different in size and density. The geographical segmentation in Microzones is public and each area is described in the TREMO web site, which also include the main price indices for each area. For this reason Microzones seem to be a reasonable benchmark for both sellers and buyers. The choice to model location using geographical areas is in line with recent research, see e.g. Bourassa *et al.* (2007), Bourassa *et al.* (2008) and Fregonara *et al.* (2012).

5. Descriptive statistics

In Table 1 listing prices descriptive statistics are summarized and sorted by variables: Listing Price (LP), Size, Apartment condition, Buildings quality level, EPC level. It is important to underline that, before calculating the following descriptive statistics, some wrong or uncompleted data have been deleted from the initial sample of 577 advertisements.

By analyzing the descriptive statistics in Table 1 it is interesting to notice that the mean listing price is 298235.50€ and the mean size of 101.62m^2. Notice that most frequent apartment condition is the level "good" (45%), while the most frequent quality level of buildings is "medium" (54%).

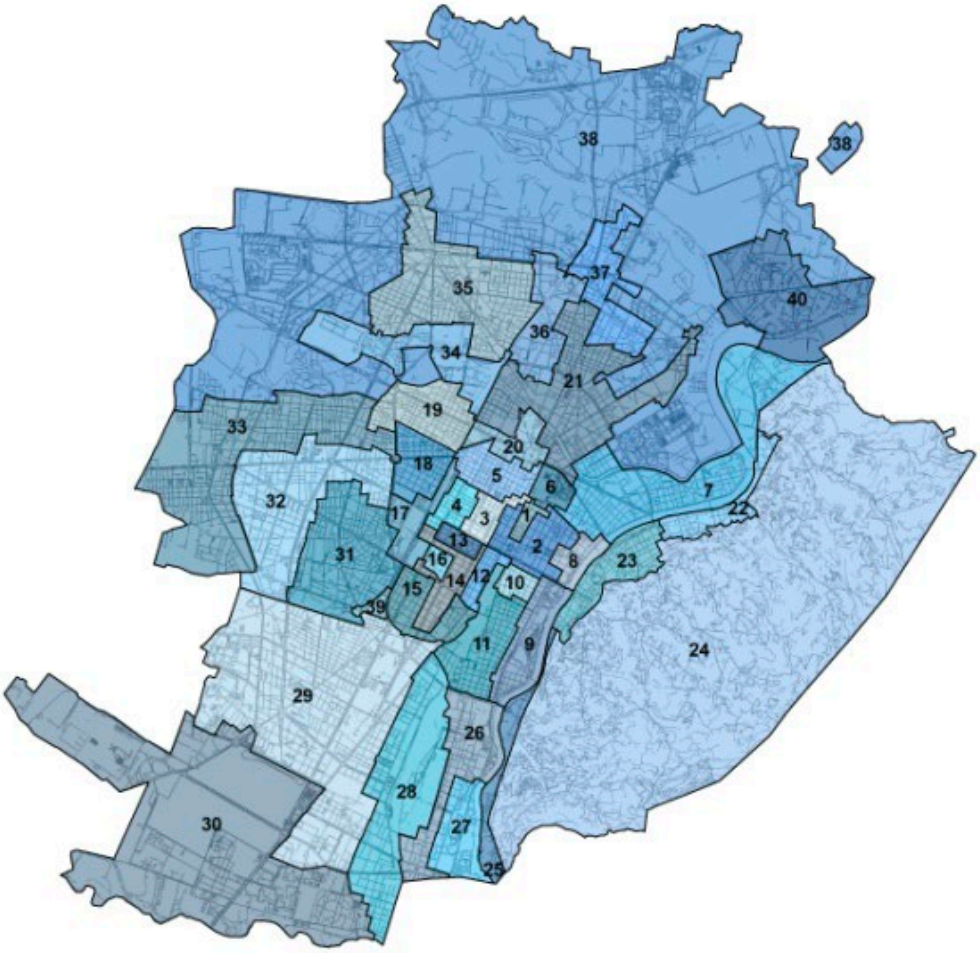
A first descriptive analysis of data justify the further investigation developed in the sequel. In fact, the mean listing price decreases in accordance with the EPC levels (Table 2).

