

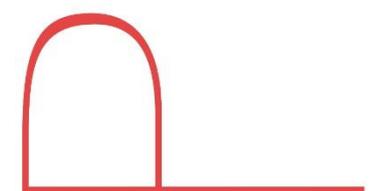
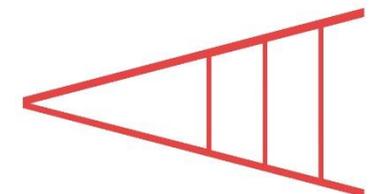
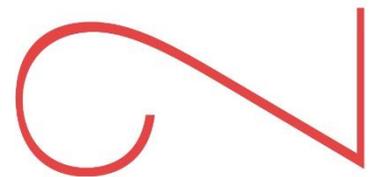
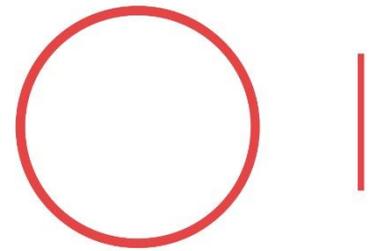
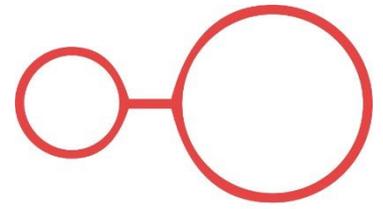
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Do Energy Performance Certifications Matter in Housing Selection?

Evidence from choice experiments in Barcelona

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ABSTRACT: Energy Performances Certificates have been implemented in Spain just in the moment of the largest real estate recession, such situation does not allow to observe consumers' preferences on energy efficient homes. This paper uses choice experiment to study the relative importance of energy efficiency in relation to other functional and quality attributes. In order to evaluate the role of framework information in the formation of household preferences the sample has been split into 2 sets and informed on the economic and environmental implications of energy efficiency using technical and illustrative units. Results suggest that households do give importance to energy efficiency mainly when they are informed in an easy-to-understand way. This latter finding has important implications for the design of energy policy.

KEYWORDS: Energy efficiency, choice experiments, Energy-performance-certificates

1. INTRODUCTION

Fifteen years ago the EU introduced the energy performance certifications (EPC) to give universal energy transparency to the real estate market. The aim of such policy is to foster energy-efficiency informed purchasing and letting decisions. Under the hypothesis that an increased utility coming from energy bill savings and the preservation of environment might transform into explicit preferences for efficient real estate. Such utility can capitalise on higher prices and preference of efficient buildings. Empirical evidence, coming from different EU countries has found a market premium for EPC efficient residential and commercial buildings (see Mudgal et al. 2013). In the case of Spain, such evidence is scarce (Marmolejo, 2016), and the few existing studies do report market premiums that are quite below in relation to other countries. One of the reason is the very recent transposition of the Energy Performance of Buildings Directive by means of the Real Decree 235/2013, that has it made mandatory to include the energy label as of the 1st of June of 2013. The second reason is that such transposition came into force in the worst real estate recession which does not allow to observe consumers' preferences for energy efficient homes.

This paper tries to fill this gap by means of 2 clearly different objectives:

1. To identify the relative importance of energy performance certifications in relation to other housing attributes in choice selection
2. To study whether such importance, if any, is different in the event that housing consumers are informed on the economic and environmental implications of energy efficiency using easy-to-understand units, instead of the technical units legally established.

Previous research has strengthened the importance of information background on the preference formation for efficient homes (Marmolejo, et al., 2017).

In order to achieve such objectives a family of choice based experiments have been done in order to identify the implicit preferences of a sample of potential multifamily users in Barcelona. In order to quantify the marginal utility of the assessed housing attributes, a conventional logistic regression has been implemented.

