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The energy efficiency price premium of residential buildings in three Italian regions

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The aim of this paper is to investigate the impact of higher energy efficiency of residential buildings on market prices in Italy. We employ novel, and almost unexploited, data on Energy Performance Certificates of three Italian regions (Emilia-Romagna, Lombardy and Piedmont) and merge them with house prices and socio-economic variables at various aggregation levels. The relationship between house prices and energy efficiency is estimated by means of hedonic regression models, quantile regressions and fixed effects panel data models. Our results reveal the existence of an energy-efficiency price premium in the three regions, with significant differences among them. Heterogeneity is also detected along the price distribution, at least for Lombardy and Piedmont. Finally, relevant variables showing a positive association with price are more recent construction years, higher mobility in the housing market and higher income within municipalities.

Keywords: Energy Performance Certificates; Energy Performance of Buildings Directive; House prices; Hedonic regression; Quantile regression; Fixed effects panel data models.

JEL classification: Q40; C21; C23.

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1. Introduction

Energy efficiency is expected to reduce energy consumption and is therefore central to achieving the European Union's (EU) energy and climate goals, at the same time enhancing energy affordability (Pagliuca et al., 2022; Ge, 2023). As reported by the European Commission (EC), "by using energy more efficiently, and thereby consuming less, Europeans can lower their energy bills, help protect the environment, mitigate climate change, improve their quality of life, reduce the EU's reliance on external suppliers of oil and gas and support the sustainable growth of the EU economy".[1] To benefit from these gains, energy efficiency needs to be improved across the entire energy supply chain, from power generation to final consumption (Louis and Pongrácz, 2017; Gatto et al., 2023). As far as final consumption is concerned, data show that there is room for improvement, since buildings are the largest energy consumer in Europe: in 2021, 42% of energy consumed was used in buildings, over one third of energy-related greenhouse gas emissions (GHG) came from buildings and around 80% of the energy used by households was for heating, cooling and hot water.[2]

The Energy Performance of Buildings Directive (EPBD) – first published in 2002 as Directive 2002/91/EC and then recast in 2010 as Directive 2010/31/EU – and the Energy Efficiency Directive (EED) 2012/27/EU compose the legislative framework established by the European Union to boost buildings' energy performance (Li et al., 2019). One of the key requirements of the EPBD was the introduction of the Energy Performance Certificates (EPCs), which provide transparent information on buildings' energy performance. An EPC assigns an energy efficiency label to a dwelling on a scale from G (the least efficient) to A4 (the most efficient) according to its expected energy consumption with respect to heating, lighting and hot water. EPCs were adopted by European countries at different times (Andaloro et al., 2010); in Italy, they have been compulsory since 2007 for new constructions, since 2009 for all buildings for sale, and since 2010 for those to let. In particular, for dwellings for sale or to let, the energy performance label reported in the EPC

1 https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-targets_en#final-2030-target, accessed 18/06/2024.

2 https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en, accessed 18/06/2024.

must be stated in the advertisement, with a view to making prospective buyers and renters able to compare dwellings in terms of their energy usage (Khazal and Sønstebø, 2020).

At the end of 2021, the EC implemented a major recast of the EPBD (commonly referred to as the 'Green buildings' directive), which was revised in December 2023 setting that energy use of residential buildings must be reduced by 16% by 2030 and by 20-22% by 2035 – compared to 2020 levels – and that at least 55% of such reductions must be achieved through the renovation of the worst-performing buildings. To ensure that buildings are fit for the EU's enhanced climate ambition under the European Green Deal, the revised directive will contribute to the objective of reaching emission reductions of at least 60% in the building sector by 2030 compared to 2015 and achieving climate neutrality by 2050.

Italy has embarked on the path to increase buildings' energy efficiency since the 1998 Budget Law that introduced tax credits on housing renovations ('Bonus casa'), extended in 2007 to include energy-efficiency retrofits ('Ecobonus'). In 2020, the government intervened substantially by introducing the 'Superbonus', a 110% tax credit on energy efficiency renovations, provided that the building improved its energy performance by at least two classes. All this resulted in a steady fall in the percentage of residential buildings in the least efficient class (from 37.3% in 2015 to 25.3% in 2023).[3] However, this has come at a huge cost, 150 billion euros so far.

The aim of this paper is to investigate whether a higher energy efficiency of residential buildings translates into higher market prices in Italy. To this end, we employ novel, and almost unexploited, biannual data on Energy Performance Certificates of three Italian regions (Emilia-Romagna, Lombardy and Piedmont) and merge them with house prices by micro area and with a set of local socio-economic characteristics such as income, population density and altitude. The period covered is 2016H1-2022H2, where H1 and H2 indicate the first and the second half of the year, respectively. To estimate the relationship between house prices and energy efficiency, we apply hedonic regression models, quantile regressions as well as panel data models.

Estimation of the energy efficiency/price relationship is of interest for more than one reason. First, higher prices translate into a higher value of households' real wealth, giving an incentive to owners to renovate their properties (Mogensen and Thøgersen, 2024). Second, the potentially positive impacts of increased energy efficiency on prices can partially

[3] https://siape.enea.it/caratteristiche-immobili, accessed 18/06/2024.

compensate for the retrofit costs that households would incur to renovate their homes. Third, concern and attitudes towards environmentally related issues, captured by the willingness to pay higher prices, may have changed over time (Panarello, 2021).

We contribute to the literature by employing EPCs microdata for three Italian regions (Emilia-Romagna, Lombardy and Piedmont), unexploited in the literature, to estimate the energy efficiency price premium in the North of Italy by means of hedonic regression models, quantile regressions and fixed effects panel data models. To this end, we merge EPCs datasets with house prices through geocoding techniques to convert EPCs addresses into geographic coordinates (latitude and longitude) corresponding to those of prices. With our dataset, we can deliver a wider range of analyses at territorial level than the ones provided in the literature for Italy so far, except for Loberto et al. (2023) who cover the whole of Italy but employ privately owned listing data not accessible to the public.

Our results unveil the existence of an energy efficiency price premium in the three analysed regions, with significant differences among them (stronger in Emilia-Romagna than in Lombardy and Piedmont). We also detect heterogeneity along the price distribution, especially in Lombardy and Piedmont. Other relevant variables in explaining the price premium of energy efficiency are more recent construction years, higher mobility within micro areas (captured by a higher share of property transactions, rentals and second homes), population density and higher incomes within municipalities. Finally, fixed effects panel data models show a weaker relationship between the energy efficiency class and house prices.

The findings of this study highlight some policy implications. First, the presence of a significant energy efficiency price premium suggests that market mechanisms may incentivise energy-efficient investments, but this effect is highly variable across regions and price segments. Therefore, regional differentiation in policy design may be necessary to account for the observed local dynamics. Second, accounting for the fact that the most recent EPBD recast set that energy use of residential buildings must be reduced by 2035 and that at least 55% of this reduction must be achieved through the renovation of the worst-performing buildings, it is relevant to know how much residential properties would be valued after renovation, to compensate, at least partially, for the retrofit costs. Third, the heterogeneity in price responses should guide the allocation of public resources and the structuring of financial incentives. Therefore, targeting incentives more effectively – by focusing on regions or price segments with lower responsiveness – could enhance policy efficiency and reduce the fiscal burden. Finally, given that other factors, such as population density and income levels, also significantly affect property values, policymakers may consider integrating energy efficiency policies with urban planning and economic development programmes to maximise their effectiveness.

The paper starts with a review of the literature on the relationship between buildings' energy efficiency and their price (Section 2), followed by descriptive statistics of the data employed in the analysis (Section 3). Then, Section 4 outlines the econometric models used to estimate the energy/price relationship, Section 5 presents the results, and Section 6 concludes with a summary of the main findings and their key implications.

2. Literature review

There is a wealth of literature on the relationship between buildings' energy performance and their prices. The rationale for investigating the topic lies in the idea that increased awareness and concern about climate and energy issues (Gatto et al., 2024) and the recent debate around the EU policy on energy-efficient buildings (von Malmborg et al., 2023) are expected to shift households' preferences towards more sustainable dwellings and to make homebuyers more willing to pay higher prices in exchange of greater energy efficiency.

Possibly the seminal paper investigating the existence of an energy efficiency price premium is the one of Berry et al. (2008), in which house prices are regressed on dwellings' energy ratings for a sample of Australian EPCs and in which greater energy efficiency is found to be associated with higher house values. Brounen and Kok (2011) investigated the issue for a European country, namely the Netherlands that were among the first countries to formally introduce energy labels for residential dwellings, in January 2008: they document that homebuyers are willing to pay a higher price for dwellings with a more energy-efficient label. For the same country, Chegut et al. (2016) examined a dataset of homes sold by Dutch affordable housing institutions between 2008 and 2013, discovering that A-labelled properties were 6.3% more valuable than those with a C label.

Nevertheless, for commercial properties in the UK, Fuerst and McAllister (2011) find no evidence of a significant relationship between energy performance and rental and capital values. Similarly, Olaussen et al. (2017), estimating a hedonic time dummy model and a fixed-effect model on sales price data from Oslo, Norway, find no indication of a price premium for labelled dwellings. The same result is reached by Olaussen et al. (2019). Contrary to the last two studies, Khazal and Sønstebø (2020), employing a hedonic multilevel approach with data from approximately 440,000 rental contracts in the Norwegian residential rental market between 2011 and 2018, demonstrate that labelled dwellings command a premium over non-labelled ones, with the premium increasing with a higher EPC label. Högberg (2013) investigated whether energy performance influences the sale prices of single-family homes in Sweden and whether recommendations for cost-effective energy efficiency improvements affect these prices. Her findings, based on hedonic regression analysis, suggest that superior energy performance positively impacts selling prices, while recommendations about complex energy efficiency measures lead to a price discount. Similarly, Khazal and Sønstebø (2023) find a price premium in Norway, both in the rental and the sales markets, but stress the existence of endogeneity and methodological limitations when assessing the price effects of energy efficiency and the signalling effect of energy labels.

A survey conducted by Amecke (2012) targeted resident owners of existing dwellings in Germany who had acquired their properties after the implementation of the EPC mandate. His findings suggest that energy efficiency held minimal significance as a purchasing criterion. Conversely, factors such as location, pricing, outdoor amenities and the overall condition of the dwelling emerged as relevant factors. Furthermore, the study reveals that energy efficiency fails to rise in importance even when potential buyers are faced with comparable purchasing alternatives. Cajias and Piazolo (2013) examined the impact of energy performance on building values using a panel framework in the German housing market between 2008 and 2010. Their analysis provides evidence that improved energy efficiency positively correlates with increased market value of buildings, even after accounting for regional, geographical and building-specific variables. Kok and Jennen (2012) focused on office rents, conducting an empirical analysis of approximately 1,100 leasing transactions in the Netherlands spanning the 2005–2010 period. Their findings reveal that buildings classified as inefficient (with an EU Energy Performance Certificate of D or worse) experience rental rates approximately 6.5 percent lower compared to energy-efficient buildings of similar characteristics (labelled A, B or C). Feige et al. (2013) discover a positive association between sustainable features and rental prices in Switzerland. Nappi-Choulet and Décamps (2013) explored the influence of energy efficiency on the economic value of buildings within a French corporate real estate portfolio. Employing hedonic methods, they ascertain that energy efficiency is reflected in rental rates, with the relationship varying according to building type. Their findings indicate a stronger premium for energy efficiency in commercial and office buildings compared to industrial ones.

De Ayala et al. (2016) present evidence of a premium in sales prices for higher labelled dwellings compared to lower labelled ones (D or lower) in Spain. Marmolejo-Duarte and Chen (2022), in their analysis of a sample of listed apartments in Barcelona, suggest that EPC ratings exhibit a positive association with prices only when factors such as location, general architectural attributes and basic quality attributes are taken into account. Conversely, when architectural quality is rigorously controlled for, this relationship dissipates. Nonetheless, EPC ratings always show an impact on prices for the higher tier of apartments in central and affluent areas.

When investigating the price/energy efficiency relationship for residential properties in Wales, Fuerst et al. (2013) estimate positive price premia for dwellings in the most efficient classes (A, B and C). Again for Wales, a similar result is obtained by McCord et al. (2020a), with the add-on that EPCs are valued differently along the price distribution and that the effects are asymmetrical: only property prices in the upper end of the price distribution show significant capitalisation effects, and only with regard to the highest energy efficiency scores. In McCord et al. (2020b), the analysis is extended to test for spatial differentials in the Belfast metropolitan area. However, there is no evidence of a positive effect of EPCs on property values when controlling for space. Hyland et al. (2013), Cerin et al. (2014) and Droutsa et al. (2016) also find that the property market values energy performance in Ireland, Sweden and Greece, respectively.

As for international comparisons, Bio Intelligence Service et al. (2013) performed a comparative analysis on Austria, Ireland and some regions of Belgium, France, and the UK, finding that the price (sale or rental) of a dwelling is explained by the EPC score and a series of characteristics, such as size, number of rooms and location, and that energy efficiency is generally capitalised into the price. Charalambides et al. (2019), through a survey spanning 12 European Union countries, reveal that EPCs typically influence the decision-making process for renting or purchasing flats. Most respondents indicated that the energy efficiency rating of their building significantly impacted their choice to buy or rent, with many considering it an important or decisive factor in their decision-making process.

As regards non-European countries, Bloom et al. (2011) compared the prices of energy-efficient and non-energy-efficient homes in Colorado, offering empirical evidence that homebuyers acknowledge the added value of enhanced energy efficiency by paying higher sales prices. Similarly, Kahn and Kok (2014) performed a hedonic pricing analysis on all single-family home sales in California between 2007 and 2012, discovering that green-labelled homes sold at an average 5% price premium compared to similar non-labelled homes, with this effect being more pronounced in warmer areas. Walls et al. (2017) estimate the price premium of certified dwellings in five areas of the USA, finding a positive association between prices and level of energy efficiency in only two of the five areas analysed. Concerning China, Zhang et al. (2017) investigated the impact of the 'Chinese Green Building Label', which has assessed buildings' sustainability performance the country since 2008. Their findings reveal that newly constructed and green-labelled housing projects command a 6.9% price premium over non-labelled ones.

Evidence for Italy is limited, given the scarcity of combined data on EPCs and house prices. Recently, Loberto et al. (2023) worked on granular data of a real-estate portal providing listing prices across the entire country and performed regression analysis to quantify the energy efficiency price premium: their results show that dwellings' listing prices increase along with the energy label, and that for dwellings with the highest energy label the price is 25% higher than the worst energy-performing ones, on average. They also find that the price premium is highly diversified across the country. We are aware of only two other papers dealing with the issue for the Italian case: Fregonara et al. (2017) apply a hedonic price model to the real estate market of the city of Turin and find a very mild impact of energy labels on prices, while Bisello et al. (2020) estimate a price premium of around 6% on moving from the worst to the best energy class for the city of Bolzano and uncover spillover effects to nearby properties.