It is however interesting to notice that the mean listing price related to the lowest level "G" is higher than the one related to the level "F". This fact is expected since the Ministerial states that the owners can self-certificate that their apart-

[3] The condition levels of single apartments have been defined based on the descriptions found in advertisements.

[4] Building quality levels are defined by TREMO according to their cadastral classification which considers several building characteristics, such as building materials and the age of the building.

Figure 1. The 40 Turin City Cadastral Microzones.



Source: Turin Real Estate Market Observatory (TREMO)

ments can be assigned to the lowest EPC level "G", even if it has not been calculated. This represents an important factor to take into account during the analysis of the results related to the EPC level "G", which are to be considered not totally representative.

It is worthwhile to cite that that none apartment presents the highest EPC level "A" and a large number of advertisement (NA=18%) do not provide EPC, although it is a mandatory requirement.

Table 3 provides for the dataset separately for energy efficient assets with energy level listed by sellers as "B" or "C" levels, for less efficient assets with energy level listed as "D" or "E" levels and for the lower efficient assets listed as "F" or

Table 1. Listing Prices descriptive Statistics.

Variable	Mean	St.Dev.	Levels	Freq.
Listing price (LP)	298235.50	257621.60		
Size	101.62	51.97		
Apartment condition			to be completely renovated	0.07
			to be partially renovated	0.26
			good	0.45
			refurbished	0.21
Buildings quality level			council housing	0.04
			economical	0.19
			medium-level	0.54
			distinguished	0.12
			classy	0.03
Energy Performance Certificate (EPC) level			A	0.00
			B	0.02
			C	0.08
			D	0.15
			E	0.12
			F	0.11
			G	0.34
			NA	0.18

Source: authors' own work.

"G" levels. By analyzing the mean listing prices related to the three energy level clusters, it is possible to highlight an around 300 €/m^2 difference between the "B-C EPC levels" cluster and the "D-E EPC levels" one, as well as an around 200 €/ m^2 difference between the "D-E EPC levels" cluster and the "F-G EPC levels" one.

6. Results

Before performing the hedonic analysis, we investigate the relation between EPC level and the characteristics: Location (Microzone), Buildings quality, Apartment condition.

To test the independence between the energy level and Location (Microzone), Buildings quality, Apartment condition, we performed a chi-square test. The results, provided in Table 4, show that the chi-square test does not reject independence between the EPC levels and the considered housing characteristics. As a con-

Table 2 – Listing Prices descriptive statistics: energy level subsamples.

EPC Level	Listing Price per square meter				
	Frequency	Mean	Stan dev	Min	Max
A	0.00	-	-	-	-
B	0.02	3195.96	771.81	2187.5	4259.26
C	0.08	2944.65	1091.78	1362.73	5588.23
D	0.15	2778.32	1295.68	1000.00	8695.65
E	0.12	2604.23	1235.09	947.37	6531.25
F	0.11	2235.08	870.54	1061.54	4967.74
G	0.34	2574.06	1141.12	916.67	7000.00
NA	0.18	-	-	-	-

Source: authors' own work.

Table 3. Listing Price descriptive statistics: energy level subsamples grouped in three clusters.

EPC level	Listing Price per square meter				
	Frequency	Mean	Stan dev	Min	Max
B-C	0.10	2997.34	1032.36	1362.73	5588.23
D-E	0.27	2699.09	1267.38	947.37	8695.65
F-G	0.45	2491.28	1088.82	916.67	7000.00

Source: authors' own work.

sequence, the EPC level does not result to be associated to the building quality or to the apartment condition. In that we do not evidence a relationship with high level houses and high level of energy performance. The influence of EPC on prices is measured by the regression analysis provided in Table 5, where the EPC levels explain the log listing price.

The explanatory power of the EPC level is measured by the coefficient of determination $R^2 = 0.03$. The coefficient is significant and indicates a weak relationship between EPC and prices: the EPC level do not explain listing price variations. Notice that for each regression performed here the coefficients sign of each dummy variable is dependent upon which level is omitted.

We now perform the hedonic analysis including the characteristics listed in Table 1, excluding the EPC level in the set of explanatory variables. The model explains just over 75% of listing price variation (Table 6). In that, location, quality of the building and state of the apartment explain most of listing prices. Nevertheless, this results indicates the possible presence of unobservable factors, i.e. characteristics not described in advertisements, which contribute to listing price. Notice that almost all the regression coefficients are significant, indicating that

Table 4. Chi-square test results.

