Juan Pablo Filippini

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Barcelona, 6 August 2025

Dear Selection Committee,

I am writing to express my interest in the PhD Student Workshop on Climate Finance. I am currently a PhD candidate at IESE Business School, University of Navarra, under the supervision of Professor Carles Vergara-Alert. I expect to complete my PhD program by 2027.

My current and future research interests lie at the intersection of macroeconomics, climate finance, energy efficiency, and green urban economics. I am particularly interested in understanding how financial systems and policy frameworks can foster climate resilience and sustainable urban development. My work combines empirical methods with structural modelling, aiming to contribute to both academic literature and practical policy applications.

I would be happy to provide further information or documentation upon request. Professor Carles Vergara-Alert (cvergara@iese.edu) has agreed to serve as a reference.

Thank you for considering my application. I look forward to the possibility of contributing to your program.

Sincerely,

Juan Pablo Filippini

JUAN PABLO FILIPPINI - DNI Z0153564K

Digitally signed by JUAN PABLO FILIPPINI - DNI Z0153564K
Date: 2025.08.07 14:59:25 -03'00'

JUAN PABLO FILIPPINI

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Education

IESE Business School — *2025 – Present*
PhD Candidate — *Barcelona, Spain*

IESE Business School — *2023 – 2025*
Master of Research in Management (MRM) — *Barcelona, Spain*

Torcuato Di Tella University — *2017 – 2019*
Master in Economics — *Buenos Aires, Argentina*

Torcuato Di Tella University — *2010 – 2014*
Bachelor in Economics — *Buenos Aires, Argentina*

Skills

- **Programming:** Python, R, Stata, MATLAB, VBA, LaTeX
- **Languages:** Spanish (native), English (C1), Italian (Basic), Portuguese (Basic), Catalan (Basic)

Academic Positions & Employment

PhD Candidate — *2025 – Present*
IESE Business School — *Barcelona, Spain*
– Working on doctoral thesis on energy efficiency and climate finance, supervised by Prof. Carles Vergara-Alert.

Research Assistant (Predoc) — *2022 – 2023*
IESE Business School — *Barcelona, Spain*
– Data analysis and manuscript preparation for Revise & Resubmit projects with Prof. Carles Vergara-Alert.

Consultant — *2022*
World Bank Group — *Washington, DC, USA*
– Fiscal and macroeconomic analysis for Grenada, focusing on PPPs and climate resilience.

Economist — *2016 – 2022*
Banco Ciudad de Buenos Aires — *Buenos Aires, Argentina*
– Macroeconomic analysis and strategic advice to senior management. Chief Economist Office.

Ongoing Research Projects

- Energy Efficiency and Residential Real Estate Values in Spain (with Carles Vergara-Alert)
- Green Urban Planning and Consumer Satisfaction: Evidence from the Barcelona Superblock Model (with Carles Vergara-Alert)
- Climate Disasters, Labor Loss, and Capital Transformation in an Extended Solow Growth Model (solo authored)

Top-tier Conferences Presentations

- IV Catalan Economic Society Conference, May 2025. Chair and presenter of the Urban Economics Session.
- AREUEA International Conference, July 2025. Organizing Team and presenter in Urban Economics and Climate Risk sessions.

Media Appearances

- "La letra que hace que su vivienda valga más", *El País*, May 10, 2025: https://elpais.com/economia/negocios/2025-05-10/la-letra-que-hace-que-su-vivienda-valga-mas.html
- "Las crisis alimentaria y energética: dos desafíos gigantes para la humanidad", *La Nación*, June 6, 2022: https://www.lanacion.com.ar/economia/las-crisis-alimentaria-y-energetica-dos-desafios-gigantes-para-la-humanidad-nid06062022/

Teaching Experience

Visiting Professor *2023 – Present*
Pompeu Fabra University *Barcelona, Spain*
– Courses: Macroeconomics II & III, Intro to Macro, Econometrics I, International Economics I & II. Average feedback: 9.3/10 (dept. avg. 7.8/10).

Adjunct Professor *2022*
UADE Business University *Buenos Aires, Argentina*
– Taught Economics I to undergraduate students.

Certifications and Awards

Selected as a Leader of Tomorrow for the 51st and 52nd St. Gallen Symposiums (2022 and 2023), recognizing exceptional leadership potential and global impact.

Awarded the title of Global Leader in 2021 by The Oxford Character Project for demonstrating outstanding leadership qualities and commitment to ethical leadership

Strengthening the Public vocation with the Private initiative for development. (IAE Business School).

Fiscal and Monetary Programming (Argentine Association of Budget).

Estimation and Forecast in Time Series Models (Central Bank of Argentina).

Academic References

Carles Vergara-Alert *Professor of Finance*
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Xavier Vives *Professor of Economics and Finance*
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The Impact of Energy Efficiency on Property Values: Evidence from the Spanish Residential Market [1]

Juan Pablo Filippini Carles Vergara-Alert

DO NOT CIRCULATE – PRELIMINARY VERSION

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Abstract

This paper studies the causal relationship between energy efficiency and house values. For the assessment, the energy certification scale uses seven letters: from A (the highest level of energy efficiency) to G (the least efficient). We employ a regression discontinuity identification strategy to exploit the locally exogenous variations in efficiency certificate's letters in a buffered band area around the thresholds. We use granular micro-data at the certificate-house level and house values for residential properties in Spain. This paper presents evidence of the existence of green premiums in the Spanish housing market as a result of an improvement in the CO_2 emissions rating. This result supports semi-strong market efficiency, showing that house values are reflecting publicly available energy efficiency data. Additionally, we find that green premiums are sensitive to both high house energy prices and extreme cold winters, with the latter having a greater impact.

Keywords: Energy Efficiency, Housing Market Valuation, Regression Discontinuity Design, Green Premium Effect

JEL classification:

[1]Filippini: IESE Business School, Email: jfilippini@iese.edu. Vergara-Alert: IESE Business School, email: cvergara@iese.edu. Vergara-Alert acknowledges financial support from the State Research Agency of the Spanish Ministry of Science, Innovation and Universities, project TED2021-131238B-I00, MCIN/AEI/10.13039/501100011033 and NextGenerationEU/PRTR and the Social Trends Institute (STI) Foundation.

1 Introduction

The real estate sector is a cornerstone of the global economy and a key driver of urban sustainability. However, it is also a major contributor to environmental degradation, accounting for approximately 40% of global and 35% of European greenhouse gas emissions (Economidou et al. 2020). According to calculations by the Spanish National Statistics Institute (INE, in spanish acronyms), residential properties alone emitted approximately 63 million tons of CO_2 in 2022, underscoring the sector's substantial climate impact. Housing's high energy demand—driven by heating, cooling, lighting, and ventilation—further exacerbates climate change, making it a focal point of international decarbonization efforts (IEA 2021). Buildings alone account for nearly 30% of global final energy consumption, making energy efficiency improvements critical for achieving net-zero emissions targets (IPCC 2022).

The economic potential of the real estate renovation market is substantial, given the widespread inefficiency of the existing housing stock. In Spain alone, the residential sector comprises over 26 million homes, with approximately 95% of the dwellings classified as energy inefficient. This presents a massive market opportunity, with millions of homes requiring energy retrofitting. The scale of this challenge aligns with European decarbonization targets, making energy-efficient renovations not only an environmental necessity but also a major economic driver for the real estate and construction industries. Beyond its environmental and economic impact, improving energy efficiency presents a significant economic benefit to citizens. According to our estimates, in 2022, energy retrofitting could have resulted in at least 93.4 billion euros in energy bill annual savings under a moderate scenario. These savings underscore the economic potential of large-scale efficiency upgrades, which benefit both households and broader sustainability goals.

In response to this, policymakers have intensified efforts to integrate sustainability criteria into

real estate markets. The European Green Deal, the Energy Performance of Buildings Directive (EPBD), and national climate action plans mandate stricter efficiency standards, retrofitting programs, and sustainability disclosures (Commission 2021, 2022). Financial regulators have also recognized energy efficiency as a material risk factor, prompting the inclusion of sustainability metrics in mortgage lending, valuation methodologies, and investment strategies (Ehlers & Packer 2018). Regulatory changes, such as the proposed amendment to Ministerial Order ECO/805/2003, embed sustainability within the mortgage valuation framework, strengthening the financial materiality of energy performance in property pricing.

Despite the increasing emphasis on energy efficiency, its direct impact on property values remains an area of ongoing debate. Existing studies largely rely on hedonic pricing models, which, while informative, struggle to establish causal relationships. This paper addresses that gap by employing a quasi-experimental approach to identify the causal effect of energy efficiency improvements on housing values. Specifically, we exploit locally exogenous variations in energy ratings at certification thresholds, allowing us to isolate the effect of energy efficiency from confounding factors. By leveraging a comprehensive dataset of 243,414 residential properties across Spain from 2012 to 2024, which integrates energy efficiency certificates, structural and functional property characteristics, and professional appraisal-based market valuations, we provide robust estimates of the green premium associated with energy-efficient properties. The findings reveal that each one-letter improvement in a property's energy efficiency rating leads to an average price increase of 1.3%, a robust effect observed across regions, value segments, and property age and type categories. This provides strong empirical support for the existence of a green premium, where energy-efficient homes command higher market prices due to anticipated energy cost savings, regulatory incentives, and increasing consumer demand for sustainable housing. Additionally, we find that green premiums

are sensitive to both high house energy prices and extreme cold winters, with the latter having a greater impact.