3. Data and descriptive statistics

To perform the analysis, we employ EPC microdata of the Emilia-Romagna region to which we were granted access and publicly available microdata on EPCs of Lombardy and Piedmont.[4] The original datasets are semi-annual and cover the period 2016H1-2022H2 for Emilia-Romagna, 2015H1-2022H2 for Lombardy and 2015H1-2023H1 for Piedmont (H1

[4] Emilia-Romagna data were provided by Regione Emilia-Romagna under an agreement with the University of Padua within the GRINS (Growing Resilient, INclusive and Sustainable) Partnership. For Lombardy the data are made available by CENED (https://www.cened.it/opendata-cened-2.0), and for Piedmont by Regione Piemonte (https://www.dati.piemonte.it/#/catalogo).

and H2 identify the first half of the year and the second half, respectively). For comparability across regions, we perform our analysis over the period 2016H1-2022H2, for a total of 2,071,790 observations: 558,163 in Emilia-Romagna, 1,118,162 in Lombardy and 395,465 in Piedmont, which represent 21.9%, 20.0% and 14.2% of all residential buildings in each of the three regions, as reported in the 2021 Census.

For our analysis, the most relevant variable provided by the EPCs is the energy class, which ranges between G, the least efficient level, to A4, the most efficient one. The energy class is derived by comparing how well a dwelling/building performs compared to a reference one. The reference dwelling/building has the same geometric characteristics, exposure and location of the housing unit to be certified but with energy performance parameters equivalent to a standard newly constructed building, which would be categorised into class A1. The energy class of each dwelling is based on the ratio between its own non-renewable energy performance index (one of the parameters of the EPC) and the reference standard one (also provided in the EPC), according to the scheme of Table 1.

TABLE 1 ABOUT HERE

The distribution of the energy class of the pooled dataset and by region is displayed in Table 2, in which we also report percentages retrieved from SIAPE (Energy Performance Certificates Information System).[5]

TABLE 2 ABOUT HERE

In addition to the energy performance class, the datasets provide other buildings' characteristics, such as address, size in square metres, number of housing units in the building, construction year or period, and climate zone. Energy-related pieces of information are the global non-renewable energy performance index, the global renewable energy performance index, the reference standard non-renewable energy performance index, CO2 emissions, dispersion surface, and annual consumption of all types of energy. The datasets also collect the recommendations provided to improve the energy efficiency of the property

[5] SIAPE is the portal of ENEA (Italy's national agency for new technologies, energy, and economic and sustainable development), containing information on EPCs at national and regional levels. Data are available at: https://siape.enea.it/analisi-territoriali.

and the energy class that could be reached by implementing the retrofits.[6] Finally, other technical details are available, which are not employed in our analysis.

To estimate the price premium of energy efficiency, we need house prices. However, we do not have access to granular prices, but only to those provided by Italy's Revenue Agency through its Real Estate Market Observatory ('Osservatorio del Mercato Immobiliare', OMI). The Observatory provides prices by OMI area (hereafter 'micro area'), where micro areas are defined as portions of the municipal territory reflecting a homogeneous segment of the local real estate market, where there is uniformity in the economic and socio-environmental conditions. Prices provided by the Observatory are minimum and maximum values by micro area in which at least five transactions have occurred within one semester, and they refer to various types of properties (flats, detached and semi-detached houses, garages, shops, industrial warehouses, laboratories, offices, etc.). For the purposes of our work, we keep only residential dwellings (i.e. flats and detached and semi-detached houses). In addition, we compute the means to have single minimum and maximum values by micro area and finally, we compute average overall values from the minimum and maximum ones by micro area.

Now, we associate an energy class to each micro area for which a price is available. Given that the EPCs datasets provide the geographical coordinates of each dwelling and that the OMI dataset provides the delimiting coordinates of each micro area, we can geolocalise micro areas in our EPCs datasets and compute average energy performance classes by area. To do so, we take the average of the ratio between the non-renewable energy performance index and the reference standard non-renewable one, weighed by housing units' size (in square metres), the so-called K-index (Fabbri and Gaspari, 2021). Then, based on the indicator's values obtained by micro area, we employ the reference scale of Table 1 to assign an energy class to each micro area, from G to A4.

In addition to the energy class, other factors may influence house prices. From the EPCs datasets, we retrieve three variables at the micro area level: the share of EPCs for rental purposes, the share of EPCs for selling purposes, and the share of second homes. These indicators may signal greater mobility in the housing market and possibly be associated with higher prices. External sources are income, population density and altitude, available at the municipality level. Income is the average individual net income, provided by the Italian

[6] Forni et al. (2024) employ the recommendations provided by the energy appraiser to quantify the costs and the benefits associated with the implementation of energy efficiency measures in residential buildings implied by the recast Energy Performance of Buildings Directive.

Revenue Agency, while population density is given by the ratio of the population to square kilometres, both provided by Istat, as well as altitude.

Finally, we collapse the datasets so that the new unit of analysis is the micro area, and we drop the observations affected by missing values to avoid biased estimates (Gatto and Panarello, 2022). Thus, we are left with a total of 84,821 observations in the pooled sample, of which 16,975 refer to Emilia-Romagna, 39,392 to Lombardy and 28,454 to Piedmont. As expected, by working at the micro area level, we lose variability in the energy class. Table 2 shows that, in the original dataset, class A (the grouping of classes A1 to A4) represents 10.6% of the overall sample, while classes B, C and D represent 3.3%, 6.1% and 12.7%, respectively. When working with our micro area level dataset, the percentage of dwellings in class A drops to 0.02% and that of B, C and D classes to 0.03%, 0.3% and 1.6%, respectively. This is because we are averaging by micro area and, since the most efficient classes are the minority within each micro area, they lose relevance despite weighting with dwellings' size. To obtain a reasonable percentage of observations in the most efficient classes, we group the first four ones into a single class, which represents 1.9% of the overall sample, while classes E, F and G sum up to 15.2%, 59.8% and 23.1%, respectively. Descriptive statistics of the variables employed in the analysis are reported in Table 3.

TABLE 3 ABOUT HERE

4. The models

To estimate the relationship between house prices and energy performance, we proceed along three lines: first, we estimate hedonic regression models; then, we move to quantile regressions, to account for a potentially different behaviour along the price distribution; finally, we implement fixed effects panel data models, to take into account unobserved heterogeneity. Moreover, to ensure the robustness of our main findings, we perform additional analyses using alternative dependent variables. The rationale for these robustness checks and the resulting estimations are presented in the Appendix (Tables A1-A10).

4.1 Hedonic regression models

A hedonic price regression assumes that the price of a good is a function of a combination of its own characteristics and contextual factors (Rosen, 1974). "The hedonic regression method recognizes that heterogeneous goods can be described by their attributes or characteristics. That is, a good is essentially a bundle of (performance) characteristics. In the housing context, this bundle may contain attributes of both the structure and the location of the properties" (de Haan and Diewert, 2013). According to this framework, we run the following model, for micro areas $i = 1, ..., N$:

$$lnp_i = \beta_0 + \sum_{k=1}^{K} \beta_k x_{ik} + \varepsilon_i \qquad (1)$$

where lnp_i is the natural logarithm of the semi-annual house price, β_0 the intercept, β_k the parameters to be estimated and $\varepsilon_i \approx N(0, 1)$ the error term. Ideally, the k characteristics x_{ik} are split into two sets: one referring to the property itself and one referring to the location of the property (Zhang et al., 2024). Since we are working with micro area level data, it is not possible to have dwelling-specific characteristics. Therefore, we proxy some housing features such as whether the dwelling is owned outright, rented or second home by the corresponding shares by micro area, i.e. the share of EPCs compiled for property purchase purposes (which we label 'share of properties owned outright'), the share of EPCs compiled for property rental purposes (which we label 'share of rented out properties') and the share of second homes. Other features employed in the literature, such as the internal composition of the dwelling, cannot be properly identified. We also take account of province and time fixed effects. Therefore, x contains the following three sets of variables:

(i) Energy class (the aggregate of classes from A4 to D is the reference category), share of properties owned outright, share of rented out dwellings, share of second homes, construction year by class ("built before 1945" is the reference category) – all at the micro area level.

(ii) Climate zone (the aggregate of zones D and E is the reference category), quartiles of average individual net income (the first quartile is the reference category), population density and altitude – all at the municipality level.

(iii) Province dummies (Bologna is the reference province for Emilia Romagna, Milan for the pooled model and for Lombardy, Turin for Piedmont) and semester dummies (2016H1 is the reference period).

We estimate equation (1) by ordinary least squares (OLS) for the pooling of the three regions and for each region separately.

4.2 Quantile regression models

To account for possible differences in the relationship between prices and energy efficiency along the price distribution, we also run quantile regressions as in, among others, McCord et al. (2020a). Indeed, different segments of the housing market (e.g. lower-end vs. upper-end properties) might respond differently to energy efficiency improvements. Analysing different quantiles of the house price distribution separately allows us to investigate whether the impact of energy efficiency varies across different market segments.

Quantile regression, as introduced by Koenker and Bassett (1978), is a statistical technique used in econometrics to estimate the relationship between a dependent variable and one or more independent variables across different quantiles of the conditional distribution of the dependent variable. Unlike OLS regression, which estimates the conditional mean of the dependent variable given the independent variables (Giacalone et al., 2018), quantile regression allows us to analyse how the relationships between variables vary across different parts of the distribution. The coefficients obtained from quantile regression represent the change in the conditional quantile of the dependent variable associated with a one-unit change in the independent variable, holding the other variables constant. Unlike OLS regression coefficients, quantile regression coefficients provide insights into how the relationship between variables varies across different parts of the distribution. Quantile regression is robust to outliers and heteroscedasticity since it minimises the sum of absolute deviations rather than the sum of squared deviations. This makes it particularly useful in situations where the assumptions of OLS regression are violated, such as heteroscedasticity.

Quantile regression estimates the conditional quantiles by minimizing a specific loss function for each quantile of interest. The q^{th} quantile regression estimator $\hat{\beta}_q$ minimises the following objective function over β_q (Cameron and Trivedi, 2005):

$$Q_N(\beta_q) = \sum_{i: y_i \geq x_i' \beta_q}^{N} q \left| y_i - x_i' \beta_q \right| + \sum_{i: y_i < x_i' \beta_q}^{N} (1 - q) \left| y_i - x_i' \beta_q \right| \qquad (2)$$

where y_i is the outcome variable and x_i is the set of independent variables, for each observation i (in our case micro areas). The outcome variable y is housing price by micro-area, while the variables contained in x are the same as those listed in the hedonic regression case of Section 4.1. In our empirical application we look at quartiles of the house price distribution (q = 0.25, 0.50, 0.75) and we perform the estimation both on the pooled sample and on each region separately.

Equation (2) is nondifferentiable: therefore, optimisation techniques, such as linear programming, are employed to obtain $\hat{\beta}_q$. Moreover, since there is no explicit solution for $\hat{\beta}_q$, its asymptotic distribution cannot be obtained using the OLS approach: bootstrap methods are employed to obtain standard errors and to perform inference.

4.3 Fixed effects panel data models

Given that we follow micro areas over time, we can also estimate a fixed effects panel data model to account for unobserved heterogeneity as follows:

$$lnP_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k x_{itj} + u_{it} \quad i = 1, \ldots, N \quad t = 2016H1, \ldots, 2022H2 \qquad (3)$$

where the error term u_{it} is equal to $\alpha_i + \varepsilon_{it}$, and α_i is unobserved heterogeneity for which $E(x_i) \neq 0$, and $\varepsilon_{it} \approx N(0, 1)$. Condition $E(x_i, \alpha_i) = 0$ must also hold. The j characteristics x_{ij} are a subset of x_{ik} of equation (2), which include only the time-varying variables. A first group of variables is obtained by averaging over micro area and time: energy class, percentage of owned properties, percentage of second homes, percentage of rented dwellings and construction year; a second group is at municipality level and by time (population density and individual income); and finally, semester dummies. Other variables, such as province, altitude and climate zone, are time-invariant and cannot be included among the regressors since they are collinear with the fixed effects. As before, we estimate equation (3) on the pooling of the three regions and by region.

5. Estimation results

In what follows, we present the estimation results of the models introduced in Section 4: hedonic models, quantile regressions and fixed effects panel data models. We recall that the unit of analysis is the micro area and that we estimate both pooled models and region-level ones.

5.1 Hedonic regression models

The results on the pooling of the three regions reveal the existence of a price premium: the coefficients of the energy class dummies are significant, negative and increasing in absolute value (Table 4, column 1). This means that, compared to the reference energy class A4-D, the price of less energy-efficient dwellings is lower, and the price reduction is more pronounced the less efficient a property is. Since the estimated coefficients represent semi-elasticities, for an average dwelling the loss of value from class A4-D to class G is 20.6%, while for a dwelling in class F it is 11.3% and for a property in class E it is 4.9%. Our results are coherent with those of Loberto et al. (2023) as far as the existence of an energy price premium is concerned, but direct comparison of coefficients is not straightforward since their dataset allows them to estimate the coefficients associated with all energy classes (from A to F, with G the reference category). However, we find some coherence between their and our results. For instance, the price premia of classes A to D compared to class G range between 0.227 and 0.106, an interval which includes our estimated coefficient (in absolute terms) of 0.206, i.e. by how less a G-class dwelling is valued compared to an A-D one.

The micro area level variables are all significant: dwellings in areas with higher mobility captured by higher shares of home purchases and rentals experience a positive effect on their prices and newer dwellings are associated with higher prices. At the municipality level, properties located in a colder climate zone are less expensive (even if the result seems to be in contradiction with the positive sign of altitude), a higher population density is associated with a higher price, capturing the evidence that in more highly concentrated municipalities (usually larger towns) prices are higher, and municipalities in which the average income level is higher exhibit higher prices (the higher the quartile the higher the price compared to the lowest quartile of the income distribution).

TABLE 4 ABOUT HERE

The specification of column (2) labelled 'Interacted pooling' displays the results of a model in which we interact the energy class dummies with the region ones, to test whether significant differences in the price premium among regions exist. The region dummies are significant as well as all the interaction terms.[7] The overall marginal effects of the energy class and of the interacted terms on prices are reported in Table 5. They show that for all the classes and regions, the effects are negative: this means that the reduction in price of each energy class is stronger compared to the reference energy class A4-D. Finally, all other coefficients displayed in Table 4, column (2), are in line with the specification of column (1).

TABLE 5 ABOUT HERE

The estimated coefficients of the regional models (Emilia-Romagna, Lombardy and Piedmont) are displayed in columns (3), (4) and (5) of Table 4. In all the three regions, the existence of a significant relationship between prices and the energy class is confirmed: the estimated semi-elasticities are with the expected sign and order of magnitude, i.e. more negative as we move towards less efficient dwellings, and they range between -0.2149 and -0.3514 in Emilia-Romagna, between -0.0431 and -0.1983 in Lombardy and between -0.0327 and -0.1509 in Piedmont. All the other coefficients are coherent with those of the previous two specifications, with only a few exceptions: climate zone F is not statistically different from climate zone D/E in Emilia-Romagna and the construction year shows a couple of incoherences in its sign, i.e. class 1945-1959 displays a negative sign in Emilia-Romagna and Lombardy, as well as class 1980-1999 in Lombardy.