	EPC level
Location (Microzone)	X-squared = 10.30, df = 5, p-value = 0.07
Buildings quality	X-squared = 4.17, df = 5, p-value = 0.53
Apartment condition	X-squared = 2.52, df = 5, p-value = 0.77

Source: authors' own work.

Table 5. The explanatory power of the EPC level.

Residuals:
Min 1Q Median 3Q Max
-0.946274 -0.300495 -0.003115 0.291018 1.229920

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	80.41	0.80	70.22	< 2e-16	***
B			*Omitted*		
C	-0.12	0.89	-0.98	0.33	
D	-0.20	0.85	-1.60	0.10	
E	-0.27	0.86	-2.17	0.03	*
F	-0.40	0.87	-3.23	0.00	**
G	-0.27	0.82	-2.32	0.02	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.41 on 497 degrees of freedom
Multiple R-squared: 0.04, **Adjusted R-squared: 0.03**
F-statistic: 4.16 on 5 and 497 DF, p-value: 0.00

Source: authors' own work.

all the characteristics considered have a significant impact on listing price, in that they are considered by agents important factors in selling a house. Also notice that the omitted Microzone is a central one, explaining the fact that most of the coefficients are negative.

Since the EPC is not associated with quality of the building, apartment condition and Microzone, we perform the regression including the EPC level, to measure the contribution of EPC to explain the model price variability. Table 7 provide the results of the regression performed including EPC level in the set of explanatory variables. The explanatory power of the model is Adjusted R^2=0.76, showing that to include the EPC levels does not improve the fit of the model (the Adjusted R^2 increase is only 0.01). Furthermore, if we consider each EPC level coefficient we notice that only level F is significant. By considering that level G is not reliable since it includes property whose level has not been assigned the level F is the low-

Table 6. Hedonic regression results (Model 1, excluding the EPC level in the set of explanatory variables).

Residuals					
	Min	1Q	Median	3Q	Max
	-0.84666	-0.11911	0.00676	0.12933	0.53547
	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	785.08	0.06	133.75	< 2e-16	***
Microzone 1	0.19	0.12	1.66	0.1	.
Microzone 2		*Omitted*			
Microzone 3	0.13	0.08	1.55	0.12	
Microzone 4	0.07	0.08	0.58	0.4	
Microzone 5	-0.02	0.07	-0.22	0.82	
Microzone 6	0.26	0.11	2.32	0.02	*
Microzone 7	-0.14	0.06	-2.22	0.03	*
Microzone 8	0.01	0.08	0.11	0.87	
Microzone 9	-0.11	0.08	-1.38	0.17	
Microzone 10	-0.22	0.08	-2.87	0	**
Microzone 11	-0.32	0.07	-4.92	1.17E-06	***
Microzone 12	-0.12	0.07	-1.65	0.1	.
Microzone 14	0.04	0.07	0.42	0.55	
Microzone 15	-0.08	0.07	-1.13	0.26	
Microzone 16	0.4	0.12	3.45	0	***
Microzone 17	-0.1	0.1	-1.06	0.29	
Microzone 18	-0.27	0.08	-2.73	0	**
Microzone 19	-0.45	0.07	-6.47	2.18E-10	***
Microzone 20	-0.51	0.07	-7.08	4.54E-12	***
Microzone 21	-0.8	0.06	-13.37	< 2e-16	***
Microzone 22	-0.19	0.08	-2.43	0.01	*
Microzone 23	0.15	0.07	2.13	0.03	*
Microzone 24	-0.06	0.06	-1.04	0.3	
Microzone 25	-0.17	0.09	-1.99	0.05	*
Microzone 26	-0.45	0.07	-6.74	4.25E-11	***
Microzone 27	-0.41	0.08	-4.87	1.44E-06	***
Microzone 28	-0.54	0.08	-6.64	8.01E-11	***
Microzone 29	-0.36	0.06	-6.38	3.78E-10	***
Microzone 30	-0.49	0.07	-6.66	6.82E-11	***