The presence of a Green Premium creates economic incentives for property owners to invest in energy-efficient renovations, fostering a transition toward a more sustainable and competitive housing market. This dynamic aligns with broader climate and energy policies that seek to reduce carbon emissions while enhancing asset value. The results highlight that energy efficiency is not merely an environmental imperative but also a key economic factor shaping real estate markets. As sustainability considerations continue to shape regulatory landscapes and consumer preferences, the integration of energy efficiency into valuation frameworks will become increasingly crucial, reinforcing its role as a determinant of long-term asset value and market resilience.

Our paper builds on a well-established hedonic-pricing literature that documents correlations between energy-efficiency ratings and property values. Eichholtz et al. (2010) analyze 1,360 U.S. commercial buildings (2004–2007) and report rental premiums of 2.8–3.5%, 11% higher occupancy, and sale-price gains of 15.8–16.8% for certified green properties. Kahn & Kok (2014) study 30,036 Dutch single-family homes (2008–2011), finding that a 10% improvement in efficiency correlates with a 2.2% increase in price. In Helsinki, Fuerst & Shimizu (2016) show that only the top three certification tiers command a significant premium (1.3%), with negligible effects at mid-range levels.

More recently, two influential studies have employed regression discontinuity designs (RDD) at energy-label thresholds, closely aligning with our empirical identification strategy. Sejas-Portillo et al. (2025) leverage discontinuities in EU label classes to estimate threshold effects on transaction prices and retrofit activity, while Lu & Spaenjers (2025) adopt a comparable RDD framework to uncover distortions arising from misreporting and heuristic biases in hedonic pricing. Although

we similarly exploit certification cutoffs to identify causal estimates of the green premium, our contribution advances the literature in two substantive dimensions.

First, we propose and calibrate a stylized theoretical model that articulates the multiple mechanisms—informational frictions, energy cost exposure, regulatory uncertainty, and climate-related salience—through which energy efficiency ratings are capitalized into housing values. Second, we empirically disentangle and quantify the relative contribution of each channel, demonstrating, for instance, that elevated energy prices and extreme cold events significantly magnify the green premium beyond what can be explained by reduced information asymmetry alone. In contrast, both Sejas-Portillo et al. (2025) and Lu & Spaenjers (2025) focus predominantly on the informational channel and do not attempt to separately identify these interacting effects.

The remainder of the paper is organized as follows. Section 2 describes the institutional and methodological details of energy certification. Section 3 describes a simple theoretical asset pricing framework. Section 4 presents the data and describes the empirical design, including descriptive statistics and methodology. Section 5 discusses the results, focusing on energy certification ratings, robustness checks, and heterogeneity tests, followed by an analysis of the impact of high energy prices and extreme temperature events. Finally, Section 6 concludes, summarizing the main findings and their implications.

2 Energy Certification Details

The evolution of European energy efficiency regulations advanced with the 2010 Energy Performance of Buildings Directive (EPBD), which updated Directive 2002/91/EC on the energy

performance of buildings, progressively moving towards stricter and more ambitious standards. Key milestones include the 2012 Energy Efficiency Directive, the 2018 Clean Energy Package, and the 2020 European Renewable Strategy. In 2024, the revision of the EPBD introduces the "zero emissions" standard for new buildings. This regulatory progression reflects a continuous increase in sustainability requirements, reshaping the European real estate sector.

[INSERT FIGURE 1 HERE]

The classification of energy efficiency varies across European countries, even among European Union (EU) member states, despite the overarching regulatory framework established by EU directives. While the Energy Performance of Buildings Directive (EPBD) provides general guidelines, the implementation and categorization of energy performance differ significantly at the national level. Some nations employ finer gradations, such as A+, A++, or A+++, whereas others adhere to a simpler A-G scale. Additionally, the thresholds for each rating category are not uniform across countries, leading to variations in how buildings with similar energy performance are classified.

Figure 2 illustrates these discrepancies, highlighting how various countries define and classify energy consumption within their certification systems. An E in Germany would be in the Netherlands an A. These differences underscore the challenges of comparing energy efficiency ratings across countries and highlight the need to assess the impact of energy efficiency within each national context.

[INSERT FIGURE 2 HERE]

In Spain, energy efficiency is rated with a number and a letter (between A and G, representing the highest and lowest energy efficiency, respectively). The numerical value is expressed in terms of emissions (measured in kilograms of CO2 per square meter emitted by the property annually) and in terms of non-renewable primary energy consumption (measured in kilowatt hours per square meter consumed annually by the property). The energy efficiency certification is issued by a qualified technician after a physical inspection of the building, and includes an energy label (visual summary) and a technical report with annexes detailing characteristics, rating, recommendations for improvement, and observations of the certifier. In cases where the non-renewable primary energy consumption letter of the building is different from the CO2 emissions letter, the overall rating of the building is expressed in terms of emissions.

[INSERT FIGURE 3 HERE]

In this study we focus on the CO2 emissions rating, which is calculated based on the estimated carbon dioxide released by the energy consumption required to maintain the annual thermal comfort in the property. Therefore, the rating depends on the reference thermal comfort measure, which varies according to: the climate zone, whether it is peninsular or not, and the type of dwelling (block or single-family).

3 A Simple Asset–Pricing Framework

We consider a risk–neutral buyer whose valuation of a residential property depends on its unknown energy-efficiency, $\theta \in [0,1]$. To capture a tractable discrete prior, we assume that the property's efficiency arises from n independent components, each efficient with probability p, so that

$$\theta = \frac{K}{n}, \quad K \sim \text{Binomial}(n,p),$$

and hence $\theta \in \{0, 1/n, \ldots, 1\}$. Prior to purchase, the buyer knows only (n,p); upon inspection she observes an energy certificate label L, which conveys a noisy indicator of θ.

Crucially, we assume that the physical efficiency parameter θ and the future energy-price process $p_e(t)$ are independent. That is,

$$\theta \perp\!\!\!\perp \{p_e(t) : t \geq 0\},$$

so that learning about θ via the certificate reveals no information about energy-price dynamics, and vice versa. This assumption greatly simplifies both identification and calibration by allowing us to treat the Binomial prior and the price-process separately.

The asset delivers a constant gross flow R (e.g. rental income) but also incurs energy costs. If at date t the spot price of energy is $p_e(t)$ and a baseline usage level is $\bar{e}$, then instantaneous cost is

$$C(t) = \frac{\bar{e}}{\theta}\, p_e(t),$$

and the label-conditional present value of net benefits is

$$P(L) = \mathbb{E}\Big[\int_0^\infty e^{-rt}\big(R - C(t)\big)\,dt \;\Big|\; L\Big] = \frac{1}{r}\,\mathbb{E}\big[R - C(t) \mid L\big].$$

Certification proceeds via a noisy signal

$$s = \theta + \varepsilon, \qquad \varepsilon \sim \mathcal{N}(0, \sigma^2),$$

mapped into a discrete label $L = f(s)$. Bayes' rule updates the prior $\Pr(K = k) = \binom{n}{k} p^k (1-p)^{n-k}$ to the posterior

$$\Pr(K = k \mid L) \;\propto\; \Pr(L \mid K = k) \binom{n}{k} p^k (1-p)^{n-k}.$$

We summarize this posterior by its mean efficiency,

$$\mathbb{E}[\theta \mid L] = \sum_{k=0}^{n} \frac{k}{n} \Pr(K = k \mid L),$$

and by the probability of falling below a regulatory threshold $\bar{\theta}_{\min}$,

$$\Pr(\theta < \bar{\theta}_{\min} \mid L) = \sum_{k/n < \bar{\theta}_{\min}} \Pr(K = k \mid L).$$

Beyond energy outlays, inefficient properties may incur fines if $\theta < \bar{\theta}_{\min}$. With inspection probability π and per-unit penalty φ, the buyer's expected, discounted cost of energy and regulatory

risk is

$$\mathscr{C}(L) = \frac{\bar{e}\,\bar{p}_e}{\mathbb{E}[\theta \mid L]} \;+\; \pi\,\varphi\;\Pr(\theta < \bar{\theta}_{\min} \mid L),$$

where $\bar{p}_e = \int_0^\infty e^{-rt} p_e(t)\,dt$. In equilibrium under perpetual ownership, price equals net expected flow discounted at r:

$$P(L) = \frac{1}{r}\big(R - \mathscr{C}(L)\big).$$

The resulting "green premium" between two labels A and B can be written compactly as

$$\Delta P_{A\to B} = \frac{1}{r}\Big[\underbrace{\bar{e}}_{\substack{\text{Extreme}\\ \text{weather}}}\ \underbrace{\bar{p}_e}_{\text{Energy price}}\ \underbrace{\left(\tfrac{1}{\mathbb{E}[\theta|B]} - \tfrac{1}{\mathbb{E}[\theta|A]}\right)}_{\text{Perceived efficiency gain}} \;+\; \underbrace{\pi\varphi}_{\text{Regulatory risk}}\ \big(\Pr(\theta < \bar{\theta}_{\min}\,|\,B) - \Pr(\theta < \bar{\theta}_{\min}\,|\,A)\big)\Big].$$

This framework delivers clear comparative-static predictions: the green premium widens when expected energy prices $\bar{p}_e$ rise, when regulatory risk $\pi\varphi$ intensifies, or when the marginal benefit of efficiency (for example under more extreme weather) increases.