The main takeaways from the hedonic regressions are that a price premium for higher energy efficiency exists and it is heterogenous across provinces of the same region and across regions and that it seems to be stronger in Emilia-Romagna than in Lombardy and Piedmont. Prices are also influenced by factors such as population density (more urbanised areas are on average associated with higher prices), construction year (the newer the dwelling the higher the price), municipality inhabitants' income (higher income earners tend to live in areas where house prices are higher) and mobility within the municipality (a more lively property

[7] Interpretation of the region coefficients is counterintuitive, since we would have expected higher prices in Lombardy, as reported by OMI (2024), which reports higher average prices in Lombardy (188,500€) than in Emilia-Romagna (157,900€) and Piedmont (130,500€) in 2023. However, the result may be explained by the fact that region-level prices of our database are not weighed, since we do not have the number of transactions by micro area.

market – more home purchases, more rents and more second homes – is associated with higher prices).

5.2 Quantile regression models

As outlined in Section 4.2, the rationale for estimating a quantile regression model is to verify whether differences in the relationship between price and energy class exist along the price distribution. Specifically, we estimated a set of models on the quartiles of the price distribution. Table 6 displays the results of a simple pooled model (columns 1 to 3) and of an interacted pooled model (columns from 4 to 6). There is evidence of the existence of an energy-efficiency price premium in all the quartiles of the price distribution: coefficients are negative and increase in absolute terms the lower the energy efficiency (except for class E in the first quartile). The noteworthy result is that the premium increases along the price distribution: for instance, the price loss of the reference dwelling in class G (compared to class A4-D) is 7.5% in the first quartile, 13.6% in the second and 21.3% in the third. Similar results hold for the other two energy classes. F-tests show that these differences are statistically significant. The magnitude and sign of all other estimated coefficients are coherent with those obtained from the hedonic regressions (except for climate zone in Emilia-Romagna and share of owned outright properties in Lombardy and Piedmont, which are not significant).

TABLE 6 ABOUT HERE

In the interacted model (Table 6), the estimated coefficients are of the expected sign and order of magnitude (except for class E in the second quartile). However, the regularity observed in the simple pooled model (i.e. larger coefficients in absolute terms in higher quartiles) does not hold fully in the interacted model: it holds between the first and the third quartile and between the second and the third, but not between the first one and the second one. The second quartile is the weakest in terms of statistical significance of the price premia: in addition to class E, some of the interaction terms are not significant either, specifically classes E and F for both Lombardy and Piedmont. As for the remaining variables, the main overall results hold, if we exclude climate zone in the first quartile and altitude in the first and second quartiles.

The overall energy class marginal effects on log prices for each class and region with respect to class A4-D are reported in Table 7: the third quartile is the one in which all the marginal effects are significant and negative, while a weaker relationship between energy class and prices is observed in the first quartile, especially for classes E and F; finally, in the second quartile, all coefficients are significantly negative, with the exception of the E-class ones in Emilia-Romagna and Lombardy.

TABLE 7 ABOUT HERE

TABLE 8 ABOUT HERE

Table 8 displays the results of region-level models. The estimated energy class coefficients are negative along the price distribution of all the three regions, although with a few exceptions (in Lombardy, class E in the first two quartiles; in Piedmont, class F in the first quartile and class E in the second quartile). Their magnitude in absolute terms is greater for less efficient classes and it increases along the price distribution. The latter aspect holds in Lombardy and Piedmont, where F-tests of the equality of the coefficients across quartiles are all rejected at the 0.01% significance level. Unexpectedly, this does not hold in Emilia-Romagna, where all tests show the absence of statistically significant differences. For instance, in Lombardy, a class-G dwelling is priced 5.8% less than an A-class dwelling in the first quartile, while the corresponding loss of price is 15.6% in the second quartile and 22.2% in the third one, while in Piedmont the corresponding values are 4.3%, 7.3% and 14.2% in the first, second and third quartile, respectively.[8] Overall, the other regressors are more relevant (i.e. significant and with the expected sign) in the highest quartile, but also in the other two quartiles the main conclusions of both the other model specifications hold: a higher degree of mobility is associated with higher prices, as well as higher income and more recent construction years.

To sum up, the quantile regressions confirm the main results obtained in the hedonic regressions, but they add an interesting feature of the energy class/price relationship, that is the existence of heterogeneity along the price distribution: prices seem to react more strongly to the energy class at the higher end of the distribution, especially in Lombardy and Piedmont.

[8] In Emilia-Romagna, the values are 27.0% in the first quartile, 31.4% in the second one and 32.5% in the third one, but they are not significantly different.

5.3 Panel data models

Since we follow micro areas through time, we also estimated a fixed effects panel data model to take account of unobserved heterogeneity (Table 9). The results of the pooled model (column 1) tell us that the price premium is weaker than that estimated in the previous specifications (hedonic and quantile regressions): the dummy associated with energy class E is not significant and the magnitude of classes F and G drops dramatically to -0.0033 and -0.0060, respectively. The weak overall significance of the price-energy efficiency relationship seems to be driven mainly by the Emilia-Romagna and Piedmont regions, as can be seen from the estimation of the interacted model (column 2), in which the only significant interaction terms are those associated with Lombardy. Also, in the region-level models (columns 3 to 5) significant energy efficiency effects are detected for Lombardy (despite the coefficient of class E displaying a positive sign).

TABLE 9 ABOUT HERE

Given the unsatisfactory results, we re-estimated the models on the balanced longitudinal dataset in which we kept only the micro areas staying in the sample in all the 14 considered semesters. The estimation results are reported in Table 10. As before, in the pooled model, we observe the existence of a price premium when comparing classes G and F with class A4-D, while class E does not seem to penalise homeowners compared to the more efficient reference class. The regional interaction terms show a slightly higher statistical significance, since also one coefficient of the Piedmont model is significant, in addition to Lombardy's ones (column 2). Region-level estimates (columns 3 to 5) worsen for Lombardy (only class F is significant), they improve for Piedmont (for which class E gains significance) and display no price premia at all for Emilia-Romagna. An explanation for these results may lie in the way the dataset is built and that makes us lose variability within observations (micro areas) since, as explained in Section 3, we are working on average price values and average energy classes by micro area.

TABLE 10 ABOUT HERE

6. Conclusions

In this paper, we empirically investigate the existence of an energy efficiency price premium in three Northern Italian regions (Emilia-Romagna, Lombardy and Piedmont) for residential dwellings by employing novel Energy Efficiency Certificates (EPCs) data and merging them with house prices. The analysis is conducted at the micro area level, which is the aggregation level with which house price data are distributed by the Italian Revenue Agency. The paper aims at assessing whether residential dwellings benefit from a higher price when more energy efficient, once controlling for surrounding features.

The rationale for conducting this empirical investigation lies in the fact that energy efficiency is expected to reduce energy consumption and is therefore central to achieving the EU's energy and climate goals. The various recasts of the Energy Performance of Buildings Directive (EPBD) compose the legislative framework established by the European Union to boost buildings' energy performance. The 2002 EPBD set the introduction of the EPCs to provide transparent information on buildings' energy performance, which were adopted by European countries at different times. In Italy, they were made compulsory for new constructions in 2007, for all buildings for sale in 2009, and for those to be let in 2010. An EPC assigns an energy efficiency label to a dwelling on a scale from G (the least efficient) to A4 (the most efficient) according to its expected energy consumption with respect to heating, lighting and hot water.

To test whether house prices are influenced by their energy efficiency class, we employ three sets of models: hedonic regressions, quantile regressions and fixed effects panel data ones, both on the pooling of the three regions and by each region separately. The analysis is conducted on the period 2016-2022 on semi-annual data and the unit of analysis is the micro area, that is when we talk about energy efficiency – and the corresponding energy classes – we refer to average energy efficiency by area. In our models, we regress the logarithm of average dwelling price per square metre and area on energy classes, on a set of micro-area-level controls (share of properties owned outright, share of rented out dwellings, share of second homes, and construction year) and on municipality-level variables (climate zone, quartiles of average individual net income, population density and altitude), controlling for provinces and semesters.

The main takeaways from our analysis are the following. First, a price premium for higher energy efficiency exists and it is heterogenous across provinces of the same region and across regions, with evidence of a stronger relationship in Emilia-Romagna. Second, we find evidence of heterogeneity along the price distribution: prices react more strongly to the energy class at the higher end of the distribution, especially in Lombardy and Piedmont. Third, prices are also influenced by factors such as population density, construction year, municipality inhabitants' income and mobility within the municipality.

The findings from this study underscore several critical implications for policymakers as they design and implement energy efficiency regulations and incentives. First, the presence of a significant energy efficiency price premium suggests that market mechanisms may incentivise energy-efficient investments, but this effect is highly variable across regions and price segments. Therefore, regional differentiation in policy design may be necessary to account for the local dynamics observed, particularly the stronger relationship in Emilia-Romagna and the higher sensitivity at the upper end of the price distribution in Lombardy and Piedmont.

Second, taking into account the fact that the most recent EPBD recast set that energy use of residential buildings must be reduced by 16% by 2030 and by 20-22% by 2035 (compared to 2020 levels) and that at least 55% of such reductions must be achieved through the renovation of the worst-performing buildings, it is imperative to know how much residential properties would be valued after renovation, to compensate, at least partially, for the retrofit costs. Indeed, the heterogeneity in price responses should guide the allocation of public resources and the structuring of financial incentives. This aspect is very relevant from a policy perspective, since currently it is not known who will bear the burden of the retrofits. In 2020, Italy introduced the 'Superbonus', a 110% tax credit on energy efficiency renovations, provided that the building improved its energy performance by at least two classes. It has resulted in a fall in the percentage of residential buildings in the least efficient class, but the impact on public finances has been huge so far (around 150 billion euros). This is an amount that cannot be borne entirely by the state for the second time but of course neither by households. Targeting incentives more effectively – by focusing on regions or price segments with lower responsiveness – could enhance policy efficiency and reduce the fiscal burden. Furthermore, the study highlights the need for clear policy direction on the allocation of retrofit costs. Considering the unsustainable impact of the Superbonus on public finances, future schemes must balance fiscal responsibility with the need to avoid placing excessive financial strain on households. Hence, how to intervene in a fair and efficient way should the EPBD be implemented is an open discussion.

Lastly, the study's results suggest that other factors, such as population density and income levels, also significantly impact property values in relation to energy efficiency. Policymakers should consider integrating energy efficiency policies with urban planning and economic development strategies to maximise their effectiveness. This could involve promoting energy-efficient upgrades in conjunction with initiatives that address housing affordability, urban density and income inequality, thereby ensuring that energy efficiency improvements contribute to broader social and economic goals.

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TABLES

Table 1 - Buildings' energy performance

Class A4			ratio	≤	0.40
Class A3	0.40	<	ratio	≤	0.60
Class A2	0.60	<	ratio	≤	0.80
Class A1	0.80	<	ratio	≤	1.00
Class B	1.00	<	ratio	≤	1.20
Class C	1.20	<	ratio	≤	1.50
Class D	1.50	<	ratio	≤	2.00
Class E	2.00	<	ratio	≤	2.60
Class F	2.60	<	ratio	≤	3.50
Class G			ratio	>	3.50

Note: ratio = non-renewable energy performance index / reference standard non-renewable energy performance index

Source: Decree 26/06/2015, Italian Ministry of Economic Development

Table 2 - Distribution of energy classes

		Emilia-Romagna	Lombardia	Piemonte	Total
EPC data	A	8.3	9.8	6.7	8.8
	B	1.8	2.9	2.6	2.6
	C	3.8	4.5	5.2	4.5
	D	9.0	10.1	13.2	10.4
	E	14.4	15.5	22.2	16.4
	F	23.0	23.0	26.2	23.6
	G	39.7	34.3	24.0	33.8
		100.0	100.0	100.0	100.0
		Emilia-Romagna	Lombardia	Piemonte	Total
SIAPE	A	8.6	12.8	8.5	10.6
	B	2.3	4.2	3.1	3.3
	C	5.0	7.0	5.7	6.1
	D	10.6	14.0	12.8	12.7
	E	15.1	16.4	20.4	17.0
	F	22.6	19.4	24.4	21.6
	G	35.7	26.1	25.1	28.7
		100.0	100.0	100.0	100.0

Source: Authors' elaborations on EPCs and SIAPE data.

Table 3 - Descriptive statistics

	Pooled sample				Emilia-Romagna				Lombardy				Piedmont			
	mean	p50	sd	N	mean	p50	sd	N	mean	p50	sd	N	mean	p50	sd	N
Continuous variables																
Log house price	6.948	6.948	0.410	84,821	7.020	7.020	0.461	16,975	7.035	7.035	0.379	39,392	6.783	6.783	0.367	28,454
Population density	564.0	564.0	1,048	84,821	361.4	361.4	521.5	16,975	774.7	774.7	1,184	39,392	393.1	393.1	1,027	28,454
Altitude	283.2	283.2	258.7	84,821	162.9	162.9	227.7	16,975	254.9	254.9	235.9	39,392	394.1	394.1	263.7	28,454
Property transactions (%)	64.84	64.84	14.18	84,821	67.24	67.24	10.16	16,975	66.06	66.06	14.59	39,392	61.73	61.73	15.09	28,454
Rental (%)	22.77	22.77	12.35	84,821	24.52	24.52	9.108	16,975	21.45	21.45	12.58	39,392	23.57	23.57	13.47	28,454
Second homes (%)	4.752	4.752	11.34	84,821	3.261	3.261	7.903	16,975	4.393	4.393	11.02	39,392	6.138	6.138	13.23	28,454
Individual income (€)	21,518	21,518	3,155	84,821	21,607	21,607	2,828	16,975	22,042	22,042	3,440	39,392	20,739	20,739	2,743	28,454
Discrete variables	*%*				*%*				*%*				*%*			
EPC score																
A4-D	1.9				0.5				1.0				3.8			
E	15.2				8.2				8.8				28.2			
F	59.8				61.8				66.2				49.9			
G	23.1				29.5				24.0				18.1			
Climate zone																
D + E	86.0				91.6				89.7				77.6			
F	14.0				8.4				10.3				22.4			
Construction year																
Before 1945	14.7				3.6				5.7				33.8			
1945-1959	11.1				9.7				9.7				14.0			
1960-1979	47.7				58.9				45.4				44.3			

1980-1999	21.7	24.3	31.3	7.0
2000-2023	4.7	3.5	8.0	0.8

Source: Authors' elaborations on EPCs data.