2. EMPIRICAL EVIDENCE ON ENERGY EFFICIENCY PREFERENCES

An important number of studies uses hedonic pricing to estimate the marginal price of green labels including EPC (Marmolejo & Bravi, 2017). The pioneering work of Brounen and Kok (2011) in The Netherlands found that there is 3.6% transaction market premium from green dwellings, comparing to inefficient dwellings: improving energy EPC ranking from D to A (the more efficient rank) or from G (the most inefficient rank) to D, increase 10% or 5% housing prices respectively. Mudgal et al. (2013) have performed a study comprising a number of European cities which details that the impact of different levels of the EPC on selling prices is varied, ranging from only 0.4%, for each rank, in Oxford up to 10.5% in Vienna. Fuerst et al. (2015) report for the analysis of selling prices in England that a G->D improvement implies a 7% price increase, at the time that the improvement D->B implies a market premium on 5%. In Spain Marmolejo (2016) report an increase of only 5.11% for improving the EPC rank from G to A (it is to say only 0.8% for each rank). This latter finding may come from the late adoption of EPC policy but also different climatic conditions and environmental concerns perspectives. The above-stated

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conclusions do not shed light on consumers' preferences when other architectural attributes are present. For that reason, an increasing number of studies use choice experiments to uncover the preference structure, just as it is done in this paper.

In the literature, the use of stated preferences is well established. In such family, choice experiments (CE) have proven to be a powerful technique to study consumer's preferences. In relation to other declared preferences (Marmolejo & Ruiz, 2013). CE approach portrays 3 main advantages:

1. It is robust to strategic/complacence bias since respondents are not directly questioned to state the preference for a concrete attribute (e.g. energy efficiency)
2. It is familiar to respondents since it emulates exactly the same elicitation process that they use when acquiring products in the market
3. It allows to identify trade-offs of utility since the election of the preferred alternative implies the rejection of the remaining of the offered options.

In the Netherlands, Poortinga et al. (2013) used a paper-based on conjoint analysis where respondents declared the acceptability level of some energy-saving measures in a Likert scale. In this way, the authors identified the trade-off between energy-saving appliances and willingness to change consumption behaviour. In a similar line, Sadler [9] used two paper-based choice experiments to assess preferences for home renovations and heating systems in Canada. Each "choice set" was formed by alternative heating systems already available in the market; and the choice of home renovation with and without energy retrofits. Her results highlight that households prefer energy-efficient renovation over renovations without energy retrofits. In Switzerland, Banfi et al. (2008) used telephone-based choice experiments to determine willingness to pay for energy-saving measures in residential buildings. Each choice task consisted of reading a card that listed the features of the actual house and those of another dwelling and having to choose the one which was preferred out of the two alternatives. Offered improvements included air renewal systems and insulation of windows and facades. Their analysis indicates that consumers significantly value green attributes, due to the energy savings and environmental benefits they bring along; even though other attributes, such as thermal comfort, air quality and noise protection, are considered. Achtnicht (2014) uses face-to-face computer-assisted choice experiments to assess the consumers' energy preferences in renovations with energy retrofits resulting from insulation and heating systems. An important novelty in his study is the inclusion of the actual economic savings and CO₂ emissions, as well as professional energy consultancy

services. The respondents were provided with two hypothetical measures of upgrade regarding their heating supply and usage respectively, from which they could choose.

The research reported here is different since it explores the trade-offs between the EPC ranking and other residential attributes while selecting a standard urban apartment and taking into consideration that energy efficiency is enclosed in the EPC scheme. Moreover, it explores whether the respondents do give a different importance to energy efficiency when they are informed on the economic and environmental implications using technical units (i.e kWh/sq.m of non-renewable primary energy) versus illustrative ones (Euro/month savings in the energy bill).

3. METHOD, DATA AND CASE STUDY

We use choice based experiments (CE) to achieve the 2 objectives of the paper. CEs consist in submitting a group of individuals to a task in which they are faced with choosing, within a set of alternatives, the preferred option (usually a product or service). These alternatives are usually named "the choice set" and, from the cognitive point of view, their comparison (followed by the final choice) represents the task that the respondent is called to accomplish. The observed component of utility associated with different alternatives is usually defined as a function involving a simple linear combination of attributes and parameters estimates. The partial utility of each attribute is calculated by means of a discrete choice model.

The detractors of state preferences methods argue that the actual behaviour of people tends to be different from that stated in surveys. Such a gap is known as the hypothetical bias (HB). Nonetheless, researchers have found (List, 2001; Fifer et al., 2014) that HB tends to be smaller when: 1) goods assessed are private, as opposed to public; 2) experiments are realistic (i.e. payment vehicles are familiar and people rely on the feasibility to provide the attributes of the assessed goods); and 3) individuals are carefully selected so as to ensure convenient experience and appropriate demographics.