4 Data and Empirical Design

4.1 Data

The present study is based on the exhaustive analysis of a large database composed of 243,414 residential properties distributed throughout Spain, collected between 2012 and 2024. The records collected for these properties cover three fundamental dimensions: energy efficiency certificates; the structural and functional characteristics of the properties, such as year of construction, construction

quality and the general state of conservation of the property; and finally, the market valuation based on professional appraisals.

Additionally, in a later stage of the analysis, we integrate our database with monthly and regional house energy prices, using a time series from the Spanish National Statistical Institute (INE). Specifically, we use the CPI subcategory for housing, electricity, gas, and water as a proxy for household energy bills. Furthermore, we incorporate data from the Spanish National Meteorology Agency (AEMET), particularly seasonal extreme temperature reports, to identify widespread extreme cold temperature anomalies across the Spanish territory.

Table 1 shows the summary statistics of the variables included in the analysis[1]. The data analyzed represent a large and diverse sample, covering a broad spectrum of characteristics. This heterogeneity ensures the robustness of the results and their applicability in different real estate market scenarios.

[INSERT TABLE 1 HERE]

The average value per square meter is 1,377 euros, with a wide range varying between 495 and 2,952 euros, reflecting the inclusion of both low and high value properties. The physical characteristics of the homes show a remarkable diversity, with sizes ranging from 59 to 244 m² and construction ages ranging from 1950 to 2010. In addition, variables such as CO_2 emissions, energy demand, construction quality, general condition, and location evidence heterogeneity in the conditions of the properties analyzed. This variability ensures that the sample is representative and captures a wide range of real estate market characteristics, providing a robust analysis that is applicable to different contexts.

[1]Table A1 in the Appendix provides a detailed definition of the main variables that we use in this study.

As one progresses from category G to A, there is a steady increase in value per square meter accompanied by a reduction in the age of the homes. Table 2 elaborates on the analysis in Table 1 by segmenti ng the descriptive statistics according to energy efficiency levels. A-rated properties reach, on average, the highest values (€2,064/m²) and correspond to the most recent constructions, with an average year of construction located in 2008. In contrast, properties rated G have the lowest values (€1,214/m²) and are considerably older, with an average year of construction in 1978.

[INSERT TABLE 2 HERE]

In addition, properties with better energy ratings distinguish themselves by registering lower CO_2 emissions and achieving higher standards of construction quality. For example, A-rated homes have average emissions of 5.6 kg/m²/year, lower than the 73 kg/m²/year observed in those rated G. Similarly, construction quality shows a gradual improvement, so that A-rated homes reach an average of 2.5 on a scale of 0 to 5, while G-rated homes register the lowest level, with 2.0. The data show that, on average, the most energy-efficient homes not only stand out for their environmental sustainability, but are also characterized by being more modern and having better construction attributes.

These spurious correlations are evidence of a possible endogeneity problem, since, without adequately isolating the effects of adjacent variables, it is not possible to accurately determine the real impact of the improvement in energy rating on property values. In this context, the observed increase in value may not be attributed exclusively to greater energy efficiency, but may be conditioned by superior characteristics associated with better-rated homes, which could lead to misinterpretations if a rigorous analysis is not carried out.

The most common analyses tend to fall into the error of comparing simple differences in averages, as shown in Table 2, which can lead to misleading results. These differences indicate

that homes with A certification have an average value 14.4% higher than those with B; B, 18.1% higher than C; C, 3.4% higher than D; D, 8.2% higher than E; E, 6.5% higher than F; and F, 5.7% higher than G. On average, each improvement in energy certification would be associated with a 9.4% increase in value.

However, as previously noted, this approach is incomplete and biased, as it fails to isolate the specific impact of the energy rating from other correlated factors, such as the age of the building, the construction quality, or its location, which compromises the validity of the results.

4.2 Empirical Strategy

To address endogeneity, we implement a regression discontinuity design (RDD), exploiting locally exogenous variations in energy efficiency ratings within a narrow bandwidth around classification thresholds. This approach enables us to estimate the causal effect of an improved energy efficiency rating on house values by comparing homes just above the threshold (treated group) with those just below (control group), effectively isolating the impact of energy ratings from other confounding factors[2].

First, to formulate a foundation for examining the correlation of energy efficiency performance on house values, we calculate the following ordinary least squares (OLS) approach:

$$\log(\text{value_m}^2)_{i,t} = \alpha + \beta \text{Certificate Label}_{i,t} + \delta X_{i,t-1} + \mu_t + \gamma_i + \varepsilon_{i,t}, \tag{1}$$

Then, to test the causal effect of improvement of energy efficiency performance on house values, we estimate the following RDD model:

[2]Table A2 in the Appendix presents a summary of the balance check regressions, demonstrating that potential confounder variables are not significant in determining whether a house is just above or below the threshold. This confirms the exogeneity and validity of the RDD design.

$$\log(\text{value_m}^2)_{i,t} = \alpha + \beta_1 \cdot \text{Above}_{i,t} + \beta_2 \cdot \text{Running}_{i,t} + \beta_x X_{i,t-1} + \mu_t + \gamma_i + \varepsilon_{i,t}, \quad (2)$$

where $\log(\text{value_m}^2)_{i,t}$ is the logarithm of the house value per square meter for house i at time t, α is the intercept, $\text{Above}_{i,t}$ is a dummy variable that identifies the treated group with a 1 if or 0 if belongs to the control group, $\text{Running}_{i,t}$ is the continuous unrounded CO_2 emissions. $X_{i,t-1}$ is a vector of control variables for house i at time $t-1$, μ_t are year-month fixed effects, γ_i are location (postal code level) fixed effects, and $\varepsilon_{i,t}$ is the error term. Location and year-month fixed effects absorb time-invariant house characteristics such as differences across neighborhoods.

The RDD leverages the cutoff points in the energy efficiency rating criteria to isolate the specific impact, reducing the influence of adjacent variables[3]. The cutoff points act as a quasi-natural experiment, since in the observations immediately around those discrete jumps the effects of other adjacent variables cancel out, isolating the specific effect of the change in energy certification. Figure 4 exemplifies the thresholds for the peninsular, C2 climate zone, unifamiliar houses under analysis.

[INSERT FIGURE 4 HERE]

To estimate Equation 2, we follow the approach of Imbens & Kalyanaraman (2012) by restricting the sample to an optimal bandwidth of observations around the cutoff thresholds. This optimal bandwidth minimizes estimation errors by balancing bias and variance, thereby ensuring an accurate representation of data trends.

[3]Figure A1 in the Appendix provides an example of all the Manipulation Test we conducted to justify that the RDD design is validated.

5 Results

This section presents our empirical results, first we estimate Equation 1, an OLS approach, to have a benchmark for the correlation between energy efficiency and house values. Then we move forward to examine the causal effect of the improvement of energy efficiency rating on house value for houses that fell within the optimal bandwith for RDD analysis, identifying those which are just above the energy rating threshold (treated houses) relative to those that fell below the boundary (control houses) by estimating Eq. 2 a regression discontinuity design model.

We analyze multiple subsamples to demonstrate that the effect is neither isolated nor confined to a specific market segment but instead holds consistently across regions, price ranges, and property categories. Finally, we examine the sensitivity of this effect to high energy prices and extreme cold temperature events.

5.1 Energy Efficiency Ratings

To establish a foundational understanding of the correlation between energy efficiency and property values, we begin with an ordinary least squares (OLS) estimation. Table 3 provides the results from the panel OLS estimation using equation (1). In the first three specifications, the coefficient for the energy efficiency label remains consistently positive and statistically significant at the 1% level, with an estimated effect size of approximately 2.3%. The fourth which includes house characteristics controls is also significative but around 1.2%. This finding corroborates the notion that properties with higher energy efficiency labels tend to command higher values per square meter, indicating a positive correlation between energy efficiency and property values. This is consistent with the preliminary insights derived from the descriptive statistics presented in Section 3, where properties with higher quality and newer construction—factors often associated with better energy

efficiency—also showed higher average values.