	Estimate	Std. Error	t value	Pr(>|t|)	
Microzone 31	-0.41	0.07	-6	3.65E-09	***
Microzone 32	-0.31	0.06	-4.95	1.02E-06	***
Microzone 33	-0.44	0.07	-6.25	8.29E-10	***
Microzone 34	-0.52	0.08	-6.64	7.80E-11	***
Microzone 35	-0.65	0.06	-10.56	< 2e-16	***
Microzone 36	-0.82	0.08	-10.26	< 2e-16	***
Microzone 37	-0.64	0.07	-9.25	< 2e-16	***
Microzone 38	-0.67	0.07	-9.61	< 2e-16	***
Microzone 39	-0.11	0.09	-1.17	0.24	
Microzone 40	-0.59	0.08	-7.59	1.51E-13	***
to be completely renovated		*Omitted*			
to be partially renovated	0.07	0.04	1.81	0.07	.
good	0.17	0.04	4.67	3.73E-06	***
refurbished	0.28	0.04	7.25	1.45E-12	***
council housing	-0.08	0.05	-1.5	0.13	
economical		*Omitted*			
medium-level	0.11	0.02	4.46	1.01E-05	***
distinguished	0.25	0.03	7.17	2.59E-12	***
classy	0.46	0.07	6.2	1.15E-09	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.20 on 527 degrees of freedom
Multiple R-squared: 0.77, **Adjusted R-squared: 0.75**
F-statistic: 39.33 on 45 and 527 DF, p-value: < 2.2e-16

Source: authors' own work.

est level that could be taken into consideration. This facts lead to the conclusion that the market only distinguish medium-high levels and low levels of EPC, since to have a significant contribution to listing price we have to move from level B to level F.

We decided to investigate whether grouping EPC levels we are able to quantify the impact on price of high, medium and low EPC levels. Therefore we performed a regression analysis where EPC levels are grouped as follows: B-C, D-E, F-G. The results are provided in Table 8 and confirm the results of Table 7, the only significant contribution on prices is exhibited, by moving from high levels (BC) to low levels (FG)

Table 7. Hedonic regression results (Model 2, including the EPC level in the set of explanatory variables).

Residuals					
	Min	1Q	Median	3Q	Max
	-0.83419	-0.12765	0.00482	0.12453	0.52496
	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	79620.42	0.09	85.18	< 2e-16	***
Microzone 1	0.22	0.13	1.71	0.09	.
Microzone 2	*Omitted*				
Microzone 3	0.12	0.09	1.23	0.22	
Microzone 4	0.02	0.09	0.17	0.8	
Microzone 5	0	0.09	0	0.1	
Microzone 6	0.26	0.12	2.21	0.03	*
Microzone 7	-0.14	0.07	-1.91	0.06	.
Microzone 8	0.01	0.08	0.1	0.88	
Microzone 9	-0.08	0.09	-0.8	0.42	
Microzone 10	-0.24	0.08	-2.85	0	**
Microzone 11	-0.35	0.07	-4.84	1.79E-06	***
Microzone 12	-0.13	0.09	-1.39	0.17	
Microzone 14	0.02	0.08	0,13	0.85	
Microzone 15	-0.06	0.09	-0.59	0.56	
Microzone 16	0.38	0.12	3.04	0	**
Microzone 17	-0.17	0.13	-1.33	0.18	
Microzone 18	-0.17	0.1	-1.77	0.08	.
Microzone 19	-0.5	0.08	-6.42	3.55E-10	***
Microzone 20	-0.53	0.08	-6.33	6.22E-10	***
Microzone 21	-0.87	0.07	-12.9	< 2e-16	***
Microzone 22	-0.24	0.1	-2.5	0.01	*
Microzone 23	0.15	0.08	1.82	0.07	.
Microzone 24	-0.1	0.07	-1.38	0.17	
Microzone 25	-0.18	0.1	-1.85	0.07	.
Microzone 26	-0.46	0.07	-6.39	4.30E-10	***
Microzone 27	-0.51	0.1	-5.09	5.24E-07	***
Microzone 28	-0.56	0.09	-6.61	1.15E-10	***
Microzone 29	-0.38	0.06	-6.07	2.89E-09	***
Microzone 30	-0.5	0.08	-6.36	5.35E-10	***