All these reasons support the use of CEs in this work, in absence of data about actual transactions, since: 1) usually, people choose between a finite set of alternatives when looking for a new apartment; 2) houses are private goods and people are used to paying a price according to their attributes; 3) the EPC ranking is usually declared in the actual market offers; 4) a clear and realistic payment vehicle has been designed and the amount is in keeping both with monthly mortgage and rent payments, with which people are already familiar, and 5) respondents were carefully selected so as to ensure the necessary cognitive resources to perform the task.

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The implementation of the CE of this study consisted of:

1. Determination of the attributes and levels of each attribute
2. Design of a comprehensive survey where the CE where framed
3. Identification of the relevant population and sample size
4. Implementation of surveys
5. Analysis of the data using discrete choice models

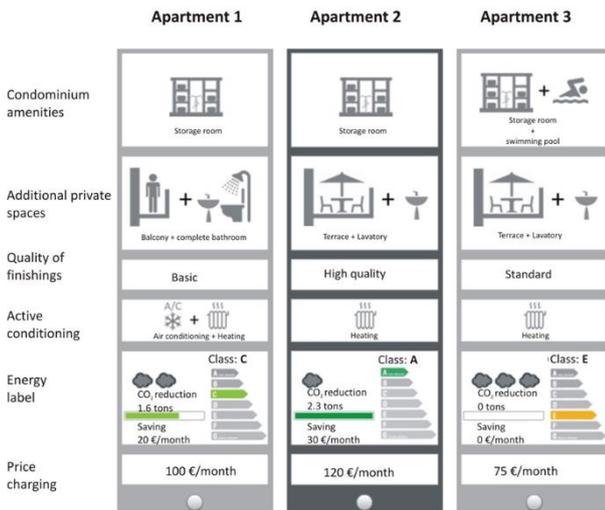


Figure 1: Example of the computer assisted choice set

In this research the selected attributes come from a specific research on typology and advertisement of new housing developments in Barcelona. The attributes/levels used in the CE are as follows:

- **Condominium amenities.** Two levels: storage room or storage room plus swimming pool. It is common that new developments in Barcelona do include such attributes even when they are targeted at medium- and medium-low income population segments.
- **Additional private spaces.** Two levels: terrace and restroom; or balcony plus complete additional bathroom. In general, new developments with three bedrooms do include two complete bathrooms; nevertheless, a trade-off between the spaces “additional bathroom/restroom” and “balcony/terrace” could be present. Due climatic reasons, privately-used open spaces, such as balconies and mainly terraces, are important in multifamily markets in Barcelona.
- **Quality of finishings.** Three levels: basic, standard and high quality. For each level, a description was given regarding the kind of material used in walls, floors and kitchen.

- **Active conditioning.** Two levels: (radiant) heating and heating plus air conditioning (heating pump).
- **Energy label.** Three levels: “E” (the minimum EPC level, according to the current building regulation in Spain), “C” and “A”. Half of the participants were informed on the economic and environmental implications of energy efficiency in two different ways as further discussed.
- **Price charging.** Respondents were informed about the fact that using high-quality finishings and energy-efficient attributes (i.e. wall/window insulation) increases the construction cost of the building. For that reason, a price charging up to 130 € would be added to the monthly payment of rent or mortgage. The price charge has been calculated by adding production and development costs for different levels of finishes and energy classes. To transform these marginal increases into monthly payments a direct capitalization has been used with a 4 % yield (which is the usual standard in Barcelona for this kind of apartments). The price charge allocation is, thus, conditional to the finishings, thus avoiding the possibility to present an unrealistic combination of low-quality apartment with high prices. The assumption is that respondents value the trade-off between price charge (marginal price) and the overall benefits derived from different apartment attributes.

The CE was incorporated into a survey applied to residents of the Barcelona’s area older than 18 years which participate in the main decision-making of their household. It is to say the sample is formed by actual owners and tenants of homes in the study area. In order to assure the representativeness of income and demographics, the respondents were recruited along the different neighbours of the city and neighbouring municipalities up to cover all the income levels as well as the age cohorts. The survey was made part face to face and part using an online platform. In total the sample consists of 2,000 CE coming from 500 participants after discarding 166 incomplete or unreliable surveys according to the under-average duration of the answering time.