[INSERT TABLE 3 HERE]

Furthermore, to rigorously examine the causal impact of energy efficiency on property values, we employ a series of regression discontinuity design (RDD) regressions. Table 4 presents the regression results for five different specifications of Equation 2, each calculated within the specified optimal bandwidth, with additional controls incrementally introduced in each model. Column (1) presents a robust regression model without clustering. Column (2) introduces clustering by postal code to account for spatial dependencies. In Column (3), errors are clustered by both year and postal code, capturing both temporal and spatial variations. Column (4) incorporates additional control variables, such as property quality, conservation status, and location, while maintaining robust error clustering by year and postal code. Finally, Column (5) introduces year-month-postalcode fixed effects. Each column builds upon the previous one, progressively refining the analysis to enhance the accuracy and relevance of the findings.

In all five models, the coefficient for "above", which isolates the effect of energy performance improvement, remains consistently positive and statistically significant. This indicates that properties with a higher energy efficiency label experience an increase in value per square meter. Model (4), which includes controls for house characteristics such as construction quality, conservation status, and location, indicates that even after accounting for these additional factors, obtaining a higher energy efficiency label still leads to a 1.3% increase in the value per square meter.

[INSERT TABLE 4 HERE]

The results provide compelling evidence that obtaining a higher energy performance label leads to a statistically significant and economically meaningful increase in property values, ranging from

1.6% to 1.3% depending on the model specification. The consistency of these findings across different models strengthens the credibility of the causal relationship between energy performance labeling and property values, underscoring the importance of this analysis in the study.

Figure 5 illustrates the robustness of the estimated coefficient across different bandwidth selections in the RDD analysis. The plot illustrates the coefficient values across various bandwidths, all of which fall within narrow 95% confidence intervals. As the bandwidth increases, the coefficient remains significant, exhibiting only minor fluctuations while consistently maintaining a positive value. This stability suggests that the estimated treatment effect is robust and not significantly influenced by the choice of bandwidth.

[INSERT FIGURE 5 HERE]

The robustness test of bandwidth selection is a crucial methodological practice, as it addresses concerns regarding potential “cherry-picking" of bandwidths to achieve a predetermined outcome. By demonstrating that the estimated effect remains consistent across a range of bandwidths, this analysis enhances the reliability and credibility of the results, thus re-enforcing the robustness of the findings.

5.1.1 Effect by rating label

After establishing the average effect of an improvement in energy efficiency performance labels on house values, the next step is to disaggregate this effect by examining the impact at each individual label threshold. This label-by-label analysis provides a more granular understanding of how incremental changes in energy efficiency ratings influence property values.

Table 5 presents the Green Premium disaggregated by energy label transitions, offering a detailed view of how different upgrades in energy efficiency impact property values. The estimates

confirm that the Green Premium is consistently positive and statistically significant across nearly all rating transitions, except for the shift from B to A, which is likely affected by a low number of observations.

[INSERT TABLE 5 HERE]

This evidence challenges the prevailing notion that energy efficiency only adds value at the top of the label scale. Instead, the results demonstrate that improvements at all levels—whether from poor to fair, or fair to good—generate tangible increases in market value. This supports the view that energy performance is a fundamental and widely recognized component of property valuation, rather than a niche feature relevant only for premium properties. The heterogeneity across transitions also reveals how buyers interpret different types of upgrades. For example, the transition from C to B results in a particularly pronounced premium of 3.9%, suggesting that this type of improvement is perceived as a significant step toward sustainability and energy savings. Similarly, transitions such as D to C or E to D yield consistent and statistically significant premiums in the range of 1.2% to 2.1%, indicating that even mid-tier upgrades are capitalized in market prices.

Interestingly, upgrades from the lowest tiers, such as G to F, also result in a positive and significant premium (1.97%). This suggests that market participants value even small improvements when they help move a property away from the least efficient categories, which are often associated with future regulatory exposure and rising renovation costs. In this context, efficiency improvements may function as a hedge against regulation, particularly in a policy environment where building standards are becoming increasingly stringent. By contrast, the non-significant coefficient for the B to A transition reflects a potential efficiency ceiling, where further gains are less economically relevant or already priced in by the market. This asymmetry in returns suggests that the marginal benefit of upgrading diminishes as a property approaches the top of the efficiency scale.

Altogether, these findings highlight that the Green Premium is not only driven by direct energy savings but also by the signal of quality, sustainability, and regulatory compliance conveyed by higher ratings. Energy efficiency appears to be internalized by market participants as both a desirable asset and a form of risk mitigation, reinforcing its role as a structural determinant of real estate value.

5.1.2 Effect by region

Furthermore, examining regional variations in the Green Premium would provide valuable insights into how different areas assign varying levels of importance to energy efficiency. Identifying regions where the effect is more pronounced or attenuated would enhance the understanding of the geographic dimension of the Green Premium and help determine which regions are driving the overall market trend.

Table 6 indicates that the effect is statistically significant throughout Spain, although there are significant differences between regions. In particular, the northern region, such as Galicia, stand out as having the most pronounced effects. This higher valuation can be attributed to the fact that in the colder regions of the country energy efficiency is perceived as a critical attribute for reducing heating costs and improving thermal comfort, which reinforces its importance in the real estate market compared to warmer areas, where these needs are less pressing.

[INSERT TABLE 6 HERE]

On the one hand, Madrid, and Catalunya regions register a relatively low Green Premium, around 1.25%-0.9%, suggesting that in these regions energy efficiency has a more moderate impact on real estate values. While Andalusia, and Valenciana are in an intermediate range, with values between 1.4% and 1.5%. This reinforces the idea that, although energy efficiency is valued throughout the

territory, its relevance depends on specific factors such as climate, local demand and real estate market characteristics, which influence the perception of the value added by this attribute.

5.1.3 Heterogeneity Tests

In line with this perspective, the analysis further demonstrates that the increase in property value associated with improved energy efficiency certification is not confined to higher-valued properties but is evident across all market segments. This effect is not limited to single-family homes but also extends to apartment buildings, nor is it exclusive to newly constructed properties, as it is equally observed in older buildings.

Table 7 breaks down the results by value quartiles, type of building and year of construction highlighting that an improved energy rating generates a positive impact in every segment analyzed. This finding confirms that Green Premium is not limited to luxury segments, new properties or single-family ones, reinforcing the idea that energy efficiency is a valued attribute across all categories of the real estate market.

[INSERT TABLE 7 HERE]

Energy efficiency is often assumed to be the primary value in newly constructed buildings; however, our study demonstrates that its positive impact extends beyond recent developments, creating opportunities for re-valuation even in older properties. The Green Premium effect in older homes remains relatively stable, ranging from 1.0% to 1.4%. In contrast, for properties built after 2006, the impact is significantly higher, reaching 1.6%. This difference can be attributed to the fact that, as previously shown, newer buildings are more likely to achieve higher energy efficiency ratings, such as A and B, further strengthening their market value.

For older buildings, energy efficiency represents a substantial opportunity for revaluation, as improvements in energy performance not only enhance property values but also reduce operating costs and improve overall livability. In contrast, for newly constructed homes, energy efficiency serves as a key differentiating factor, distinguishing them from less efficient alternatives. This underscores the growing demand for sustainability and energy savings in the real estate market, further solidifying energy efficiency as a crucial determinant of property valuation.

5.1.4 Balance Check

Table A2 in the Online Annex presents a balance check for the regression discontinuity design described in Equation 2, where explanatory variables replace the baseline outcome variable to test the randomness near the threshold. The insignificance of the treatment variable 'above' across various models indicates that these explanatory variables are unaffected by the treatment at the cutoff. This supports the RDD's validity by showing no systematic differences at the threshold.

[INSERT TABLE A2 HERE]

The results indicate that the treatment variable *above* remains statistically insignificant across various model specifications, suggesting that these explanatory variables are unaffected by treatment status at the threshold. This finding reinforces the credibility of the RDD approach by confirming that any observed discontinuity in the primary outcome variable is unlikely to be driven by underlying differences in property characteristics, but rather by the exogenous variation in energy efficiency classification.

5.2 Energy Prices

In the previous section, we presented results on the causal effect of improving the energy efficiency rating on house values. In this section, we examine how different levels of housing energy price inflation influence the value of energy efficiency.

To incorporate this dimension into our analysis, we extended our dataset by adding the average housing energy price inflation over the last three months, disaggregated by region. This data is derived from the monthly time series published by the Spanish National Institute of Statistics. Specifically, we used the category corresponding to housing, water, electricity, gas, and other fuels, where the primary component is household energy prices (electricity and gas services).

To capture the differential effects of energy price inflation, we introduced an interaction term in the model. This variable reflects the interplay between the above variable and varying levels of house energy inflation. We specified two interaction terms: one at the mean energy inflation level, and one at one standard deviation above the mean energy inflation.

[INSERT TABLE 8 HERE]

Table 8 presents the results for these four specifications, demonstrating that periods of higher household energy price inflation are associated with a higher Green Premium. This finding suggests that when household energy prices rise, energy efficiency becomes more valuable, as it offers greater cost savings and economic benefits to homeowners.