Table 4 - Hedonic regression models

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	-0.0487***	-0.2259***	-0.2149***	-0.0431**	-0.0327***
	(7.77e-03)	(2.68e-02)	(2.61e-02)	(1.78e-02)	(8.96e-03)
Energy class: F	-0.1134***	-0.2663***	-0.2144***	-0.1376***	-0.0684***
	(7.95e-03)	(2.64e-02)	(2.66e-02)	(1.72e-02)	(9.88e-03)
Energy class: G	-0.2061***	-0.5140***	-0.3514***	-0.1983***	-0.1509***
	(8.43e-03)	(2.68e-02)	(2.75e-02)	(1.73e-02)	(1.11e-02)
Region: Lombardy		-0.5967***			
		(3.26e-02)			
Region: Piedmont		-0.8546***			
		(2.94e-02)			
Class E # Lombardy		0.1793***			
		(3.23e-02)			
Class E # Piedmont		0.1881***			
		(2.80e-02)			
Class F # Lombardy		0.1272***			
		(3.14e-02)			
Class F # Piedmont		0.1767***			
		(2.77e-02)			
Class G # Lombardy		0.3596***			
		(3.17e-02)			
Class G # Piedmont		0.3316***			
		(2.82e-02)			
Climate zone: F	-0.0419***	-0.0528***	-0.0165	-0.0904***	-0.0717***
	(4.32e-03)	(4.23e-03)	(1.37e-02)	(6.59e-03)	(5.65e-03)
Population density	0.0001***	0.0001***	0.0002***	0.0001***	0.0001***
	(1.49e-06)	(1.49e-06)	(5.34e-06)	(1.81e-06)	(2.53e-06)
Altitude	0.0001***	0.0001***	-0.0002***	0.0002***	0.0003***
	(9.61e-06)	(9.48e-06)	(1.57e-05)	(1.47e-05)	(1.51e-05)
Income quartile: 2	0.0508***	0.0536***	0.0213***	0.0537***	0.0698***
	(2.57e-03)	(2.52e-03)	(7.06e-03)	(3.90e-03)	(3.48e-03)
Income quartile: 3	0.1636***	0.1642***	0.0905***	0.1666***	0.1908***
	(3.06e-03)	(3.02e-03)	(9.28e-03)	(4.16e-03)	(4.43e-03)
Income quartile: 4	0.3131***	0.3112***	0.2872***	0.2844***	0.3169***
	(3.54e-03)	(3.49e-03)	(9.74e-03)	(4.62e-03)	(6.12e-03)
% of owned outright properties	0.0004***	0.0004***	0.0016***	0.0003***	0.0010***
	(1.02e-04)	(1.01e-04)	(3.84e-04)	(1.27e-04)	(1.78e-04)
% of rented out properties	0.0043***	0.0042***	0.0096***	0.0034***	0.0033***
	(1.13e-04)	(1.12e-04)	(3.85e-04)	(1.49e-04)	(1.85e-04)
% of second homes	0.0036***	0.0032***	0.0060***	0.0030***	0.0007***
	(1.50e-04)	(1.50e-04)	(4.39e-04)	(2.17e-04)	(2.16e-04)
Construction year: 1945-1959	0.0163***	0.0186***	-0.0409***	-0.0784***	0.0650***
	(3.87e-03)	(3.83e-03)	(1.53e-02)	(7.85e-03)	(4.36e-03)
Construction year: 1960-1979	0.0588***	0.0675***	0.1163***	-0.0892***	0.1272***
	(3.42e-03)	(3.43e-03)	(1.36e-02)	(7.34e-03)	(3.83e-03)
Construction year: 1980-1999	0.1041***	0.1128***	0.2183***	-0.0596***	0.1936***
	(4.09e-03)	(4.07e-03)	(1.43e-02)	(7.72e-03)	(7.24e-03)
Construction year: 2000-2023	0.0529***	0.0572***	0.1954***	-0.1037***	0.0424**

	(5.56e-03)	(5.61e-03)	(1.69e-02)	(8.88e-03)	(2.03e-02)
Constant	6.8531***	7.4495***	6.8565***	7.0451***	6.3686***
	(1.27e-02)	(2.86e-02)	(4.24e-02)	(2.19e-02)	(1.74e-02)
Observations	84,821	84,821	16,975	39,392	28,454
R-squared	0.655	0.663	0.712	0.673	0.582
Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10.*

Source: Authors' elaborations on EPCs data.

Table 5 – Interacted hedonic regression: Overall marginal effects of the energy class on log prices

Energy class	Region	Marginal effect		Standard error (delta-method)
E	Emilia-Romagna	-0.2259	***	0.0268
E	Lombardy	-0.0466	***	0.0179
E	Piedmont	-0.0378	***	0.0085
F	Emilia-Romagna	-0.2663	***	0.0264
F	Lombardy	-0.1391	***	0.0173
F	Piedmont	-0.0897	***	0.0089
G	Emilia-Romagna	-0.5140	***	0.0268
G	Lombardy	-0.1544	***	0.0174
G	Piedmont	-0.1824	***	0.0097

*Note: *** p<0.01*

Source: Authors' elaborations on EPCs data.

Table 6 – Quantile regression models: pooled sample

	Pooling			Pooling interacted		
	q1	q2	q3	q1	q2	q3
	(1)	(2)	(3)	(4)	(5)	(6)
Energy class: E	0.0134**	-0.0249***	-0.0835***	-0.1287***	-0.0210	-0.2364***
	(6.72e-03)	(7.98e-03)	(8.22e-03)	(1.41e-02)	(2.69e-02)	(1.46e-02)
Energy class: F	-0.0145**	-0.0714***	-0.1467***	-0.1808***	-0.0912***	-0.2960***
	(6.95e-03)	(8.23e-03)	(8.35e-03)	(1.33e-02)	(2.60e-02)	(1.40e-02)
Energy class: G	-0.0751***	-0.1357***	-0.2126***	-0.3589***	-0.2832***	-0.5025***
	(7.44e-03)	(8.65e-03)	(8.90e-03)	(1.36e-02)	(2.62e-02)	(1.48e-02)
Region: Lombardy				-0.4696***	-0.4518***	-0.6737***
				(1.88e-02)	(3.76e-02)	(1.94e-02)
Region: Piedmont				-0.7820***	-0.6917***	-0.9397***
				(1.84e-02)	(2.88e-02)	(2.09e-02)
Class E # Lombardy				0.1303***	-0.0048	0.1639***
				(1.79e-02)	(3.77e-02)	(1.93e-02)
Class E # Piedmont				0.1556***	0.0033	0.1731***
				(1.58e-02)	(2.81e-02)	(1.82e-02)
Class F # Lombardy				0.1644***	0.0220	0.1252***
				(1.70e-02)	(3.65e-02)	(1.73e-02)
Class F # Piedmont				0.1748***	0.0359	0.1904***
				(1.53e-02)	(2.73e-02)	(1.77e-02)
Class G # Lombardy				0.3354***	0.2102***	0.3295***
				(1.73e-02)	(3.66e-02)	(1.82e-02)
Class G # Piedmont				0.3059***	0.1579***	0.3193***
				(1.58e-02)	(2.77e-02)	(1.86e-02)
Climate zone: F	0.0054	-0.0092**	-0.0169***	-0.0060	-0.0232***	-0.0312***
	(3.73e-03)	(3.88e-03)	(4.42e-03)	(3.77e-03)	(3.83e-03)	(4.07e-03)
Population density	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(1.01e-06)	(1.57e-06)	(2.80e-06)	(9.98e-07)	(1.56e-06)	(2.90e-06)
Altitude	-0.0001***	-0.0000***	-0.0000	-0.0000	0.0000	0.0000***
	(8.76e-06)	(8.16e-06)	(1.06e-05)	(8.48e-06)	(7.80e-06)	(9.96e-06)

Income quartile: 2	0.0397***	0.0400***	0.0459***	0.0372***	0.0445***	0.0479***
	(2.49e-03)	(2.20e-03)	(2.39e-03)	(2.30e-03)	(2.12e-03)	(2.23e-03)
Income quartile: 3	0.1174***	0.1318***	0.1587***	0.1158***	0.1304***	0.1596***
	(2.80e-03)	(2.66e-03)	(2.86e-03)	(2.67e-03)	(2.64e-03)	(2.80e-03)
Income quartile: 4	0.2143***	0.2685***	0.3157***	0.2112***	0.2637***	0.3107***
	(3.36e-03)	(3.26e-03)	(3.47e-03)	(3.28e-03)	(3.22e-03)	(3.30e-03)
% of owned outright properties	0.0004***	0.0001	-0.0001	0.0002***	0.0000	-0.0001
	(8.06e-05)	(8.87e-05)	(1.09e-04)	(7.83e-05)	(8.57e-05)	(9.85e-05)
% of rented out properties	0.0027***	0.0032***	0.0041***	0.0025***	0.0030***	0.0039***
	(9.11e-05)	(1.00e-04)	(1.26e-04)	(8.87e-05)	(1.00e-04)	(1.18e-04)
% of second homes	-0.0006***	0.0024***	0.0068***	-0.0008***	0.0021***	0.0064***
	(1.50e-04)	(1.70e-04)	(2.71e-04)	(1.59e-04)	(1.56e-04)	(2.23e-04)
Construction year: 1945-1959	0.0351***	0.0390***	0.0143***	0.0419***	0.0373***	0.0160***
	(3.49e-03)	(3.44e-03)	(3.66e-03)	(3.59e-03)	(3.41e-03)	(3.43e-03)
Construction year: 1960-1979	0.0872***	0.0753***	0.0412***	0.0898***	0.0754***	0.0526***
	(3.17e-03)	(3.01e-03)	(3.29e-03)	(3.34e-03)	(3.04e-03)	(3.10e-03)
Construction year: 1980-1999	0.1232***	0.1090***	0.0708***	0.1276***	0.1114***	0.0772***
	(3.72e-03)	(3.58e-03)	(3.90e-03)	(3.89e-03)	(3.52e-03)	(3.76e-03)
Construction year: 2000-2023	0.0869***	0.0691***	0.0288***	0.0955***	0.0805***	0.0297***
	(4.67e-03)	(5.02e-03)	(5.63e-03)	(4.50e-03)	(5.23e-03)	(5.00e-03)
Constant	6.7915***	6.8650***	7.0009***	7.2618***	7.3141***	7.6888***
	(1.02e-02)	(1.19e-02)	(1.37e-02)	(1.68e-02)	(2.77e-02)	(1.91e-02)
Observations	84,821	84,821	84,821	84,821	84,821	84,821
Province dummies	YES	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES	YES

*Note: Bootstrapped standard errors in parentheses (100 replications). *** p<0.01, ** p<0.05, * p<0.10. Province dummies and semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Table 7 – Interacted quantile regression: Overall marginal effects of the energy class on log prices

		q1			q2			q3		
Energy class	Region	Marginal effect		Standard error (delta-method)	Marginal effect		Standard error (delta-method)	Marginal effect		Standard error (delta-method)
E	Emilia-Romagna	-0.1287	***	0.0141	-0.0210		0.0269	-0.2364	***	0.0146
	Lombardy	0.0016		0.0122	-0.0257		0.0254	-0.0725	***	0.0130
	Piedmont	0.0269	***	0.0078	-0.0177	**	0.0083	-0.0633	***	0.0105
F	Emilia-Romagna	-0.1808	***	0.0133	-0.0912	***	0.0260	-0.2960	***	0.0140
	Lombardy	-0.0164		0.0122	-0.0692	***	0.0248	-0.1708	***	0.0110
	Piedmont	-0.0060		0.0081	-0.0553	***	0.0088	-0.1057	***	0.0108
G	Emilia-Romagna	-0.3589	***	0.0136	-0.2832	***	0.0262	-0.5025	***	0.0148
	Lombardy	-0.0235	*	0.0126	-0.0729	***	0.0249	-0.1729	***	0.0116
	Piedmont	-0.0529	***	0.0088	-0.1252	***	0.0097	-0.1831	***	0.0114

*Note: *** p<0.01, ** p<0.05, * p<0.10.*

Source: Authors' elaborations on EPCs data

Table 8 - Quantile regression models by region

	Emilia-Romagna			Lombardy			Piedmont		
	q1	q2	q3	q1	q2	q3	q1	q2	q3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Energy class: E	-0.1933***	-0.1515***	-0.1755***	0.0017	-0.0499	-0.0643***	0.0220***	-0.0003	-0.0415***
	(1.69e-02)	(1.97e-02)	(3.80e-02)	(1.38e-02)	(3.21e-02)	(1.59e-02)	(7.42e-03)	(8.58e-03)	(8.02e-03)
Energy class: F	-0.1872***	-0.1969***	-0.2108***	-0.0238*	-0.1098***	-0.1703***	-0.0050	-0.0163*	-0.0644***
	(1.65e-02)	(2.18e-02)	(3.97e-02)	(1.39e-02)	(3.17e-02)	(1.43e-02)	(8.45e-03)	(9.34e-03)	(8.76e-03)
Energy class: G	-0.2704***	-0.3135***	-0.3249***	-0.0580***	-0.1555***	-0.2220***	-0.0434***	-0.0733***	-0.1423***
	(1.80e-02)	(2.27e-02)	(4.04e-02)	(1.43e-02)	(3.18e-02)	(1.51e-02)	(9.72e-03)	(1.03e-02)	(9.62e-03)
Climate zone: F	0.0507***	-0.0057	0.0069	-0.0222***	-0.0497***	-0.0670***	-0.0087	-0.0260***	-0.0721***
	(1.54e-02)	(1.13e-02)	(1.55e-02)	(4.99e-03)	(6.78e-03)	(7.06e-03)	(5.87e-03)	(4.82e-03)	(6.37e-03)
Population density	0.0002***	0.0002***	0.0002***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(4.29e-06)	(4.64e-06)	(1.04e-05)	(1.19e-06)	(2.62e-06)	(3.37e-06)	(2.86e-06)	(3.02e-06)	(2.49e-06)
Altitude	-0.0002***	-0.0002***	-0.0002***	0.0001***	0.0001***	0.0001***	0.0000***	0.0001***	0.0002***
	(2.07e-05)	(1.51e-05)	(1.50e-05)	(1.07e-05)	(1.23e-05)	(1.58e-05)	(1.58e-05)	(1.29e-05)	(1.75e-05)
Income quartile: 2	0.0499***	0.0397***	0.0448***	0.0421***	0.0456***	0.0343***	0.0425***	0.0482***	0.0680***
	(5.53e-03)	(5.62e-03)	(7.44e-03)	(3.34e-03)	(3.27e-03)	(3.73e-03)	(3.64e-03)	(2.92e-03)	(3.74e-03)
Income quartile: 3	0.1295***	0.0989***	0.1125***	0.1184***	0.1333***	0.1473***	0.1129***	0.1499***	0.1900***
	(6.07e-03)	(6.52e-03)	(9.45e-03)	(3.89e-03)	(3.83e-03)	(4.47e-03)	(4.47e-03)	(3.95e-03)	(4.83e-03)
Income quartile: 4	0.2800***	0.2892***	0.3076***	0.1856***	0.2234***	0.2649***	0.2043***	0.2723***	0.3404***
	(7.05e-03)	(7.25e-03)	(1.07e-02)	(4.76e-03)	(4.70e-03)	(5.28e-03)	(7.00e-03)	(6.41e-03)	(5.75e-03)
% of owned outright properties	0.0018***	0.0022***	-0.0008*	0.0001	0.0001	-0.0004***	0.0005***	0.0003*	0.0005***
	(3.35e-04)	(3.75e-04)	(4.75e-04)	(8.28e-05)	(1.35e-04)	(1.61e-04)	(1.76e-04)	(1.58e-04)	(1.51e-04)
% of rented out properties	0.0081***	0.0095***	0.0061***	0.0016***	0.0028***	0.0036***	0.0024***	0.0019***	0.0028***