The survey itself consisted of the following structure:

1. **Contextualization.** The goal of this section is to understand the previous knowledge of respondents about the EPC scheme, as well as their energy consumption and sustainable habits and their satisfaction about the status-quo option.
2. **Choice experiment.** Each respondent was asked to perform four choice tasks after being clearly

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informed about each of the attributes and levels used in the different apartment alternatives included in choice sets. In doing so, complementary graphic material was used in order to visualize the quality of the finishings.

3. **Socio-economic profile.** In order to test whether preferences depend on individuals' heterogeneity, socio-economic characteristics (SECs) such as gender, age, income, professional status and educational level were controlled.

After being informed on the attributes and levels than a recently completed apartment may have, respondents were asked to indicate the preferred one in the event that they have to move to another apartment. An example of the choice task is illustrated in Fig 1.

Two different experiments were applied to each half of the sample. In the first one (EVP1) the economic and environmental implications of energy efficiency were stated using the technical legal units (kWh/sq. m/annum of primary non-renewable energy and tons of CO₂). In the second experiment (EVP2), illustrative easy-to-understand units were used: monthly savings in energy bills expressed in Euro; and the emissions equivalent in terms of car mileage. In order to avoid a selection bias the participants were randomly assigned to the 2 choice experiments.

4. RESULTS

Fig. 2 contains the sociodemographics of the 500 participants. As seen, the cohort of 18-30 comprises half of the sample, which although does not exactly correspond to the general age distribution provides important insights on preferences of young households most in a tenant tenure.

Age		Household net disposable income	
Year		Euro/month	
18-30	50%	<600	3%
31-45	20%	600-1200	11%
46-65	26%	1201-1800	15%
>65	4%	1801-2400	17%
		2400-3000	16%
		3001-3600	15%
		3601-4200	10%
		4201-4800	6%
		>4800	8%
Completed studies		Sex	
Primary	1%	Women	49%
Secondary	1%	Men	51%
Technical High School	7%		
High School	17%		
1st University degree	19%		
Bachelor	34%		
Postgraduated	20%		

Source: Own elaboration

Figure 2: Sociodemographic data from the sample

Fig. 3 contains the results of the discrete choice models calibration for the 2 choice experiments carried

out (EVP1 and EVP3). Broadly, the outcomings for the 2 experiments are the same, despite the fact that respondents were different as it has been said. Such results suggest that respondents are attracted more for the swimming pool rather than only having a storage room. As well, they do prefer apartments with a terrace instead of a balcony, despite that this latter option includes an additional bathroom. This finding strength the importance of open spaces over additional interior spaces in the Mediterranean climate. Regarding the quality of finishings clearly the high-quality option is the less popular among respondents, since the additional price to be paid for the apartment as a leasehold or mortgage payment was correlated with the quality. So the larger the quality, the larger the price.

Interestingly, the basic quality of finishings does not represent the most desired alternative, but the standard one. In other words, people declare to prefer standard qualities but not expensive ones. For that reason, developers in Spain even when apartments are targeted to the upper demand segment do exhibit medium-high quality finishings allowing in this way a further customisation.

On the active conditioning systems, respondents were clearly attracted by the flats portraying air conditioning and heating, instead of having only heating. This finding is important since in Mediterranean countries the summer tends to be very hot.

Coming to the energy efficiency, clearly the respondents rejected the alternatives containing the worst of the EPC class "E" and prioritized those including class "A", the most efficient one. Regarding the price, as expected the coefficient is negative, which suggest that larger prices do represent a loss of utility for consumers. This trend is common in all choice experiments regardless its thematic application.

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	EPV1 MOD 1			EPV3 MOD 1		
Model adjustment						
rh	0.42139			0.42041		
Log-likelihood model	- 853			- 854		
Log-likelihood null model	- 1,099			- 1,099		
Dif	246			244		
Certainty percentage	22			0		
Consisten Akaike Info Criteri	18			1,772		
Chi sq	5			489		
Chi sq relative	55			61		
	Effecto	Std Err	T ratio	Effecto	Std Err	T ratio
Condominium amenities						
Storage room	- 0.14	0.04	- 3.55	- 0.14	0.04	- 3.63
Storage room + swimming poc	0.14	0.04	3.55	0.14	0.04	3.63
Additional private spaces						
Balcony + complete bathroo-	- 0.13	0.04	- 3.20	- 0.20	0.04	- 5.01
Terrace + lavatory	0.13	0.04	3.20	0.20	0.04	5.01
Quality of finishings						
Basic	0.41	0.06	7.40	0.38	0.06	6.95
Standard	0.98	0.06	7.06	0.30	0.06	5.39
High quality	- 0.80	0.07	- 12.20	- 0.68	0.06	- 10.59
Active conditioning						
Heating	- 0.27	0.04	- 6.74	- 0.25	0.04	- 6.29
Air conditioning + Heating	0.27	0.04	6.74	0.25	0.04	6.29
Energy class						
Class E	- 0.84	0.07	- 12.64	- 0.95	0.07	- 13.70
Class C	0.17	0.06	1.27	0.18	0.06	3.25
Class A	0.77	0.05	14.08	0.77	0.06	13.98
Additional price						
Lineal	-0.15693	0.04909	-3.19664	-0.19618	0.04828	-4.06297