5.3 Extreme cold temperature anomalies

In this section, we investigate how the value of energy efficiency varies in response to extreme temperature anomalies. To capture this dimension, we use seasonal temperature anomaly reports

from the Spanish National Meteorology Agency (AEMET) to identify instances of extreme cold winters—defined as months registering historically low temperature deviations across the national territory.[4]

To estimate the effect of these climatic shocks, we include interaction terms between the treatment variable ("above") and a binary indicator of extreme cold conditions equal to 1 if the temperature anomaly falls below the 1% percentile of the historical winter temperature distribution, and 0 otherwise. This allows us to test whether the green premium intensifies during periods when thermal comfort is most salient to households.

[INSERT TABLE 10 HERE]

Table 10 presents the results of this specification. The coefficient on the "above" variable remains positive and significant across all model specifications, indicating a persistent and robust green premium. More importantly, the interaction term between "above" and extreme cold winter months is large, positive, and statistically significant (approximately 8.2%), suggesting that the value of energy efficiency increases substantially during extreme cold conditions. This indicates that energy-efficient homes become particularly valuable when heating demand is unusually high, possibly due to reduced energy costs and improved indoor comfort.

In contrast, the interaction between "above" and energy price inflation (column 4) is positive but notably smaller in magnitude (approximately 0.9%), although still statistically significant. This comparison suggests that extreme cold events have a stronger amplifying effect on the green premium than energy price shocks of similar statistical relevance. One possible interpretation is that thermal discomfort from cold exposure is more immediate and salient to buyers than more abstract considerations like future energy bill increases.

[4]Figures A2 illustrate the spatial distribution of these anomalies.

Overall, these findings highlight that the market capitalization of energy efficiency is not static, but context-dependent. The green premium intensifies in periods of extreme cold, suggesting that both climatic and economic stressors play a key role in shaping buyers' valuation of energy performance. This result underscores the importance of integrating climatic risk into housing and energy policy, especially in the context of increasing weather variability linked to climate change.

6 Conclusions

The findings of this study provide robust evidence that energy efficiency exerts a positive and statistically significant effect on property values in the Spanish real estate market. Far from being an isolated or niche phenomenon, the Green Premium emerges as a consistent and widespread feature across regions, property types, and value segments. On average, an upgrade in the energy efficiency rating is associated with an increase of 1. 3% in the value of the property. This effect is particularly pronounced in transitions between higher efficiency labels, such as from C to B, but is also observable in lower efficiency upgrades, confirming the broad relevance of energy performance as a determinant of market value.

The analysis further reveals that green premiums are sensitive to contextual factors, particularly climatic and economic stressors. In periods of extreme cold, the premium associated with energy efficiency intensifies considerably, suggesting that buyers place greater value on thermal comfort and energy savings when heating demand spikes. In comparison, increases in energy prices also elevate the green premium, though to a lesser extent. These findings underscore the asymmetric salience of energy efficiency across seasons and conditions, with winter discomfort emerging as a

key driver of valuation.

Beyond price effects, the results offer important insights into the functioning of the housing market. The consistent capitalization of energy ratings into property prices supports the hypothesis of semi-strong market efficiency, wherein publicly available information, suchh as energy performancecertificates, isis effectively incorporated into asset valuations. This market recognition of energy efficiency establishes a credible Green Premium, which in turn generates a powerful economic incentive for homeowners and investors to undertake energy upgrades.

This incentive structure has significant implications for policy. The existence of a market-driven premium suggests that widespread adoption of energy-efficient technologies can be achieved without heavy-handed regulation. Rather than mandating improvements, policymakers should focus on enhancing the availability, credibility, and visibility of energy performance information. In doing so, they can foster an environment in which consumers make informed decisions aligned with both economic and environmental objectives.

Ultimately, this study highlights a promising alignment between financial incentives and sustainability goals. By reinforcing the economic value of energy efficiency, the housing market can serve as a vehicle for accelerating the green transition, supporting both climate policy and housing sector resilience. Encouraging this alignment through transparent information and light-touch regulation may prove to be one of the most effective strategies for driving energy efficiency improvements at scale.

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Tables and Figures

Table 1: Descriptive Statistics. The table presents summary statistics including the number of observations (Obs), mean, standard deviation (Std. Dev.), and the 5th and 95th percentiles (p5 and p95) for each variable. These statistics offer insights into the distribution and range of values for variables such as property value, emissions, energy demand, construction quality, and location.

Variable	Obs	Mean	Std. Dev	p5	p95
value_mt2	243,410	1377	852	495	2952
emissions_CO2	243,410	43	120	13	81
energy_demand	243,410	203	633	64	373
m2	243,410	120	87	59	244
quality_construction	243,410	2	1	1	3
conservation_construction	243,410	3	1	3	4
location_construction	243,410	7	1	6	9
year_construction	243,410	1985	23.14	1950	2010

Table 2: Descriptive Statistics. The table presents summary statistics including the number of observations (Obs), mean, standard deviation (Std. Dev.), and the 5th and 95th percentiles (p5 and p95) for each variable.

Variable	Obs	Mean	Std. Dev	p5	p95
value_m2					
A	2,965	2,064	1,311	722	4,540
B	4,319	1,804	992	720	3,750
C	8,301	1,528	944	600	3,283
D	33,664	1,478	930	570	3,306
E	142,899	1,366	834	500	2,935
F	21,989	1,283	799	440	2,705
G	29,273	1,214	687	430	2,397
year_construction					
A	2,965	2008	23	1963	2023
B	4,319	2008	20	1966	2022
C	8,301	1996	22	1957	2018
D	33,665	1992	22	1955	2011
E	142,902	1984	22	1950	2008
F	21,989	1977	24	1936	2007
G	29273	1979	23	1940	2008
emissions_CO2					
A	2965	5.6	17.7	0.2	10.0
B	4319	9.6	21.1	4.6	17.0
C	8301	15.9	17.6	7.4	27.3
D	33665	24.6	91.4	12.0	40.0
E	142902	40.6	82.7	20.5	64.0
F	21989	65.6	222.3	34.6	92.9
G	29273	73.0	190.4	26.2	132.0
quality_construction					
A	2965	2.5	0.6	2.0	4.0
B	4319	2.4	0.6	2.0	3.0
C	8301	2.2	0.5	2.0	3.0
D	33665	2.2	0.5	2.0	3.0
E	142902	2.1	0.5	2.0	3.0
F	21989	2.0	0.5	2.0	3.0
G	29273	2.0	0.6	2.0	3.0

Table 3: Baseline OLS. This table presents the results from the baseline Ordinary Least Squares (OLS) regression, where the dependent variable is the logarithm of value per square meter. Model (1) includes only the Energy Label variable, while models (2), (3), (4), and (5) progressively incorporate more fixed effects, along with different clustering specifications for standard errors, and more house characteristics controls. The Energy Label shows a statistically significant positive relationship with value per square meter in all models.

	Natural Logarithm of Value per Square Meter				
	(1)	(2)	(3)	(4)	(5)
certificate label	0.0234***	0.0234***	0.0234***	0.0115***	0.0105***
	(0.0006)	(0.0012)	(0.0021)	(0.0019)	(0.0018)
year_const	0.0061***	0.0061***	0.0061***	0.0042***	0.0041***
	(0.0000)	(0.0001)	(0.0003)	(0.0002)	(0.0003)
quality_const				0.0895***	0.0938***
				(0.0076)	(0.0071)
conservation_const				0.1073***	0.1065***
				(0.0031)	(0.0033)
location_const				0.0698***	0.0773***
				(0.002)	(0.0031)
Fixed effects	yr-mnth, postal	yr-mnth, postal	yr-mnth, postal	yr-mnth, postal	yr-month-postal
Clustering	No	postal	year, postal	year, postal	year, postal
Observations	243,222	243,222	243,222	243,222	169,552
Adjusted - R^2	0.7487	0.7487	0.7487	0.7976	0.8679

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Main RDD results. This table presents the main results from the RDD analysis, where the dependent variable is the logarithm of value per square meter. Models (1) through (5) include different specifications with fixed effects and clustering for standard errors. Results indicate a positive and statistically significant effect for the "above" variable, which isolates and represents the average effect of an improvement in the energy certificate label.

	Dep. Var.: log_value_m2				
	(1)	(2)	(3)	(4)	(5)
above	0.0161***	0.0161***	0.0161***	0.0131***	0.0168***
	(0.0023)	(0.0026)	(0.0034)	(0.0029)	(0.0038)
running	0.0006	0.0006	0.0006	0.0007	-0.0026
	(0.0012)	(0.0013)	(0.0023)	(0.0018)	(0.0020)
year_const	0.0064***	0.0064***	0.0064***	0.0044***	0.0043***
	(0.0001)	(0.0001)	(0.0003)	(0.0002)	(0.0005)
quality_const				0.1009***	0.1091***
				(0.0065)	(0.0074)
conservation_const				0.0883***	0.0899***
				(0.0057)	(0.0060)
location_const				0.0739***	0.0788***
				(0.0025)	(0.0047)
Fixed effects	yr-mnth, postal	yr-mnth, postal	yr-mnth, postal	yr-mnth, postal	yr-month-postal
Clustering	No	postal	year, postal	year, postal	year, postal
Observations	61,625	61,625	61,625	61,625	25,377
Adjusted - R^2	0.7459	0.7459	0.7459	0.7977	0.8277

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: RDD results by Energy Label. This table presents the RDD results for different energy label transitions. The transitions analyzed are from B to A, C to B, D to C, E to D, and F to E. The effect of moving above the energy label threshold, with significant positive coefficients observed for transitions from B to A, D to C, and E to D, suggesting that better energy labels are associated with higher values.