	(3.28e-04)	(4.20e-04)	(4.75e-04)	(9.68e-05)	(1.51e-04)	(1.88e-04)	(1.88e-04)	(1.50e-04)	(1.84e-04)
% of second homes	-0.0005	0.0041***	0.0089***	-0.0002	0.0020***	0.0072***	-0.0021***	0.0001	0.0041***
	(8.40e-04)	(4.51e-04)	(4.40e-04)	(2.27e-04)	(2.45e-04)	(3.79e-04)	(1.95e-04)	(2.40e-04)	(2.91e-04)
Construction year: 1945-1959	0.0086	-0.0127	-0.0146	-0.0060	-0.0357***	-0.0971***	0.0526***	0.0592***	0.0496***
	(1.31e-02)	(1.33e-02)	(1.34e-02)	(6.34e-03)	(7.31e-03)	(1.14e-02)	(4.75e-03)	(4.06e-03)	(4.46e-03)
Construction year: 1960-1979	0.1136***	0.0748***	0.0726***	0.0069	-0.0406***	-0.1166***	0.1107***	0.1152***	0.1134***
	(1.12e-02)	(1.28e-02)	(1.25e-02)	(6.21e-03)	(7.16e-03)	(1.08e-02)	(4.19e-03)	(3.39e-03)	(3.91e-03)
Construction year: 1980-1999	0.2184***	0.1789***	0.1537***	0.0274***	-0.0268***	-0.1113***	0.1822***	0.1778***	0.1479***
	(1.24e-02)	(1.40e-02)	(1.23e-02)	(6.71e-03)	(7.41e-03)	(1.11e-02)	(7.00e-03)	(5.81e-03)	(6.07e-03)
Construction year: 2000-2023	0.1966***	0.1276***	0.0957***	0.0044	-0.0494***	-0.1467***	0.0345	0.0630**	0.0681***
	(1.51e-02)	(1.83e-02)	(1.53e-02)	(7.14e-03)	(8.35e-03)	(1.22e-02)	(2.22e-02)	(2.47e-02)	(1.54e-02)
Constant	6.6982***	6.8191***	7.2053***	6.9336***	7.0713***	7.2464***	6.3359***	6.5211***	6.6201***
	(3.15e-02)	(4.14e-02)	(4.54e-02)	(1.57e-02)	(3.47e-02)	(2.25e-02)	(1.74e-02)	(1.52e-02)	(1.65e-02)
Observations	16,975	16,975	16,975	39,392	39,392	39,392	28,454	28,454	28,454
Province dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Note: Bootstrapped standard errors in parentheses (100 replications). *** p<0.01, ** p<0.05, * p<0.10. Province dummies and semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Table 9 – Fixed effects panel data models

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	0.0011	0.0017	0.0025	0.0018*	-0.0017
	(7.70e-04)	(2.07e-03)	(1.97e-03)	(1.05e-03)	(1.16e-03)
Energy class: F	-0.0033***	0.0004	0.0016	-0.0028***	-0.0020*
	(7.64e-04)	(1.87e-03)	(1.79e-03)	(1.05e-03)	(1.14e-03)
Energy class: G	-0.0060***	-0.0030	-0.0022	-0.0021*	-0.0018
	(8.22e-04)	(1.87e-03)	(1.87e-03)	(1.11e-03)	(1.25e-03)
Class E # Lombardy		-0.0010			
		(2.35e-03)			
Class E # Piedmont		-0.0026			
		(2.35e-03)			
Class F # Lombardy		-0.0107***			
		(2.16e-03)			
Class F # Piedmont		-0.0007			
		(2.14e-03)			
Class G # Lombardy		-0.0124***			
		(2.18e-03)			
Class G # Piedmont		0.0035			
		(2.16e-03)			
Population density	0.0000***	0.0000***	0.0000***	0.0000***	-0.0000
	(6.98e-07)	(6.90e-07)	(3.57e-06)	(1.03e-06)	(8.28e-07)
Income quartile: 2	-0.0181***	-0.0179***	-0.0104***	-0.0180***	-0.0138***
	(1.57e-03)	(1.57e-03)	(2.57e-03)	(2.58e-03)	(2.42e-03)
Income quartile: 3	-0.0229***	-0.0226***	-0.0051	-0.0281***	-0.0151***
	(2.05e-03)	(2.04e-03)	(3.95e-03)	(3.08e-03)	(3.31e-03)
Income quartile: 4	-0.0165***	-0.0163***	0.0101**	-0.0282***	-0.0115**
	(2.55e-03)	(2.54e-03)	(5.15e-03)	(3.45e-03)	(4.77e-03)
% of owned outright properties	0.0000	0.0000	-0.0001**	0.0000	0.0000
	(8.71e-06)	(8.73e-06)	(2.81e-05)	(1.06e-05)	(1.44e-05)
% of rented out properties	0.0000***	0.0000***	-0.0000	0.0000*	0.0000
	(1.04e-05)	(1.04e-05)	(3.33e-05)	(1.31e-05)	(1.68e-05)
% of second homes	0.0000***	0.0000***	0.0001***	0.0000	0.0000
	(1.38e-05)	(1.38e-05)	(4.79e-05)	(1.37e-05)	(1.79e-05)
Construction year: 1945-1959	-0.0009	-0.0005	0.0006	-0.0006	-0.0004
	(7.58e-04)	(7.55e-04)	(1.53e-03)	(9.67e-04)	(1.18e-03)
Construction year: 1960-1979	-0.0011*	-0.0006	0.0000	-0.0010	-0.0008
	(6.44e-04)	(6.41e-04)	(1.41e-03)	(8.90e-04)	(9.31e-04)
Construction year: 1980-1999	-0.0002	0.0000	-0.0006	-0.0006	0.0008
	(7.02e-04)	(7.01e-04)	(1.58e-03)	(9.80e-04)	(1.14e-03)
Construction year: 2000-2023	0.0013	0.0003	0.0001	0.0000	0.0014
	(8.37e-04)	(8.34e-04)	(1.88e-03)	(1.06e-03)	(1.63e-03)
Constant	6.9931***	6.9953***	7.0501***	7.0868***	6.8358***
	(1.83e-03)	(1.84e-03)	(4.15e-03)	(2.92e-03)	(2.62e-03)
Observations	79,467	79,467	16,968	34,416	28,083
R-squared	0.132	0.135	0.167	0.028	0.292
Number of micro areas	7,146	7,146	1,338	3,211	2,597

Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Table 10 – Fixed effects panel data models, balanced sample with all 14 semesters

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	-0.0006	0.0021	0.0027	0.0005	-0.0037**
	(1.19e-03)	(2.14e-03)	(2.17e-03)	(1.71e-03)	(1.85e-03)
Energy class: F	-0.0055***	-0.0000	0.0016	-0.0036**	-0.0037*
	(1.24e-03)	(2.06e-03)	(2.12e-03)	(1.71e-03)	(1.95e-03)
Energy class: G	-0.0094***	-0.0036	-0.0015	-0.0023	-0.0031
	(1.35e-03)	(2.27e-03)	(2.33e-03)	(1.78e-03)	(2.25e-03)
Class E # Lombardy		-0.0052*			
		(2.80e-03)			
Class E # Piedmont		-0.0046*			
		(2.75e-03)			
Class F # Lombardy		-0.0164***			
		(2.78e-03)			
Class F # Piedmont		-0.0007			
		(2.70e-03)			
Class G # Lombardy		-0.0199***			
		(3.01e-03)			
Class G # Piedmont		0.0042			
		(3.02e-03)			
Population density	0.0000**	0.0000**	0.0000***	0.0000*	-0.0000
	(8.38e-07)	(8.26e-07)	(3.67e-06)	(1.19e-06)	(9.67e-07)
Income quartile: 2	-0.0200***	-0.0196***	-0.0119***	-0.0103***	-0.0218***
	(2.31e-03)	(2.30e-03)	(2.86e-03)	(2.88e-03)	(4.61e-03)
Income quartile: 3	-0.0251***	-0.0245***	-0.0050	-0.0190***	-0.0240***
	(2.99e-03)	(2.98e-03)	(4.56e-03)	(3.77e-03)	(5.91e-03)
Income quartile: 4	-0.0230***	-0.0224***	0.0075	-0.0238***	-0.0265***
	(3.60e-03)	(3.58e-03)	(5.47e-03)	(4.39e-03)	(7.85e-03)
% of owned outright properties	0.0000	0.0000	-0.0001*	0.0000**	-0.0000
	(1.51e-05)	(1.51e-05)	(3.38e-05)	(1.68e-05)	(2.88e-05)
% of rented out properties	0.0001***	0.0001***	-0.0000	0.0001***	-0.0000
	(1.72e-05)	(1.72e-05)	(3.77e-05)	(1.84e-05)	(3.24e-05)
% of second homes	0.0001***	0.0001***	0.0002**	0.0000	0.0001
	(3.50e-05)	(3.47e-05)	(7.02e-05)	(3.97e-05)	(4.56e-05)
Construction year: 1945-1959	-0.0010	-0.0005	0.0003	0.0004	-0.0006
	(1.20e-03)	(1.20e-03)	(1.97e-03)	(1.47e-03)	(1.90e-03)
Construction year: 1960-1979	-0.0006	0.0001	0.0005	0.0012	-0.0011
	(1.10e-03)	(1.10e-03)	(1.90e-03)	(1.59e-03)	(1.60e-03)
Construction year: 1980-1999	0.0003	0.0007	0.0004	0.0012	0.0006
	(1.12e-03)	(1.13e-03)	(2.00e-03)	(1.62e-03)	(1.83e-03)
Construction year: 2000-2023	0.0011	0.0000	0.0012	0.0008	0.0006
	(1.28e-03)	(1.28e-03)	(2.31e-03)	(1.67e-03)	(2.63e-03)
Constant	7.1119***	7.1148***	7.0988***	7.1960***	6.9823***
	(3.14e-03)	(3.07e-03)	(4.82e-03)	(4.05e-03)	(5.49e-03)
Observations	46,662	46,662	13,188	19,614	13,860
R-squared	0.100	0.105	0.183	0.022	0.259

Number of micro areas	3,333	3,333	942	1,401	990
Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Appendix A - Robustness analysis of the relationship between house prices and energy efficiency

To ensure the robustness of our main findings regarding the relationship between house prices and energy efficiency, we perform additional analyses using alternative dependent variables. Specifically, we replicate our hedonic regression models, quantile regressions and fixed effects panel data models with the minimum house price and maximum house price within each micro-area as the dependent variables.

Indeed, the average house price in a micro-area provides a useful aggregate measure but may hide important variations within the distribution of house prices. By examining the minimum and maximum house prices, we can capture the extremes of the price distribution, providing a more comprehensive understanding of the relationship between house prices and energy efficiency.

The results of these robustness checks are presented in Tables A1 to A5, considering minimum price as the dependent variable, and in Tables A6 to A10, when setting maximum price as the outcome. The results are comparable with those obtained in the main models employing average house price as the dependent variable (i.e. those presented in Tables 4, 6, 8, 9 and 10).

The consistency of the findings with our main results suggests that the relationship between energy efficiency and house prices is robust across different specifications of the dependent variable. These additional analyses provide a more nuanced understanding of how energy efficiency impacts house prices across the price distribution, showing that energy efficiency positively influences prices at both the lower and upper ends of the distribution – although the magnitude of the effect may vary. Thus, our results are proven to be robust to different model specifications and are likely not driven by specific segments of the housing market or by the presence of outliers.

Table A1 - Hedonic regression models (dependent variable: log minimum house price by micro-area)

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	-0.0492***	-0.2433***	-0.2248***	-0.0429**	-0.0335***
	(7.75e-03)	(2.61e-02)	(2.59e-02)	(1.76e-02)	(8.96e-03)
Energy class: F	-0.1121***	-0.2839***	-0.2197***	-0.1356***	-0.0693***
	(7.92e-03)	(2.56e-02)	(2.64e-02)	(1.69e-02)	(9.90e-03)
Energy class: G	-0.2054***	-0.5386***	-0.3605***	-0.1953***	-0.1504***
	(8.43e-03)	(2.60e-02)	(2.74e-02)	(1.71e-02)	(1.11e-02)
Region: Lombardy		-0.5627***			
		(3.17e-02)			
Region: Piedmont		-0.9113***			
		(2.87e-02)			
Class E # Lombardy		0.1976***			
		(3.15e-02)			
Class E # Piedmont		0.2054***			
		(2.73e-02)			
Class F # Lombardy		0.1486***			
		(3.05e-02)			
Class F # Piedmont		0.1952***			
		(2.69e-02)			
Class G # Lombardy		0.3887***			
		(3.08e-02)			
Class G # Piedmont		0.3602***			
		(2.74e-02)			
Climate zone: F	-0.0427***	-0.0545***	-0.0032	-0.0948***	-0.0754***
	(4.36e-03)	(4.26e-03)	(1.37e-02)	(6.74e-03)	(5.66e-03)
Population density	0.0001***	0.0001***	0.0002***	0.0001***	0.0001***
	(1.49e-06)	(1.49e-06)	(5.29e-06)	(1.81e-06)	(2.51e-06)
Altitude	0.0001***	0.0001***	-0.0002***	0.0002***	0.0003***
	(9.72e-06)	(9.59e-06)	(1.59e-05)	(1.50e-05)	(1.51e-05)
Income quartile: 2	0.0004***	0.0004***	0.0017***	0.0003***	0.0008***
	(1.03e-04)	(1.01e-04)	(3.95e-04)	(1.27e-04)	(1.80e-04)
Income quartile: 3	0.0042***	0.0041***	0.0098***	0.0033***	0.0032***
	(1.13e-04)	(1.12e-04)	(3.98e-04)	(1.49e-04)	(1.86e-04)
Income quartile: 4	0.0035***	0.0031***	0.0063***	0.0026***	0.0006***
	(1.53e-04)	(1.53e-04)	(4.54e-04)	(2.21e-04)	(2.18e-04)
% of owned outright properties	0.0524***	0.0553***	0.0285***	0.0562***	0.0694***
	(2.59e-03)	(2.54e-03)	(7.05e-03)	(3.94e-03)	(3.53e-03)
% of rented out properties	0.1649***	0.1653***	0.1017***	0.1692***	0.1875***
	(3.09e-03)	(3.05e-03)	(9.39e-03)	(4.18e-03)	(4.47e-03)
% of second homes	0.3146***	0.3124***	0.2980***	0.2862***	0.3148***
	(3.56e-03)	(3.52e-03)	(9.83e-03)	(4.64e-03)	(6.13e-03)
Construction year: 1945-1959	0.0144***	0.0172***	-0.0403**	-0.0750***	0.0635***
	(3.91e-03)	(3.87e-03)	(1.57e-02)	(7.87e-03)	(4.40e-03)
Construction year: 1960-1979	0.0560***	0.0652***	0.1259***	-0.0905***	0.1240***
	(3.44e-03)	(3.44e-03)	(1.40e-02)	(7.36e-03)	(3.84e-03)
Construction year: 1980-1999	0.1048***	0.1138***	0.2355***	-0.0590***	0.1906***

	(4.11e-03)	(4.09e-03)	(1.47e-02)	(7.75e-03)	(7.24e-03)
Construction year: 2000-2023	0.0522***	0.0568***	0.2218***	-0.1055***	0.0347*
	(5.60e-03)	(5.66e-03)	(1.74e-02)	(8.91e-03)	(2.04e-02)
Constant	6.7444***	7.3038***	6.7151***	6.9305***	6.1927***
	(1.28e-02)	(2.78e-02)	(4.29e-02)	(2.18e-02)	(1.75e-02)
Observations	84,821	84,821	16,975	39,392	28,454
R-squared	0.669	0.678	0.714	0.684	0.566
Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10.*

Source: Authors' elaborations on EPCs data.