	Estimate	Std. Error	t value	Pr(>|t|)	
Microzone 31	-0.41	0.08	-5.43	9.60E-08	***
Microzone 32	-0.32	0.07	-4.62	5.01E-06	***
Microzone 33	-0.45	0.07	-6.04	3.40E-09	***
Microzone 34	-0.55	0.08	-6.64	9.51E-11	***
Microzone 35	-0.66	0.07	-9.89	< 2e-16	***
Microzone 36	-0.85	0.08	-10.07	< 2e-16	***
Microzone 37	-0.69	0.08	-8.88	< 2e-16	***
Microzone 38	-0.69	0.07	-9.19	< 2e-16	***
Microzone 39	-0.19	0.11	-1.73	0.08	.
Microzone 40	-0.65	0.09	-7.41	6.85E-13	***
to be completely renovated		*Omitted*			
to be partially renovated	0.08	0.04	1.76	0.08	.
good	0.16	0.04	3.98	8.09E-05	***
refurbished	0.26	0.05	5.78	1.48E-08	***
council housing	-0.06	0.06	-0.95	0.34	
economical		*Omitted*			
medium-level	0.1	0.03	3.74	0	***
distinguished	0.24	0.04	6.05	3.21E-09	***
classy	0.49	0.08	5.85	9.77E-09	***
B		*Omitted*			
C	-0.03	0.07	-0.41	0.68	
D	-0.1	0.067	-1.42	0.15	
E	-0.06	0.07	-0.92	0.36	
F	-0.14	0.07	-2.01	0.04	*
G	-0.1	0.07	-1.45	0.15	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.21 on 426 degrees of freedom
Multiple R-squared: 0.79, **Adjusted R-squared: 0.76**
F-statistic: 31.24 on 50 and 426 DF, p-value: < 2.2e-16

Source: authors' own work.

7. Conclusion

The European Directives 2002/91/EC and 2010/31/EU, adopted by Member States at national and regional level, turned the attention towards energy performance of buildings and Energy Performance Certificate (EPC).

Table 8. Hedonic regression results (Model 2, including the EPC level in the set of explanatory variables) – with EPC levels grouped in three clusters.

Residuals					
	Min	1Q	Median	3Q	Max
	-0.82932	-0.12475	0.00498	0.12349	0.53022
	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	7.95	0.07	106.31	< 2e-16	***
Microzone 1		*Omitted*			
Microzone 2		*Omitted*			
Microzone 3	0.11	0.09	1.15	0.25	
Microzone 4	0.02	0.09	0.24	0.81	
Microzone 5	-0.02	0.09	-0.22	0.82	
Microzone 6	0.25	0.12	2.16	0.03	*
Microzone 7	-0.14	0.07	-1.96	0.05	.
Microzone 8	0	0.08	0.02	0.99	
Microzone 9	-0.09	0.09	-0.91	0.36	
Microzone 10	-0.25	0.08	-2.96	0	**
Microzone 11	-0.36	0.07	-4.93	1.15E-06	***
Microzone 12	-0.13	0.09	-1.38	0.17	
Microzone 14	0.01	0.08	0.13	0.89	
Microzone 15	-0.07	0.09	-0.73	0.46	
Microzone 16	0.36	0.12	2.94	0	**
Microzone 17	-0.18	0.13	-1.36	0.17	
Microzone 18	-0.18	0.1	-1.8	0.07	.
Microzone 19	-0.51	0.08	-6.62	1.09E-10	***
Microzone 20	-0.54	0.08	-6.5	2.27E-10	***
Microzone 21	-0.88	0.07	-13.09	< 2e-16	***
Microzone 22	-0.25	0.09	-2.63	0	**
Microzone 23	0.14	0.08	1.69	0.09	.
Microzone 24	-0.11	0.07	-1.63	0.1	
Microzone 25	-0.2	0.1	-1.97	0.05	*
Microzone 26	-0.47	0.07	-6.48	2.57E-10	***
Microzone 27	-0.52	0.1	-5.16	3.70E-07	***
Microzone 28	-0.57	0.08	-6.73	5.33E-11	***
Microzone 29	-0.39	0.06	-6.29	7.60E-10	***
Microzone 30	-0.51	0.08	-6.68	7.37E-11	***