	Dep. Var.: log_value_m2					
	From: B to A	From: C to B	From: D to C	From: E to D	From: F to E	From: G to F
above	0.0205	0.0392***	0.0213***	0.0127***	0.0131**	0.0197*
	(0.0135)	(0.0118)	(0.0050)	(0.0037)	(0.0055)	(0.0085)
running	0.0211	-0.0006	-0.0016	-0.0022	-0.0009	0.0038
	(0.0116)	(0.0055)	(0.0030)	(0.0037)	(0.0036)	(0.0039)
year_const	0.0044***	0.0442***	0.0038***	0.0039***	0.0040***	0.0034***
	(0.0006)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0005)
calidad_const	0.0811***	0.1041***	0.0829***	0.0836***	0.0932***	0.0929***
	(0.0131)	(0.0122)	(0.0111)	(0.0061)	(0.0065)	(0.0109)
estado_const	-0.0041	0.0272**	0.0848***	0.1098***	0.1213***	0.1217***
	(0.0118)	(0.0094)	(0.0050)	(0.0042)	(0.0047)	(0.0071)
ubicacion_const	0.0242***	0.0542***	0.0674***	0.0687***	0.0802***	0.0847***
	(0.0059)	(0.0069)	(0.0043)	(0.0036)	(0.0036)	(0.0039)
Year-Month Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Postal code Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	year, codpostal	year, codpostal	year, codpostal	year, codpostal	year, codpostal	year, codpostal
Observations	2,612	3,386	8,736	23,103	12,874	6,695
Adjusted - R^2	0.8479	0.7794	0.8047	0.8063	0.7938	0.7915

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: RDD Results by Region. This table presents the results of the RDD analysis by region. These results suggest regional variation in the value response to improvements in energy labels.

	Dep. Var.: log_value_m2				
	Catalunya	Andalucia	Valenciana	Madrid	Galicia
above	0.0095*	0.0151**	0.0148**	0.0125**	0.0215*
	(0.0053)	(0.0044)	(0.0060)	(0.0042)	(0.0118)
Year-Month Fixed effects	Yes	Yes	Yes	Yes	Yes
Postal code Fixed effects	Yes	Yes	Yes	Yes	Yes
House Controls	Yes	Yes	Yes	Yes	Yes
Clustering	Year, Codpostal	Year, Codpostal	Year, Codpostal	Year, Codpostal	Year, Codpostal
Observations	3,569	8,839	9,337	3,238	1,591
Adjusted - R^2	0.8341	0.7658	0.7029	0.8308	0.6711

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Green Premium by value quartile and by building type. On the left side of the table, the average shows the average Green Premium by property value quartile is shown on the left side of the figure. The data show that the Green Premium is present in all quartiles, challenging the belief that this effect is this effect is limited to only the highest value properties. to the highest value properties. On the right side of the table shows the Green Premium by housing typology (single-family or block). (single-family or block). These results show that, regardless of the type of property, energy efficiency has a positive effect on the value energy efficiency has a positive effect on the value of the value per square meter. square meter.

	Dep. Var.: log_value_m2									
	House value quartile				Building type		Year of construction			
	1st	2nd	3rd	4th	Single-Family	Blocks	< 1977	1977 - 99	1999 - 2006	>2006
above	0.0132**	0.0183***	0.0144***	0.0149**	0.0156**	0.0129***	0.0147***	0.0104**	0.0148**	0.0160***
	(0.0046)	(0.0042)	(0.0041)	(0.0067)	(0.0051)	(0.0032)	(0.0038)	(0.0047)	(0.0056)	(0.0042)
running	0.0023	0.0033	0.0008	-0.0015	0.0029	0.0004	0.0023	0.0027	-0.0034	-0.0011
	(0.0033)	(0.0025)	(0.0016)	(0.0040)	(0.0034)	(0.0016)	(0.0035)	(0.0028)	(0.0030)	(0.0022)
year_const	0.0020***	0.0021***	0.0034***	0.0044***	0.0041***	0.0046***	0.0008***	0.0062***	0.0001	0.0115***
	(0.0001)	(0.0002)	(0.0002)	(0.0004)	(0.0002)	(0.0004)	(0.0001)	(0.0005)	(0.0024)	(0.0010)
quality_const	0.0677***	0.0477***	0.0434***	0.0795***	0.1075***	0.0835***	0.0978***	0.0572***	0.0597***	0.0749***
	(0.0047)	(0.0055)	(0.0064)	(0.0078)	(0.0092)	(0.0069)	(0.0065)	(0.0084)	(0.0070)	(0.0074)
conservation_const	0.0345***	0.0654***	0.0769***	0.1142***	0.0495***	0.1202***	0.1415***	0.0948***	0.0561***	0.0189***
	(0.0076)	(0.0047)	(0.0040)	(0.0055)	(0.0070)	(0.0036)	(0.0029)	(0.0041)	(0.0054)	(0.0028)
location_const	0.0483***	0.0387***	0.0347***	0.0523***	0.0555***	0.0748***	0.0792***	0.0752***	0.0595***	0.0443***
	(0.0026)	(0.0023)	(0.0025)	(0.0036)	(0.0037)	(0.0026)	(0.0028)	(0.0039)	(0.0042)	(0.0030)
Year-Month Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Postal code Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,402	15,134	13,276	7,777	15,157	44,499	18,275	10,182	7,619	13,876
Adjusted - R^2	0.7815	0.6767	0.6206	0.6179	0.7085	0.8214	0.8499	0.7806	0.7668	0.7951

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: RDD Results with energy price inflation. This table presents the results of the RDD analysis adding interaction terms for different inflation scenarios. These results suggest variation in the green premium response to high energy price inflation.

	Dep. Var.: log_value_m2			
	(1)	(2)	(3)	(4)
above	0.0093***	0.0076***	0.0076***	0.0076***
	(0.0018)	(0.0017)	(0.0017)	(0.0014)
above × mean_energy_inflation	0.0002			
	(0.0033)			
above × 1SD_energy_inflation		0.0082**	0.0082**	0.0082**
		(0.0040)	(0.0032)	(0.0034)
Year and Month Fixed effects	Yes	Yes	Yes	Yes
Postal code Fixed effects	Yes	Yes	Yes	Yes
Clustering	month, postal	month, postal	month, region	month-region
Observations	101,538	101,538	106,571	106,571
Adjusted - R^2	0.7983	0.7983	0.7983	0.7983

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 9: RDD Results with extreme cold temperature. This table presents the results of the RDD analysis adding interaction terms for different extreme temperature scenarios. These results suggest variation in the value response to extreme cold in winter.

	Dep. Var.: log_value_m2		
	(1)	(2)	(3)
above	0.0116***	0.0116***	0.0116***
	(0.0022)	(0.0015)	(0.0021)
above × extreme_cold_winter	0.0824***	0.0824***	0.0824***
	(0.0218)	(0.0188)	(0.0191)
Year and Month Fixed effects	Yes	Yes	Yes
Postal code Fixed effects	Yes	Yes	Yes
Clustering	month, postal	month, postal	month-region
Observations	35,129	35,129	35,129
Adjusted - R^2	0.8250	0.8250	0.8250

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 10: RDD Results with extreme cold temperature. This table presents the results of the RDD analysis adding interaction terms for different extreme temperature scenarios. These results suggest variation in the value response to extreme cold in winter.

	Dep. Var.: log_value_m2		
	(1)	(2)	(3)
above	0.0110***	0.0110*	0.0110***
	(0.0035)	(0.0015)	(0.0033)
above × 2SD_high_cpu	0.0416***	0.0416**	0.0416***
	(0.0104)	(0.0124)	(0.0106)
Year and Month Fixed effects	Yes	Yes	Yes
Postal code Fixed effects	Yes	Yes	Yes
Clustering	month, postal	month, postal	month-region
Observations	16,759	16,759	16,759
Adjusted - R^2	0.8474	0.8474	0.8474

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.



Figure 1: Evolution of EU Energy Efficiency Policies for Buildings. A timeline highlighting key milestones in the European Union’s energy efficiency and building performance policies, from the 2010 EPBD directive to the 2024 revision, which establishes "zero emissions" as the new standard for buildings. Authors’ elaboration using European Commission (2025).