Table A2 – Quantile regression models: pooled sample (dependent variable: log minimum house price by micro-area)

	Pooling			Pooling interacted		
	q1	q2	q3	q1	q2	q3
	(1)	(2)	(3)	(4)	(5)	(6)
Energy class: E	0.0069	-0.0279***	-0.0828***	-0.1677***	-0.0791	-0.2353***
	(6.23e-03)	(7.75e-03)	(8.85e-03)	(1.06e-02)	(5.52e-02)	(1.60e-02)
Energy class: F	-0.0190***	-0.0707***	-0.1426***	-0.2165***	-0.1470***	-0.2960***
	(6.51e-03)	(7.98e-03)	(9.03e-03)	(9.76e-03)	(5.48e-02)	(1.59e-02)
Energy class: G	-0.0840***	-0.1318***	-0.2111***	-0.4126***	-0.3511***	-0.5231***
	(7.09e-03)	(8.38e-03)	(9.55e-03)	(9.94e-03)	(5.48e-02)	(1.67e-02)
Region: Lombardy				-0.4614***	-0.4353***	-0.6112***
				(1.55e-02)	(6.17e-02)	(2.13e-02)
Region: Piedmont				-0.8564***	-0.7878***	-0.9838***
				(1.62e-02)	(5.59e-02)	(2.27e-02)
Class E # Lombardy				0.1609***	0.0363	0.1604***
				(1.44e-02)	(6.20e-02)	(2.13e-02)
Class E # Piedmont				0.1888***	0.0671	0.1742***
				(1.32e-02)	(5.58e-02)	(1.99e-02)
Class F # Lombardy				0.1925***	0.0650	0.1240***
				(1.34e-02)	(6.13e-02)	(1.97e-02)
Class F # Piedmont				0.2010***	0.0995*	0.1956***
				(1.27e-02)	(5.54e-02)	(1.98e-02)
Class G # Lombardy				0.3802***	0.2715***	0.3469***
				(1.35e-02)	(6.13e-02)	(2.06e-02)
Class G # Piedmont				0.3506***	0.2386***	0.3438***
				(1.33e-02)	(5.55e-02)	(2.06e-02)
Climate zone: F	0.0038	-0.0048	-0.0156***	-0.0070*	-0.0212***	-0.0346***
	(4.08e-03)	(3.90e-03)	(4.83e-03)	(3.95e-03)	(3.76e-03)	(4.33e-03)
Population density	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(1.08e-06)	(1.64e-06)	(2.82e-06)	(1.07e-06)	(1.56e-06)	(2.78e-06)
Altitude	-0.0001***	-0.0001***	-0.0000	-0.0000*	-0.0000	0.0001***
	(9.58e-06)	(8.11e-06)	(1.14e-05)	(8.85e-06)	(7.85e-06)	(1.04e-05)
Income quartile: 2	0.0004***	0.0000	-0.0002**	0.0004***	-0.0000	-0.0002*
	(8.33e-05)	(9.10e-05)	(1.08e-04)	(8.20e-05)	(8.96e-05)	(1.05e-04)
Income quartile: 3	0.0027***	0.0030***	0.0037***	0.0026***	0.0029***	0.0037***
	(9.49e-05)	(1.05e-04)	(1.24e-04)	(9.11e-05)	(1.02e-04)	(1.24e-04)
Income quartile: 4	-0.0004**	0.0022***	0.0065***	-0.0007***	0.0019***	0.0060***
	(1.60e-04)	(1.67e-04)	(2.54e-04)	(1.66e-04)	(1.63e-04)	(2.34e-04)
% of owned outright properties	0.0369***	0.0402***	0.0461***	0.0353***	0.0475***	0.0471***
	(2.56e-03)	(2.19e-03)	(2.38e-03)	(2.54e-03)	(2.12e-03)	(2.29e-03)
% of rented out properties	0.1151***	0.1330***	0.1577***	0.1141***	0.1305***	0.1582***
	(2.92e-03)	(2.75e-03)	(2.90e-03)	(2.89e-03)	(2.72e-03)	(2.92e-03)
% of second homes	0.2159***	0.2701***	0.3135***	0.2134***	0.2662***	0.3083***
	(3.55e-03)	(3.32e-03)	(3.64e-03)	(3.49e-03)	(3.33e-03)	(3.58e-03)
Construction year: 1945-1959	0.0378***	0.0374***	0.0178***	0.0408***	0.0384***	0.0197***
	(3.83e-03)	(3.54e-03)	(3.69e-03)	(3.80e-03)	(3.39e-03)	(3.56e-03)
Construction year: 1960-1979	0.0862***	0.0699***	0.0389***	0.0873***	0.0736***	0.0525***
	(3.46e-03)	(3.07e-03)	(3.39e-03)	(3.53e-03)	(3.13e-03)	(3.38e-03)
Construction year: 1980-1999	0.1268***	0.1081***	0.0712***	0.1294***	0.1142***	0.0785***

	(3.92e-03)	(3.59e-03)	(3.97e-03)	(4.03e-03)	(3.60e-03)	(3.98e-03)
Construction year: 2000-2023	0.0892***	0.0630***	0.0262***	0.0959***	0.0706***	0.0265***
	(4.88e-03)	(5.12e-03)	(5.69e-03)	(4.74e-03)	(5.29e-03)	(5.33e-03)
Constant	6.6755***	6.7693***	6.9077***	7.1291***	7.2029***	7.5258***
	(1.03e-02)	(1.19e-02)	(1.42e-02)	(1.46e-02)	(5.54e-02)	(2.08e-02)
Observations	84,821	84,821	84,821	84,821	84,821	84,821
Province dummies	YES	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES	YES

*Note: Bootstrapped standard errors in parentheses (100 replications). *** p<0.01, ** p<0.05, * p<0.10.*
Province dummies and semester dummies are not displayed.
Source: Authors' elaborations on EPCs data.

Table A3 - Quantile regression models by region (dependent variable: log minimum house price by micro-area)

	Emilia-Romagna			Lombardy			Piedmont		
	q1	q2	q3	q1	q2	q3	q1	q2	q3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Energy class: E	-0.2071***	-0.1542***	-0.1610***	0.0056	-0.0602	-0.0643***	0.0219***	-0.0019	-0.0395***
	(1.70e-02)	(1.78e-02)	(3.86e-02)	(1.29e-02)	(4.56e-02)	(1.50e-02)	(7.46e-03)	(9.24e-03)	(8.78e-03)
Energy class: F	-0.2060***	-0.1919***	-0.1967***	-0.0165	-0.1126**	-0.1710***	-0.0051	-0.0176*	-0.0644***
	(1.69e-02)	(1.95e-02)	(4.06e-02)	(1.29e-02)	(4.54e-02)	(1.36e-02)	(8.46e-03)	(9.92e-03)	(9.38e-03)
Energy class: G	-0.2962***	-0.3139***	-0.3177***	-0.0569***	-0.1504***	-0.2237***	-0.0440***	-0.0718***	-0.1401***
	(1.85e-02)	(2.05e-02)	(4.14e-02)	(1.31e-02)	(4.55e-02)	(1.42e-02)	(9.90e-03)	(1.08e-02)	(1.01e-02)
Climate zone: F	0.0806***	0.0114	0.0123	-0.0199***	-0.0552***	-0.0752***	-0.0138**	-0.0317***	-0.0707***
	(1.43e-02)	(1.10e-02)	(1.58e-02)	(4.75e-03)	(6.86e-03)	(7.15e-03)	(6.05e-03)	(4.97e-03)	(6.00e-03)
Population density	0.0002***	0.0002***	0.0002***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(4.66e-06)	(4.02e-06)	(9.13e-06)	(1.16e-06)	(2.67e-06)	(2.85e-06)	(2.68e-06)	(3.03e-06)	(2.22e-06)
Altitude	-0.0002***	-0.0002***	-0.0002***	0.0000***	0.0001***	0.0001***	0.0001***	0.0001***	0.0002***
	(1.99e-05)	(1.53e-05)	(1.65e-05)	(1.01e-05)	(1.28e-05)	(1.58e-05)	(1.65e-05)	(1.30e-05)	(1.65e-05)
Income quartile: 2	0.0018***	0.0023***	-0.0008	0.0002***	0.0001	-0.0003*	0.0005***	0.0001	0.0004**
	(3.47e-04)	(3.64e-04)	(4.81e-04)	(8.43e-05)	(1.26e-04)	(1.60e-04)	(1.83e-04)	(1.59e-04)	(1.59e-04)
Income quartile: 3	0.0084***	0.0093***	0.0066***	0.0015***	0.0026***	0.0037***	0.0025***	0.0018***	0.0027***

	(3.41e-04)	(4.13e-04)	(5.15e-04)	(9.91e-05)	(1.54e-04)	(1.87e-04)	(1.88e-04)	(1.57e-04)	(1.85e-04)
Income quartile: 4	0.0003	0.0044***	0.0088***	-0.0006***	0.0017***	0.0065***	-0.0022***	0.0001	0.0042***
	(8.27e-04)	(4.20e-04)	(3.95e-04)	(1.79e-04)	(2.24e-04)	(3.89e-04)	(2.02e-04)	(2.38e-04)	(2.90e-04)
% of owned outright properties	0.0562***	0.0513***	0.0435***	0.0423***	0.0475***	0.0306***	0.0445***	0.0491***	0.0665***
	(5.68e-03)	(5.63e-03)	(7.11e-03)	(3.52e-03)	(3.26e-03)	(3.83e-03)	(3.76e-03)	(3.10e-03)	(3.62e-03)
% of rented out properties	0.1368***	0.1134***	0.1259***	0.1133***	0.1262***	0.1389***	0.1151***	0.1505***	0.1875***
	(6.63e-03)	(6.95e-03)	(1.02e-02)	(3.90e-03)	(3.88e-03)	(4.58e-03)	(4.65e-03)	(4.25e-03)	(4.71e-03)
% of second homes	0.2828***	0.2997***	0.3143***	0.1841***	0.2185***	0.2558***	0.2084***	0.2740***	0.3461***
	(7.48e-03)	(7.33e-03)	(1.09e-02)	(4.73e-03)	(4.43e-03)	(5.23e-03)	(7.07e-03)	(6.49e-03)	(5.51e-03)
Construction year: 1945-1959	0.0253*	-0.0151	-0.0075	-0.0008	-0.0356***	-0.1073***	0.0484***	0.0576***	0.0518***
	(1.44e-02)	(1.14e-02)	(1.51e-02)	(6.09e-03)	(6.23e-03)	(1.20e-02)	(5.06e-03)	(4.25e-03)	(4.38e-03)
Construction year: 1960-1979	0.1361***	0.0834***	0.0863***	-0.0031	-0.0451***	-0.1289***	0.1118***	0.1131***	0.1109***
	(1.27e-02)	(1.10e-02)	(1.44e-02)	(5.69e-03)	(6.20e-03)	(1.18e-02)	(4.24e-03)	(3.58e-03)	(3.97e-03)
Construction year: 1980-1999	0.2532***	0.1891***	0.1745***	0.0210***	-0.0282***	-0.1238***	0.1825***	0.1777***	0.1463***
	(1.39e-02)	(1.25e-02)	(1.47e-02)	(6.08e-03)	(6.40e-03)	(1.22e-02)	(7.02e-03)	(6.08e-03)	(6.34e-03)
Construction year: 2000-2023	0.2463***	0.1496***	0.1019***	0.0013	-0.0676***	-0.1596***	0.0383	0.0486***	0.0649***
	(1.66e-02)	(1.64e-02)	(1.76e-02)	(6.62e-03)	(7.46e-03)	(1.31e-02)	(3.02e-02)	(1.91e-02)	(1.94e-02)
Constant	6.5548***	6.6691***	7.0402***	6.8107***	6.9759***	7.1474***	6.1333***	6.3397***	6.4351***

	(3.23e-02)	(3.98e-02)	(4.82e-02)	(1.51e-02)	(4.69e-02)	(2.37e-02)	(1.83e-02)	(1.58e-02)	(1.71e-02)
Observations	16,975	16,975	16,975	39,392	39,392	39,392	28,454	28,454	28,454
Province dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Note: Bootstrapped standard errors in parentheses (100 replications). *** p<0.01, ** p<0.05, * p<0.10. Province dummies and semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Table A4 – Fixed effects panel data models (dependent variable: log minimum house price by micro-area)

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	0.0012	0.0017	0.0027	0.0018*	-0.0020
	(8.30e-04)	(2.14e-03)	(2.04e-03)	(1.09e-03)	(1.26e-03)
Energy class: F	-0.0029***	0.0010	0.0021	-0.0021*	-0.0018
	(8.16e-04)	(1.93e-03)	(1.83e-03)	(1.09e-03)	(1.23e-03)
Energy class: G	-0.0064***	-0.0014	-0.0017	-0.0022*	-0.0024*
	(8.87e-04)	(1.92e-03)	(1.90e-03)	(1.15e-03)	(1.37e-03)
Class E # Lombardy		-0.0010			
		(2.43e-03)			
Class E # Piedmont		-0.0026			
		(2.46e-03)			
Class F # Lombardy		-0.0115***			
		(2.22e-03)			
Class F # Piedmont		-0.0008			
		(2.22e-03)			
Class G # Lombardy		-0.0156***			
		(2.24e-03)			
Class G # Piedmont		0.0018			
		(2.25e-03)			
Population density	0.0000*	0.0000	0.0000***	0.0000	-0.0000
	(7.67e-07)	(7.60e-07)	(3.59e-06)	(9.37e-07)	(9.85e-07)
Income quartile: 2	0.0000	0.0000	-0.0001**	0.0000	-0.0000
	(9.67e-06)	(9.69e-06)	(2.87e-05)	(1.13e-05)	(1.62e-05)
Income quartile: 3	0.0000***	0.0000***	-0.0000	0.0000	0.0000
	(1.13e-05)	(1.13e-05)	(3.37e-05)	(1.38e-05)	(1.87e-05)
Income quartile: 4	0.0000***	0.0000***	0.0001***	0.0000	0.0000
	(1.49e-05)	(1.49e-05)	(4.81e-05)	(1.50e-05)	(2.01e-05)
% of owned outright properties	-0.0164***	-0.0162***	-0.0068**	-0.0167***	-0.0117***
	(1.75e-03)	(1.75e-03)	(2.69e-03)	(2.78e-03)	(2.77e-03)
% of rented out properties	-0.0222***	-0.0219***	-0.0042	-0.0260***	-0.0149***
	(2.24e-03)	(2.23e-03)	(4.03e-03)	(3.28e-03)	(3.69e-03)
% of second homes	-0.0163***	-0.0161***	0.0100*	-0.0267***	-0.0122**
	(2.73e-03)	(2.72e-03)	(5.25e-03)	(3.64e-03)	(5.05e-03)
Construction year: 1945-1959	-0.0013	-0.0009	0.0005	-0.0007	-0.0009
	(8.39e-04)	(8.37e-04)	(1.55e-03)	(1.03e-03)	(1.33e-03)
Construction year: 1960-1979	-0.0014**	-0.0009	-0.0002	-0.0010	-0.0013
	(7.08e-04)	(7.04e-04)	(1.43e-03)	(9.60e-04)	(1.02e-03)
Construction year: 1980-1999	-0.0004	-0.0001	-0.0006	-0.0008	0.0008
	(7.69e-04)	(7.68e-04)	(1.61e-03)	(1.05e-03)	(1.27e-03)
Construction year: 2000-2023	0.0006	-0.0004	-0.0000	-0.0006	-0.0002
	(9.06e-04)	(9.05e-04)	(1.92e-03)	(1.13e-03)	(1.76e-03)
Constant	6.8409***	6.8433***	6.8989***	6.9604***	6.6506***
	(2.03e-03)	(2.03e-03)	(4.22e-03)	(3.09e-03)	(2.94e-03)
Observations	79,467	79,467	16,968	34,416	28,083
R-squared	0.170	0.173	0.197	0.044	0.342