Source: Own elaboration

Figure 3: Discrete choice models results

Figure 4 depicts the relative importance of each attribute. Clearly Energy class is the most important attribute in both of the choice experiments. The second attribute in importance is the quality of finishings concomitant with price (thus it can be read as the importance of price on apartment choice), followed by the active temperature conditioning, the private spaces and condo amenities.

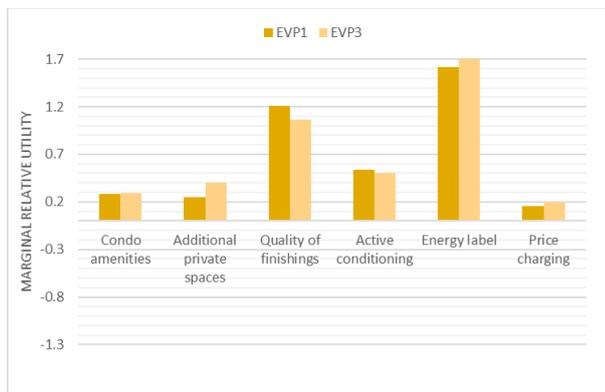


Figure 4: Relative marginal utilities coming from logit model

This latter figure also allows comparing the different importance that respondents gave to the attributes when were informed in different ways on energy efficiency implications. As said before EVP1 experiment informed using technical/legal units, it is to say kWh/sq. m2/year and CO2 tons; conversely in EVP3 respondents

were informed using illustrative units, it is to say Euro/month of energy savings and the reduction of CO2 in equivalent car mileage. As it is clear household do clearly prime more the energy efficiency of the offered apartment in the latter case when the economic and environmental implications are showed in meaningful terms. Such larger importance seems to be in detriment of the quality of the finishings which relative marginal utility decays in EVP3 sample in relation to EVP1.

5. CONCLUSIONS

Energy efficiency is a multidimensional housing attribute coming from different active and passive measures. For most of the consumers such attribute is opaque due to cognitive limitations and information asymmetry. All in all, represents a barrier for the diffusion of energy efficient homes. In order to broke down such opacity using an easy-to-understand energy-efficiency indicator, the European Union released the Energy Performance of Buildings Directive which makes it mandatory to include an Energy Performance Certificate when a property is transacted in the leasing and selling market. So as for 1st of June of 2013 almost all properties being transacted have to include the EPC class in Spain.

Nonetheless, it is not clear the relative importance of Energy Efficiency in relation to other residential attributes when choosing a property for leasing or buying. For that reason, in this paper we use choice experiments to assess the importance of this residential attribute in relation to other which are preeminent in the marketing of apartments in Barcelona such as condominium amenities, private space arrangements, quality of finishings and active thermal conditioners.

In order to test whether information framework might influence household decisions the implications of energy efficiency in economic and environmental terms where informed using technical and illustrative units.

The results suggest that respondents do positively appreciate energy efficiency in relation to the other attributes. Such preference is larger when they are informed using easy-to-understand illustrative units instead that the technical ones contained in the normative. This latter finding has an important implication for energy policy and suggests that more attention has to be placed in the design of the communication of energy efficiency, since most of the residential consumers are not experts in this field. So, the easier such implications are stated in the Energy Performance Certificates, the larger the efficacy of such policy. Of the the main criticism to the EPC labels in Spain is the completely lack of information about the scheme. The RD 235/2013 has given for granted that people are aware of what is exactly measured by the energy certificates and the implications for household economy and environmental welfare. Such assumption is far to be

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realistic and more attention need to be paid in the recasting of the Directive and its national transposition.

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