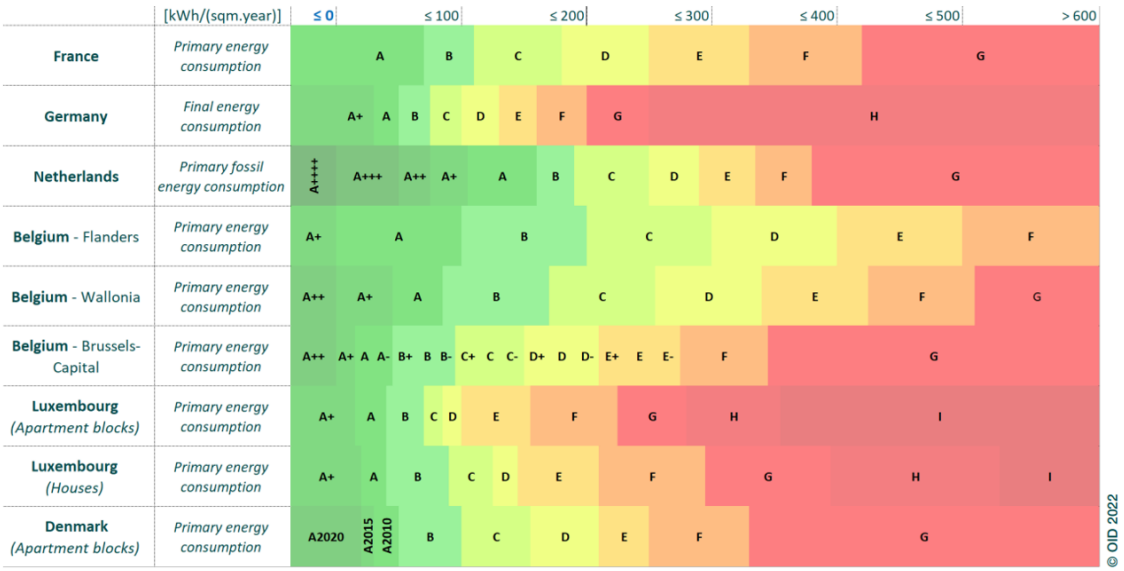


Figure 2: Energy performance classification across European countries. Energy performance classes based on primary or final energy consumption thresholds in different European countries. Source: Observatoire de l’Immobilier Durable (OID) (2022).

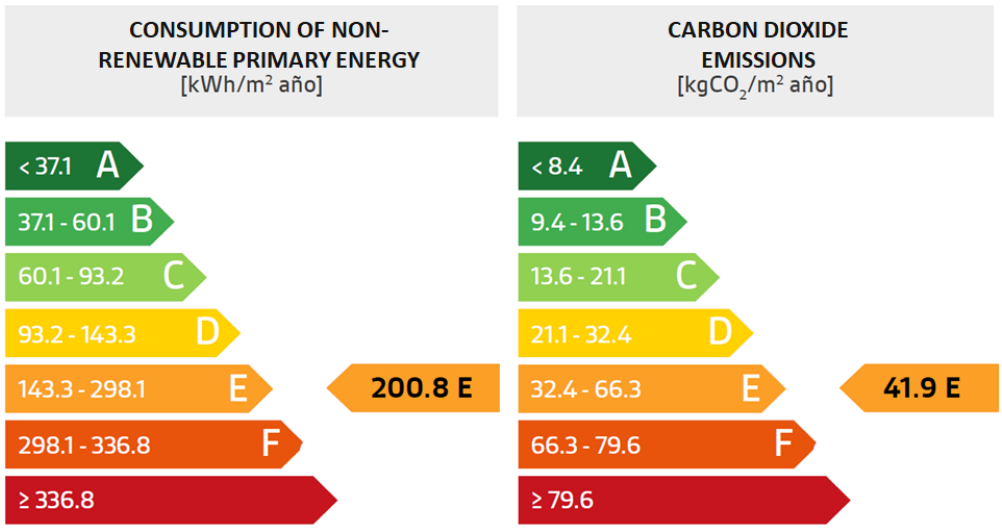


Figure 3: Example of energy rating scale. Places the values of the energy certificate on a scale from A to G, indicating in each case the in each case the value of non-renewable primary non-renewable primary energy consumption and carbon dioxide emissions.

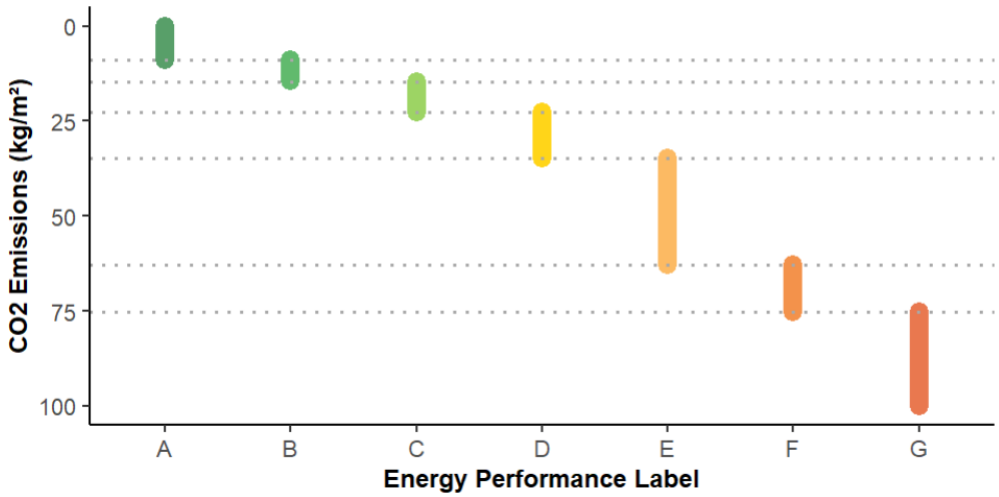


Figure 4: Example of energy rating scale thresholds. This Figure places the thresholds for the peninsular, C2 climate zone, unifamiliar houses under analysis.

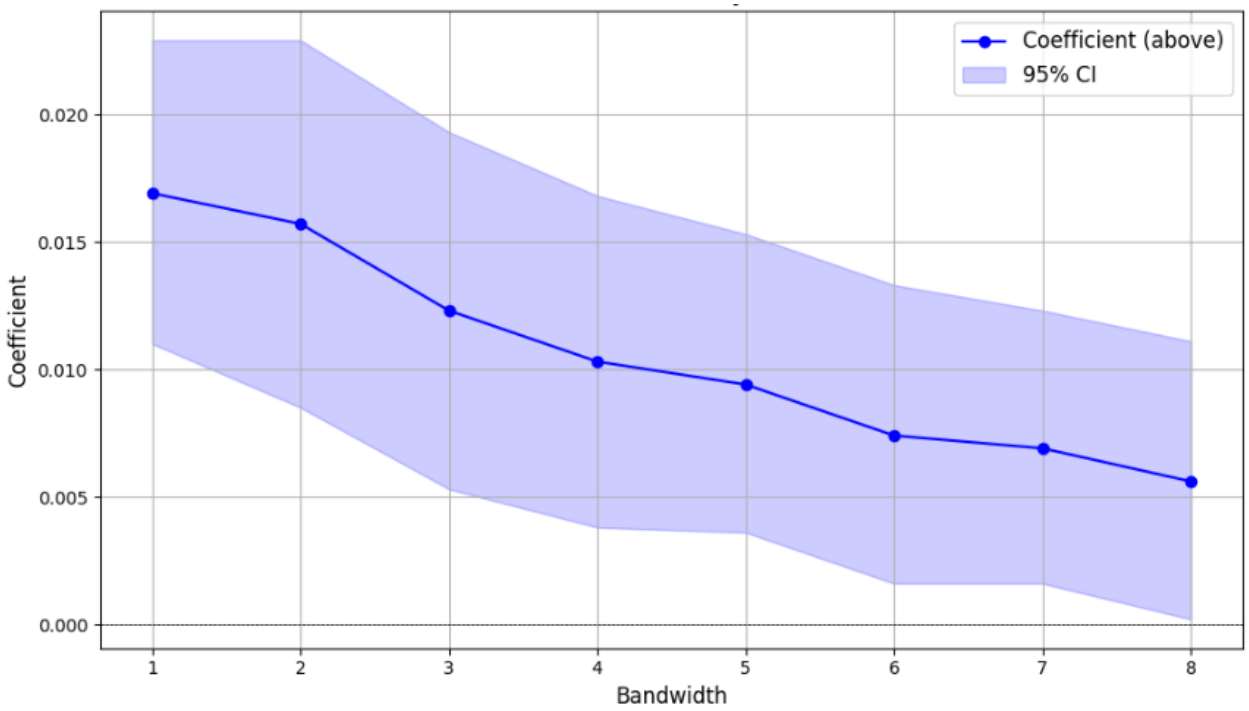


Figure 5: Stability of Coefficient Estimates Across Bandwidths. The figure shows coefficient estimates with 95% confidence intervals across different bandwidths. Around the optimal bandwidth, the coefficient remains significant, reinforcing the robustness of the results.

Online Appendix

Table A1: Description of Variables. This table provides detailed descriptions of the primary variables utilized in our empirical analysis.