Number of micro areas	7,146	7,146	1,338	3,211	2,597
Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Table A5 – Fixed effects panel data models, balanced sample with all 14 semesters (dependent variable: log minimum house price by micro-area)

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	0.0000	0.0023	0.0031	0.0015	-0.0039**
	(1.25e-03)	(2.18e-03)	(2.20e-03)	(1.72e-03)	(1.93e-03)
Energy class: F	-0.0045***	0.0009	0.0023	-0.0018	-0.0034*
	(1.30e-03)	(2.10e-03)	(2.15e-03)	(1.74e-03)	(2.03e-03)
Energy class: G	-0.0092***	-0.0019	-0.0009	-0.0019	-0.0035
	(1.42e-03)	(2.32e-03)	(2.36e-03)	(1.79e-03)	(2.40e-03)
Class E # Lombardy		-0.0047*			
		(2.83e-03)			
Class E # Piedmont		-0.0045			
		(2.85e-03)			
Class F # Lombardy		-0.0166***			
		(2.80e-03)			
Class F # Piedmont		-0.0003			
		(2.80e-03)			
Class G # Lombardy		-0.0232***			
		(3.06e-03)			
Class G # Piedmont		0.0031			
		(3.15e-03)			
Population density	0.0000	0.0000	0.0000***	0.0000	-0.0000
	(8.87e-07)	(8.79e-07)	(3.86e-06)	(1.09e-06)	(1.14e-06)
Income quartile: 2	0.0000	-0.0000	-0.0001**	0.0000*	-0.0000
	(1.68e-05)	(1.67e-05)	(3.48e-05)	(1.76e-05)	(3.24e-05)
Income quartile: 3	0.0001***	0.0001***	-0.0000	0.0000**	-0.0000
	(1.88e-05)	(1.87e-05)	(3.87e-05)	(1.92e-05)	(3.56e-05)
Income quartile: 4	0.0001***	0.0001***	0.0001**	0.0000	0.0001
	(3.63e-05)	(3.59e-05)	(6.95e-05)	(4.25e-05)	(4.87e-05)
% of owned outright properties	-0.0163***	-0.0159***	-0.0074**	-0.0078**	-0.0171***
	(2.51e-03)	(2.50e-03)	(3.02e-03)	(3.11e-03)	(5.06e-03)
% of rented out properties	-0.0225***	-0.0219***	-0.0036	-0.0155***	-0.0206***
	(3.19e-03)	(3.18e-03)	(4.66e-03)	(3.98e-03)	(6.36e-03)
% of second homes	-0.0209***	-0.0203***	0.0073	-0.0208***	-0.0230***
	(3.79e-03)	(3.77e-03)	(5.55e-03)	(4.60e-03)	(8.23e-03)
Construction year: 1945-1959	-0.0017	-0.0013	0.0005	-0.0003	-0.0015
	(1.31e-03)	(1.31e-03)	(2.01e-03)	(1.58e-03)	(2.08e-03)
Construction year: 1960-1979	-0.0014	-0.0007	0.0004	0.0008	-0.0022
	(1.20e-03)	(1.19e-03)	(1.92e-03)	(1.71e-03)	(1.73e-03)
Construction year: 1980-1999	-0.0004	-0.0000	0.0006	0.0006	-0.0009
	(1.22e-03)	(1.22e-03)	(2.05e-03)	(1.73e-03)	(2.01e-03)
Construction year: 2000-2023	-0.0000	-0.0012	0.0008	-0.0005	-0.0015
	(1.39e-03)	(1.39e-03)	(2.37e-03)	(1.80e-03)	(2.80e-03)
Constant	6.9604***	6.9637***	6.9504***	7.0695***	6.7925***
	(3.41e-03)	(3.35e-03)	(4.99e-03)	(4.20e-03)	(6.02e-03)
Observations	46,662	46,662	13,188	19,614	13,860

R-squared	0.146	0.151	0.219	0.024	0.328
Number of micro areas	3,333	3,333	942	1,401	990
Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Table A6 - Hedonic regression models (dependent variable: log maximum house price by micro-area)

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	-0.0483***	-0.2122***	-0.2070***	-0.0431**	-0.0321***
	(7.83e-03)	(2.76e-02)	(2.66e-02)	(1.81e-02)	(9.00e-03)
Energy class: F	-0.1143***	-0.2524***	-0.2098***	-0.1391***	-0.0678***
	(8.00e-03)	(2.73e-02)	(2.70e-02)	(1.75e-02)	(9.92e-03)
Energy class: G	-0.2067***	-0.4947***	-0.3439***	-0.2007***	-0.1513***
	(8.48e-03)	(2.76e-02)	(2.79e-02)	(1.76e-02)	(1.11e-02)
Region: Lombardy		-0.6214***			
		(3.35e-02)			
Region: Piedmont		-0.8122***			
		(3.02e-02)			
Class E # Lombardy		0.1652***			
		(3.32e-02)			
Class E # Piedmont		0.1745***			
		(2.88e-02)			
Class F # Lombardy		0.1104***			
		(3.23e-02)			
Class F # Piedmont		0.1620***			
		(2.85e-02)			
Class G # Lombardy		0.3368***			
		(3.26e-02)			
Class G # Piedmont		0.3092***			
		(2.90e-02)			
Climate zone: F	-0.0413***	-0.0516***	-0.0267*	-0.0868***	-0.0691***
	(4.31e-03)	(4.23e-03)	(1.38e-02)	(6.54e-03)	(5.68e-03)
Population density	0.0001***	0.0001***	0.0002***	0.0001***	0.0001***
	(1.50e-06)	(1.50e-06)	(5.41e-06)	(1.82e-06)	(2.54e-06)
Altitude	0.0001***	0.0001***	-0.0002***	0.0002***	0.0003***
	(9.57e-06)	(9.44e-06)	(1.57e-05)	(1.46e-05)	(1.52e-05)
Income quartile: 2	0.0004***	0.0005***	0.0016***	0.0003***	0.0010***
	(1.02e-04)	(1.01e-04)	(3.79e-04)	(1.27e-04)	(1.78e-04)
Income quartile: 3	0.0044***	0.0043***	0.0095***	0.0035***	0.0035***
	(1.13e-04)	(1.12e-04)	(3.79e-04)	(1.51e-04)	(1.85e-04)
Income quartile: 4	0.0037***	0.0034***	0.0059***	0.0033***	0.0007***
	(1.49e-04)	(1.48e-04)	(4.30e-04)	(2.16e-04)	(2.15e-04)
% of owned outright properties	0.0496***	0.0522***	0.0159**	0.0518***	0.0701***
	(2.57e-03)	(2.52e-03)	(7.12e-03)	(3.90e-03)	(3.48e-03)
% of rented out properties	0.1627***	0.1634***	0.0821***	0.1647***	0.1931***
	(3.07e-03)	(3.02e-03)	(9.26e-03)	(4.19e-03)	(4.43e-03)
% of second homes	0.3118***	0.3101***	0.2792***	0.2830***	0.3184***
	(3.54e-03)	(3.50e-03)	(9.73e-03)	(4.64e-03)	(6.14e-03)
Construction year: 1945-1959	0.0177***	0.0196***	-0.0415***	-0.0811***	0.0662***
	(3.86e-03)	(3.84e-03)	(1.52e-02)	(7.89e-03)	(4.36e-03)
Construction year: 1960-1979	0.0609***	0.0692***	0.1089***	-0.0879***	0.1296***
	(3.42e-03)	(3.44e-03)	(1.35e-02)	(7.37e-03)	(3.85e-03)
Construction year: 1980-1999	0.1036***	0.1121***	0.2053***	-0.0599***	0.1957***

	(4.10e-03)	(4.07e-03)	(1.41e-02)	(7.75e-03)	(7.28e-03)
Construction year: 2000-2023	0.0536***	0.0575***	0.1756***	-0.1022***	0.0486**
	(5.57e-03)	(5.62e-03)	(1.66e-02)	(8.91e-03)	(2.03e-02)
Constant	6.9511***	7.5745***	6.9776***	7.1472***	6.5166***
	(1.28e-02)	(2.94e-02)	(4.24e-02)	(2.21e-02)	(1.75e-02)
Observations	84,821	84,821	16,975	39,392	28,454
R-squared	0.643	0.651	0.707	0.662	0.592
Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10.*

Source: Authors' elaborations on EPCs data.

Table A7 – Quantile regression models: pooled sample (dependent variable: log maximum house price by micro-area)

	Pooling			Pooling interacted		
	q1	q2	q3	q1	q2	q3
	(1)	(2)	(3)	(4)	(5)	(6)
Energy class: E	0.0154**	-0.0227***	-0.0798***	-0.1175***	0.0021	-0.2501***
	(7.28e-03)	(8.01e-03)	(8.55e-03)	(1.50e-02)	(2.50e-02)	(1.89e-02)
Energy class: F	-0.0159**	-0.0702***	-0.1420***	-0.1728***	-0.0680***	-0.3160***
	(7.51e-03)	(8.32e-03)	(8.67e-03)	(1.43e-02)	(2.42e-02)	(1.83e-02)
Energy class: G	-0.0739***	-0.1362***	-0.2096***	-0.3379***	-0.2512***	-0.5083***
	(7.97e-03)	(8.77e-03)	(9.10e-03)	(1.49e-02)	(2.44e-02)	(1.90e-02)
Region: Lombardy				-0.4824***	-0.4829***	-0.7285***
				(2.10e-02)	(3.69e-02)	(2.38e-02)
Region: Piedmont				-0.7368***	-0.6397***	-0.9393***
				(1.89e-02)	(2.70e-02)	(2.37e-02)
Class E # Lombardy				0.1190***	-0.0100	0.1755***
				(2.05e-02)	(3.70e-02)	(2.36e-02)
Class E # Piedmont				0.1432***	-0.0204	0.1942***
				(1.67e-02)	(2.63e-02)	(2.16e-02)
Class F # Lombardy				0.1468***	0.0145	0.1403***
				(1.97e-02)	(3.59e-02)	(2.23e-02)
Class F # Piedmont				0.1653***	0.0095	0.2176***
				(1.63e-02)	(2.56e-02)	(2.11e-02)
Class G # Lombardy				0.3038***	0.1904***	0.3291***
				(2.01e-02)	(3.59e-02)	(2.30e-02)
Class G # Piedmont				0.2827***	0.1182***	0.3301***
				(1.69e-02)	(2.59e-02)	(2.18e-02)
Climate zone: F	0.0025	-0.0096**	-0.0131***	-0.0062*	-0.0235***	-0.0287***
	(3.72e-03)	(3.75e-03)	(4.02e-03)	(3.74e-03)	(3.87e-03)	(3.85e-03)
Population density	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(9.85e-07)	(1.62e-06)	(2.74e-06)	(9.92e-07)	(1.61e-06)	(2.95e-06)
Altitude	-0.0001***	-0.0000***	-0.0000	-0.0000	0.0000	0.0000***
	(8.72e-06)	(7.67e-06)	(9.70e-06)	(8.86e-06)	(7.92e-06)	(9.36e-06)
Income quartile: 2	0.0004***	0.0002**	-0.0001	0.0003***	0.0002**	-0.0002**
	(7.90e-05)	(8.95e-05)	(1.04e-04)	(8.16e-05)	(8.33e-05)	(9.67e-05)
Income quartile: 3	0.0027***	0.0033***	0.0041***	0.0025***	0.0033***	0.0039***
	(8.97e-05)	(1.00e-04)	(1.24e-04)	(9.07e-05)	(9.75e-05)	(1.18e-04)
Income quartile: 4	-0.0005***	0.0024***	0.0071***	-0.0007***	0.0020***	0.0066***
	(1.43e-04)	(1.69e-04)	(2.40e-04)	(1.39e-04)	(1.57e-04)	(1.98e-04)
% of owned outright properties	0.0379***	0.0375***	0.0464***	0.0372***	0.0444***	0.0506***
	(2.37e-03)	(2.14e-03)	(2.33e-03)	(2.24e-03)	(2.10e-03)	(2.22e-03)
% of rented out properties	0.1173***	0.1307***	0.1602***	0.1166***	0.1329***	0.1624***
	(2.67e-03)	(2.65e-03)	(2.67e-03)	(2.63e-03)	(2.64e-03)	(2.70e-03)
% of second homes	0.2135***	0.2646***	0.3164***	0.2117***	0.2635***	0.3123***
	(3.34e-03)	(3.35e-03)	(3.26e-03)	(3.31e-03)	(3.26e-03)	(3.16e-03)
Construction year: 1945-1959	0.0352***	0.0385***	0.0167***	0.0375***	0.0383***	0.0189***
	(3.42e-03)	(3.40e-03)	(3.60e-03)	(3.60e-03)	(3.31e-03)	(3.40e-03)
Construction year: 1960-1979	0.0868***	0.0749***	0.0460***	0.0907***	0.0743***	0.0524***
	(3.14e-03)	(2.96e-03)	(3.13e-03)	(3.24e-03)	(2.93e-03)	(3.07e-03)
Construction year: 1980-1999	0.1210***	0.1061***	0.0739***	0.1246***	0.1079***	0.0743***

	(3.75e-03)	(3.56e-03)	(3.68e-03)	(3.85e-03)	(3.46e-03)	(3.65e-03)
Construction year: 2000-2023	0.0854***	0.0748***	0.0344***	0.0955***	0.0841***	0.0282***
	(4.64e-03)	(5.10e-03)	(5.17e-03)	(4.55e-03)	(5.26e-03)	(4.98e-03)
Constant	6.8973***	6.9621***	7.0935***	7.3822***	7.4199***	7.8507***
	(1.06e-02)	(1.19e-02)	(1.36e-02)	(1.74e-02)	(2.58e-02)	(2.18e-02)
Observations	84,821	84,821	84,821	84,821	84,821	84,821
Province dummies	YES	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES	YES

*Note: Bootstrapped standard errors in parentheses (100 replications). *** p<0.01, ** p<0.05, * p<0.10.*
Province dummies and semester dummies are not displayed.
Source: Authors' elaborations on EPCs data.