	Estimate	Std. Error	t value	Pr(>|t|)	
Microzone 31	-0.43	0.08	-5.71	2.07E-08	***
Microzone 32	-0.33	0.07	-4.88	1.52E-06	***
Microzone 33	-0.46	0.07	-6.19	1.38E-09	***
Microzone 34	-0.55	0.08	-6.66	8.43E-11	***
Microzone 35	-0.67	0.07	-10.05	< 2e-16	***
Microzone 36	-0.84	0.08	-10.09	< 2e-16	***
Microzone 37	-0.7	0.08	-9.1	< 2e-16	***
Microzone 38	-0.7	0.07	-9.42	< 2e-16	***
Microzone 39	-0.19	0.11	-1.78	0.08	.
Microzone 40	-0.66	0.09	-7.6	1.86E-13	***
to be completely renovated	0.21	0.13	1.63	0.1	
to be partially renovated	0.07	0.04	1.75	0.08	.
good	0.16	0.04	3.9	0	***
refurbished	0.26	0.04	5.66	2.72E-08	***
medium-level	0.1	0.03	3.77	0	***
council housing	-0.05	0.06	-0.91	0.36	
classy	0.49	0.08	5.91	6.82E-09	***
distinguished	0.24	0.04	6.08	2.61E-09	***
BC		*Omitted*			
DE	-0.06	0.03	-1.77	0.08	.
FG	-0.09	0.03	-2.65	0.01	**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.21 on 429 degrees of freedom
Multiple R-squared: 0.78, **Adjusted R-squared: 0.76**
F-statistic: 33.16 on 47 and 429 DF, p-value: < 2.2e-16

Source: authors' own work.

In order to investigate the economic effects of the recent Italian statutory provisions related to energy performance of buildings on listing behaviour in the Italian residential real estate market, this study presents an hedonic regression analysis, performed with the aim of measuring the impact of EPC level on listing prices and its relationship with the other house characteristics.

The study is based on a sample of 577 housing property asset sited in the city of Turin, put up for sale in 2012 and promoted on real estate advertisements websites.

By analysing the sample's descriptive statistics first of all it is significant that none apartment presents the highest EPC level "A" and a large number of advertisement (18% of the sample) do not provide EPC, although it is a mandatory requirement.

Confirming the authors' expectations the mean listing price related to apartments with an high EPC level (EPC = "B" or "C") is little higher than the mean listing price related to less energy efficient apartments (EPC < "C").

After having tested that there is not dependence relationship between qualitative variables (Location, buildings quality and apartment condition), two hedonic regression analysis have been performed.

The Model 1, finalized to analyze the relation between listing price and house characteristics published on web advertisements, highlights that all the considered characteristics have a significant impact on listing price, finding evidence of the fact that house characteristics are considered by agents important factors in selling a house.

Afterwards, in addition to the house characteristics published on web advertisements, the EPC level has been considered and included in Model 2, in order to measure the EPC level contribution to explain listing price variation. By comparing the results of the two models, the EPC level effects on listing prices have been isolated: considering each EPC level coefficient we noticed that only level "F" is significant. This result has been also confirmed by a third regression analysis performed where EPC levels were grouped in three clusters ("B-C", "D-E", "F-G").

The study finds evidence of a strong relationship between energy level and listing price only for "F" energy level, drawing attention to the "G" level that could not be taken into consideration since not representative.

Some final considerations are proposed in order to clarify possible causes related to the weak relationship between listing price and high energy levels. The preliminary evidences are that the energy level is not yet taken into account by real estate agency in listing prices and this fact can be explained by a twofold reason.

Firstly the low attention to the EPC level by real estate agents reveals e weak interest from the apartments potential buyers and final users, which seem not yet aware that to make an higher initial investment in a property characterized by a high energy level means future lower maintenance costs.

On the other hand, since the apartments energy level seems not to have a direct influence on listing prices, the owners could be not incentivized to invest in refurbishment actions. This socio-economic framework stresses a real estate market not yet able to reward investments towards new innovative technological solutions finalized to improve the buildings energy consumption (Fregonara, 2012).

Nevertheless it is possible to identify some weak signals regarding its role in next the years, when the real estate market dynamics will support the actual policies and regulations directions.

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