Variable	Description
log_value_m2	Natural logarithm of the appraisal value per square meter of the property.
postal_code	Postal code where the property is located.
date_certification	Date (day, month, year) when the energy certificate was issued.
date_appraisal	Date (day, month, year) when the appraisal report was made.
above	Binary variable equal to 1 if the property's energy efficiency rating is immediately above a letter threshold, and 0 if it is immediately below.
emissions_CO2	Continuous and unrounded variable measuring the amount of carbon emissions (KgCO2/m2/year) estimated for each property.
year_construction	Control variable storing the construction year of the property.
quality_construction	Control variable assessing the quality of materials used in the construction of the property, considering elements such as finishes, cladding, flooring, and detailing. This evaluation provides a key measure for assessing the overall construction quality, where: 1 = Medium, 2 = Very High, 3 = High, 4 = Low.
conservation_construction	Control variable evaluating the current state of preservation or level of renovation of the property, categorized as: 1 = Very Good, 2 = Good, 3 = Fair, 4 = Poor, 5 = Very Poor.
location_construction	Control variable describing the quality of the property's location within the postal code, considering factors such as proximity to parks, vacant land, neighborhood safety, among others. It classifies properties on a scale where: 1 = Best location, up to 11 = Worst location.
mean_energy_inflation	Binary variable that equals 1 if energy price inflation is at or above the sample period mean, and 0 otherwise.
1SD_energy_inflation	Binary variable that equals 1 if the property's energy price inflation is at least one standard deviation above the sample period mean, and 0 otherwise.
extreme_cold_winter	Binary variable equal to 1 if the temperature anomaly falls below the 1% percentile of the historical winter temperature distribution, and 0 otherwise.
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Table A2: Summary of Balance Check Regressions. This table presents balance check regressions for the regression discontinuity design (RDD), where key explanatory variables are tested for discontinuities at the threshold. The insignificance of most coefficients suggests that these covariates do not systematically differ across the cutoff, supporting the validity of the RDD approach.

Dependent Variable	Coefficient	Std. Error	P$>|t|$	[95% Conf. Interval]
mt2	-1.5353	0.9040	0.1150	[-3.50 , 0.43]
year_construction	0.0653	0.1222	0.7080	[-0.19 , 0.34]
quality_construction	0.0092	0.0053	0.1120	[-0.00 , 0.02]
conservation_construction	-0.0146	0.0056	0.0250	[-0.27 , -0.00]
location_construction	0.0050	0.0099	0.6210	[-0.01 , 0.02]

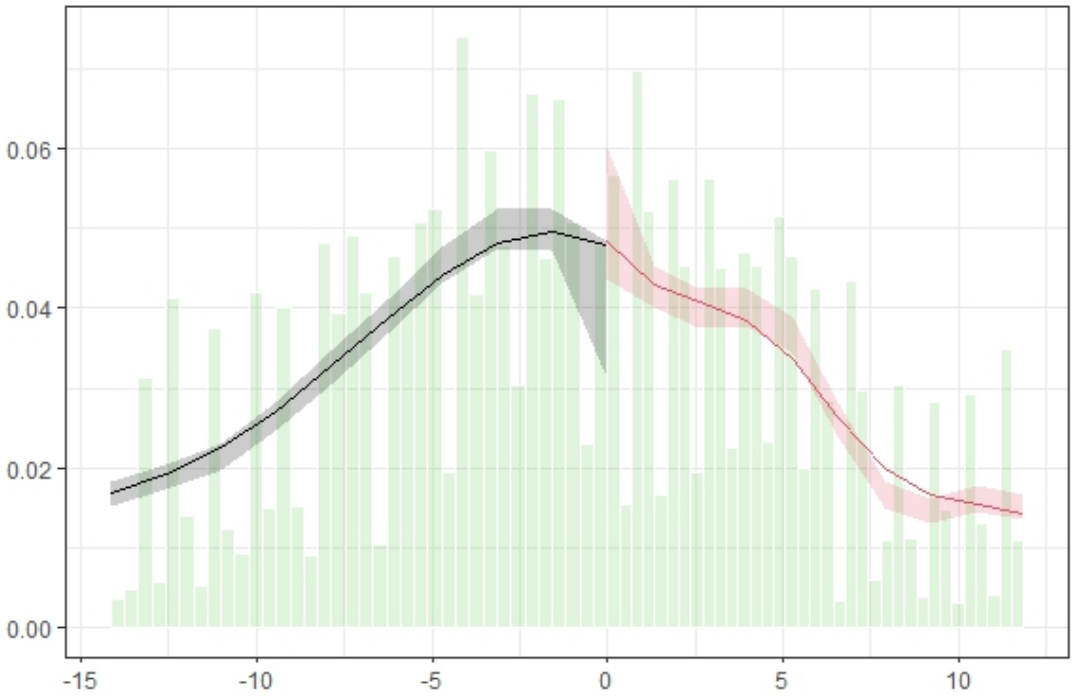


Figure A1: Example of Manipulation Test in the Distribution of the Running Variable. This figure presents the density distribution of the running variable, with fitted local polynomial regressions on both sides of the threshold. The observed discontinuity at zero suggests a potential sorting effect. The applied test is Cattaneo, Jansson, and Ma (2020) estimator and corresponds to the climate zone C2, for unifamiliar houses, in peninsular land observations.

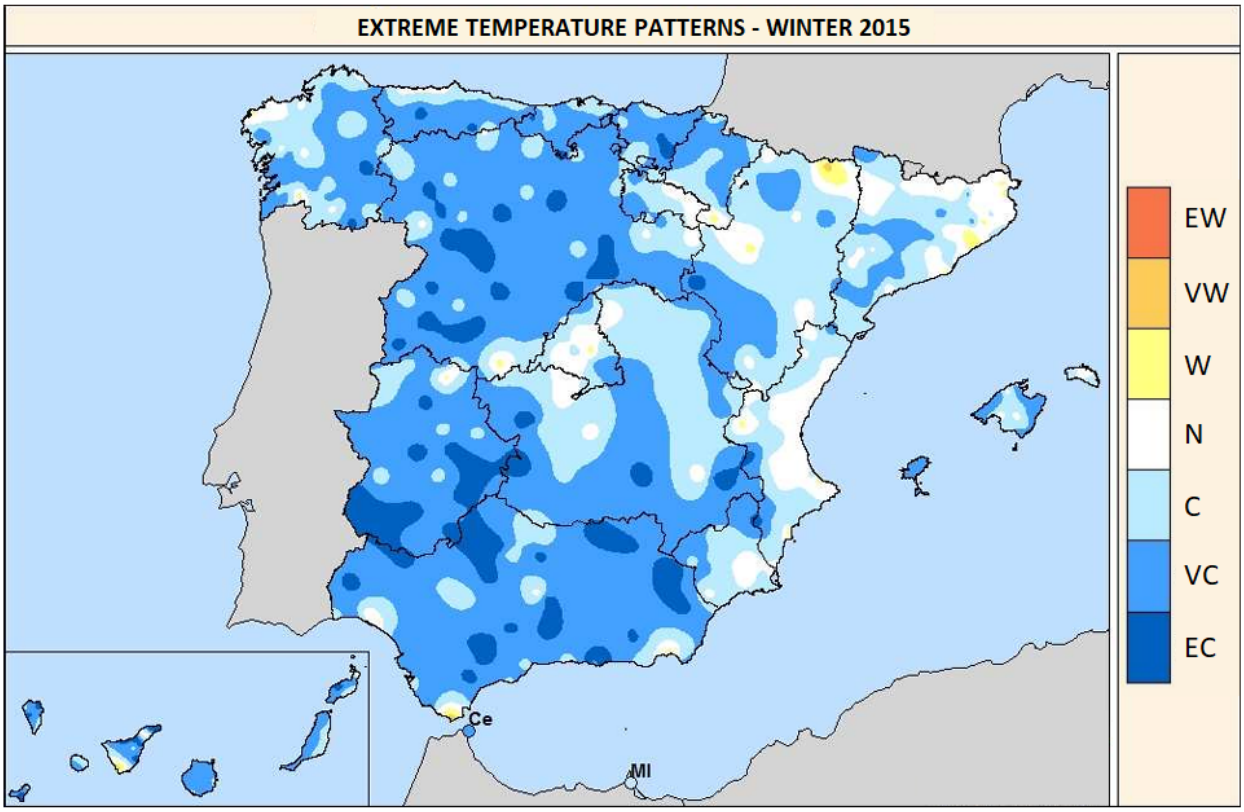


Figure A2: Temperature Anomalies in Spain This map illustrates temperature deviations across Spain during the winter of 2015, categorized into six levels ranging from extremely warm (EW) to extremely cold (EC). The classification is based on historical temperature records for the reference period. Blue shades indicate below-normal temperatures, with widespread cold (C), very cold (VC), and extremely cold (EC) conditions. Warmer anomalies are shown in yellow to red, representing warm (W), very warm (VW), and extremely warm (EW) conditions. The map highlights widespread colder-than-average temperatures across Spain. Map data and elaboration are based on sources from the Spanish State Meteorological Agency.