Table A8 - Quantile regression models by region (dependent variable: log maximum house price by micro-area)

	Emilia-Romagna			Lombardy			Piedmont		
	q1	q2	q3	q1	q2	q3	q1	q2	q3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Energy class: E	-0.1882***	-0.1532***	-0.2373***	0.0022	-0.0348	-0.0701***	0.0220***	0.0021	-0.0362***
	(1.95e-02)	(2.11e-02)	(3.65e-02)	(1.57e-02)	(2.67e-02)	(1.59e-02)	(7.51e-03)	(7.99e-03)	(8.38e-03)
Energy class: F	-0.1777***	-0.2024***	-0.2736***	-0.0248	-0.0984***	-0.1795***	-0.0062	-0.0151*	-0.0566***
	(1.91e-02)	(2.30e-02)	(3.81e-02)	(1.56e-02)	(2.61e-02)	(1.47e-02)	(8.56e-03)	(8.80e-03)	(9.06e-03)
Energy class: G	-0.2619***	-0.3143***	-0.3872***	-0.0624***	-0.1465***	-0.2295***	-0.0430***	-0.0757***	-0.1336***
	(2.06e-02)	(2.39e-02)	(3.87e-02)	(1.60e-02)	(2.62e-02)	(1.55e-02)	(9.73e-03)	(9.84e-03)	(1.00e-02)
Climate zone: F	0.0458***	-0.0174	-0.0047	-0.0272***	-0.0460***	-0.0556***	-0.0081	-0.0257***	-0.0673***
	(1.64e-02)	(1.16e-02)	(1.58e-02)	(5.31e-03)	(6.55e-03)	(6.83e-03)	(5.78e-03)	(4.87e-03)	(6.42e-03)
Population density	0.0002***	0.0002***	0.0002***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(3.95e-06)	(5.24e-06)	(1.02e-05)	(1.15e-06)	(2.15e-06)	(3.21e-06)	(3.05e-06)	(3.08e-06)	(2.57e-06)
Altitude	-0.0002***	-0.0002***	-0.0002***	0.0001***	0.0001***	0.0001***	0.0000***	0.0001***	0.0002***
	(2.25e-05)	(1.54e-05)	(1.56e-05)	(1.07e-05)	(1.26e-05)	(1.52e-05)	(1.56e-05)	(1.30e-05)	(1.78e-05)
Income quartile: 2	0.0021***	0.0019***	-0.0001	0.0001	0.0000	-0.0004***	0.0005***	0.0005***	0.0005***
	(3.58e-04)	(3.61e-04)	(5.06e-04)	(8.52e-05)	(1.26e-04)	(1.49e-04)	(1.78e-04)	(1.61e-04)	(1.51e-04)
Income quartile: 3	0.0083***	0.0094***	0.0065***	0.0016***	0.0028***	0.0039***	0.0024***	0.0022***	0.0028***

	(3.55e-04)	(3.95e-04)	(4.82e-04)	(9.76e-05)	(1.47e-04)	(1.87e-04)	(1.89e-04)	(1.53e-04)	(1.82e-04)
Income quartile: 4	-0.0001	0.0041***	0.0089***	0.0003	0.0020***	0.0075***	-0.0022***	0.0001	0.0040***
	(7.39e-04)	(5.12e-04)	(4.53e-04)	(2.21e-04)	(2.63e-04)	(3.04e-04)	(1.86e-04)	(2.30e-04)	(2.99e-04)
% of owned outright properties	0.0380***	0.0339***	0.0551***	0.0400***	0.0433***	0.0348***	0.0417***	0.0462***	0.0691***
	(5.56e-03)	(5.54e-03)	(7.38e-03)	(3.17e-03)	(3.23e-03)	(3.92e-03)	(3.59e-03)	(2.85e-03)	(3.84e-03)
% of rented out properties	0.1231***	0.0898***	0.1117***	0.1196***	0.1313***	0.1494***	0.1141***	0.1514***	0.1939***
	(5.87e-03)	(6.36e-03)	(9.58e-03)	(3.67e-03)	(3.84e-03)	(4.38e-03)	(4.41e-03)	(3.91e-03)	(5.02e-03)
% of second homes	0.2778***	0.2818***	0.3025***	0.1830***	0.2193***	0.2698***	0.2046***	0.2732***	0.3400***
	(6.94e-03)	(7.22e-03)	(1.05e-02)	(4.33e-03)	(4.70e-03)	(5.14e-03)	(7.09e-03)	(6.46e-03)	(6.04e-03)
Construction year: 1945-1959	0.0007	-0.0097	-0.0089	-0.0106*	-0.0364***	-0.0923***	0.0539***	0.0566***	0.0490***
	(1.28e-02)	(1.40e-02)	(1.37e-02)	(6.07e-03)	(6.96e-03)	(1.01e-02)	(4.67e-03)	(3.95e-03)	(4.45e-03)
Construction year: 1960-1979	0.0978***	0.0716***	0.0733***	0.0172***	-0.0373***	-0.1083***	0.1092***	0.1148***	0.1142***
	(1.08e-02)	(1.35e-02)	(1.28e-02)	(5.84e-03)	(6.74e-03)	(9.54e-03)	(4.13e-03)	(3.33e-03)	(3.91e-03)
Construction year: 1980-1999	0.1954***	0.1725***	0.1564***	0.0354***	-0.0236***	-0.1011***	0.1805***	0.1755***	0.1514***
	(1.21e-02)	(1.45e-02)	(1.26e-02)	(6.41e-03)	(7.05e-03)	(9.62e-03)	(7.11e-03)	(5.77e-03)	(6.26e-03)
Construction year: 2000-2023	0.1719***	0.1104***	0.0828***	0.0132*	-0.0456***	-0.1378***	0.0263	0.0715*	0.0748***
	(1.57e-02)	(1.88e-02)	(1.48e-02)	(6.83e-03)	(8.16e-03)	(1.09e-02)	(1.88e-02)	(4.03e-02)	(1.63e-02)
Constant	6.8030***	6.9644***	7.3135***	7.0337***	7.1613***	7.3375***	6.4925***	6.6666***	6.7752***

	(3.50e-02)	(4.10e-02)	(4.48e-02)	(1.68e-02)	(3.09e-02)	(2.17e-02)	(1.73e-02)	(1.50e-02)	(1.66e-02)
Observations	16,975	16,975	16,975	39,392	39,392	39,392	28,454	28,454	28,454
Province dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Note: Bootstrapped standard errors in parentheses (100 replications). *** p<0.01, ** p<0.05, * p<0.10. Province dummies and semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Table A9 – Fixed effects panel data models (dependent variable: log maximum house price by micro-area)

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	0.0011	0.0018	0.0024	0.0017	-0.0015
	(7.73e-04)	(2.10e-03)	(2.02e-03)	(1.09e-03)	(1.16e-03)
Energy class: F	-0.0035***	-0.0001	0.0012	-0.0033***	-0.0021*
	(7.71e-04)	(1.92e-03)	(1.87e-03)	(1.08e-03)	(1.15e-03)
Energy class: G	-0.0057***	-0.0041**	-0.0026	-0.0020*	-0.0014
	(8.25e-04)	(1.93e-03)	(1.96e-03)	(1.14e-03)	(1.25e-03)
Class E # Lombardy		-0.0011			
		(2.40e-03)			
Class E # Piedmont		-0.0026			
		(2.37e-03)			
Class F # Lombardy		-0.0103***			
		(2.22e-03)			
Class F # Piedmont		-0.0007			
		(2.18e-03)			
Class G # Lombardy		-0.0102***			
		(2.24e-03)			
Class G # Piedmont		0.0047**			
		(2.21e-03)			
Population density	0.0000***	0.0000***	0.0000***	0.0000***	-0.0000
	(7.06e-07)	(6.99e-07)	(3.68e-06)	(1.16e-06)	(8.08e-07)
Income quartile: 2	0.0000*	0.0000	-0.0001**	0.0000	0.0000
	(8.58e-06)	(8.59e-06)	(2.91e-05)	(1.05e-05)	(1.42e-05)
Income quartile: 3	0.0000***	0.0000***	-0.0000	0.0000**	0.0000
	(1.03e-05)	(1.03e-05)	(3.45e-05)	(1.32e-05)	(1.66e-05)
Income quartile: 4	0.0000***	0.0000***	0.0001***	0.0000	0.0000
	(1.37e-05)	(1.36e-05)	(4.90e-05)	(1.39e-05)	(1.72e-05)
% of owned outright properties	-0.0194***	-0.0191***	-0.0131***	-0.0190***	-0.0151***
	(1.50e-03)	(1.50e-03)	(2.60e-03)	(2.49e-03)	(2.29e-03)
% of rented out properties	-0.0235***	-0.0232***	-0.0058	-0.0297***	-0.0150***
	(2.00e-03)	(2.00e-03)	(4.07e-03)	(3.03e-03)	(3.23e-03)
% of second homes	-0.0167***	-0.0164***	0.0102*	-0.0294***	-0.0109**
	(2.55e-03)	(2.54e-03)	(5.30e-03)	(3.45e-03)	(4.83e-03)
Construction year: 1945-1959	-0.0007	-0.0003	0.0006	-0.0005	0.0000
	(7.29e-04)	(7.26e-04)	(1.58e-03)	(9.55e-04)	(1.13e-03)
Construction year: 1960-1979	-0.0009	-0.0004	0.0001	-0.0010	-0.0005
	(6.28e-04)	(6.25e-04)	(1.45e-03)	(8.72e-04)	(9.20e-04)
Construction year: 1980-1999	-0.0001	0.0001	-0.0006	-0.0005	0.0008
	(6.86e-04)	(6.84e-04)	(1.61e-03)	(9.65e-04)	(1.12e-03)
Construction year: 2000-2023	0.0018**	0.0008	0.0002	0.0005	0.0025
	(8.32e-04)	(8.30e-04)	(1.94e-03)	(1.06e-03)	(1.68e-03)
Constant	7.1236***	7.1257***	7.1805***	7.1981***	6.9908***
	(1.78e-03)	(1.79e-03)	(4.26e-03)	(2.89e-03)	(2.52e-03)
Observations	79,467	79,467	16,968	34,416	28,083
R-squared	0.093	0.096	0.133	0.022	0.229

Number of micro areas	7,146	7,146	1,338	3,211	2,597
Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.

Table A10 – Fixed effects panel data models, balanced sample with all 14 semesters (dependent variable: log maximum house price by micro-area)

	Pooling (1)	Pooling interacted (2)	Emilia-Romagna (3)	Lombardy (4)	Piedmont (5)
Energy class: E	-0.0010	0.0019	0.0024	-0.0003	-0.0036*
	(1.23e-03)	(2.24e-03)	(2.29e-03)	(1.82e-03)	(1.92e-03)
Energy class: F	-0.0062***	-0.0006	0.0011	-0.0050***	-0.0039*
	(1.28e-03)	(2.17e-03)	(2.26e-03)	(1.82e-03)	(2.01e-03)
Energy class: G	-0.0095***	-0.0049**	-0.0019	-0.0026	-0.0028
	(1.39e-03)	(2.37e-03)	(2.47e-03)	(1.91e-03)	(2.30e-03)
Class E # Lombardy		-0.0056*			
		(2.95e-03)			
Class E # Piedmont		-0.0047			
		(2.85e-03)			
Class F # Lombardy		-0.0164***			
		(2.93e-03)			
Class F # Piedmont		-0.0009			
		(2.81e-03)			
Class G # Lombardy		-0.0177***			
		(3.17e-03)			
Class G # Piedmont		0.0051			
		(3.12e-03)			
Population density	0.0000***	0.0000***	0.0000***	0.0000**	-0.0000
	(8.78e-07)	(8.64e-07)	(3.70e-06)	(1.33e-06)	(9.88e-07)
Income quartile: 2	0.0000	0.0000	-0.0000	0.0000**	-0.0000
	(1.51e-05)	(1.51e-05)	(3.54e-05)	(1.73e-05)	(2.91e-05)
Income quartile: 3	0.0001***	0.0001***	0.0000	0.0001***	-0.0000
	(1.73e-05)	(1.72e-05)	(3.92e-05)	(1.91e-05)	(3.26e-05)
Income quartile: 4	0.0001***	0.0001***	0.0002**	0.0000	0.0001*
	(3.53e-05)	(3.50e-05)	(7.25e-05)	(3.97e-05)	(4.55e-05)
% of owned outright properties	-0.0228***	-0.0224***	-0.0154***	-0.0124***	-0.0250***
	(2.25e-03)	(2.24e-03)	(2.88e-03)	(2.84e-03)	(4.46e-03)
% of rented out properties	-0.0270***	-0.0265***	-0.0060	-0.0218***	-0.0263***
	(2.98e-03)	(2.97e-03)	(4.71e-03)	(3.81e-03)	(5.88e-03)
% of second homes	-0.0245***	-0.0239***	0.0076	-0.0262***	-0.0288***
	(3.65e-03)	(3.63e-03)	(5.71e-03)	(4.49e-03)	(8.01e-03)
Construction year: 1945-1959	-0.0005	-0.0000	0.0002	0.0009	0.0000
	(1.18e-03)	(1.17e-03)	(2.02e-03)	(1.48e-03)	(1.87e-03)
Construction year: 1960-1979	-0.0001	0.0006	0.0005	0.0015	-0.0002
	(1.08e-03)	(1.08e-03)	(1.95e-03)	(1.57e-03)	(1.58e-03)
Construction year: 1980-1999	0.0008	0.0012	0.0002	0.0016	0.0017
	(1.11e-03)	(1.11e-03)	(2.04e-03)	(1.61e-03)	(1.82e-03)
Construction year: 2000-2023	0.0020	0.0009	0.0015	0.0017	0.0022
	(1.28e-03)	(1.28e-03)	(2.38e-03)	(1.67e-03)	(2.75e-03)
Constant	7.2420***	7.2447***	7.2271***	7.3075***	7.1408***
	(3.09e-03)	(3.03e-03)	(4.94e-03)	(4.17e-03)	(5.36e-03)
Observations	46,662	46,662	13,188	19,614	13,860

R-squared	0.061	0.067	0.142	0.035	0.187
Number of micro areas	3,333	3,333	942	1,401	990
Province dummies	YES	YES	YES	YES	YES
Semester dummies	YES	YES	YES	YES	YES

*Note: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. Semester dummies are not displayed.*
Source: Authors' elaborations on EPCs data.