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Original Paper

The Effect of Providing Monetary Information on Energy Savings for

Household Appliances: a Field Trial in Spain

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Abstract

Energy labels are one of the most widely used policies in the European Union for increasing the energy efficiency of household appliances. However, their effectiveness in promoting energy-efficient purchases has sometimes been called into question. One of the reasons for this is that consumers may have difficulties in fully understanding the energy consumption information provided on labels (in kilowatt-hour per year). Some authors argue that to avoid this problem energy consumption information should be converted into monetary information. We analyse whether providing monetary information on lifetime energy savings can significantly increase purchases of energy-efficient appliances. To that end, a field experiment was carried out with small retailers in Spain. The experiment involved three types of appliances: washing machines, fridges and dishwashers. The impact of monetary information on actual purchases of appliances was tested in different ways: (i) by including a

monetary label to display energy savings during the lifetime of the product; (ii) by the monetary information provided by sales staff; and (iii) by combining (i) and (ii). We find that the effectiveness of providing monetary information depends on the appliance and the specific way in which the information is provided. For washing machines, providing monetary information through a monetary label seems effective in promoting the purchase of highly energy-efficient appliances. However, for fridges, both monetary information provided by staff alone and the combination of the monetary label and information from sales staff seem to be effective in promoting purchases of A^{+++} fridges. Surprisingly, no effect is found for dishwashers.

Keywords

Energy efficiency
Monetary label
Household appliances
EU energy efficiency label
Field trial

Introduction

The production and consumption of energy is the main source of greenhouse gas emissions from the household and industry sectors in the 28 countries of the European Union (EU) (Eurostat 2018). In this context, one of the main targets and goals of EU energy policy is to increase the energy efficiency of energy-related products so as to reduce energy consumption (European Commission 2008). Particularly, the EU seeks to achieve energy savings of at least 32.5% in all sectors by 2030 under the Energy Efficiency Directive (2018/2002).

Energy efficiency has been defined as a reduction in the energy used to provide a certain energy service or product, and it has become one of the principal instruments for reducing household energy consumption (Linares and Labandeira 2010). Although energy efficiency can lead to several benefits such as cost reductions and decreases in carbon emissions, these are not always enough to boost investments in it. That is, even when energy efficiency may prove economically profitable for consumers, they may not always invest as much as seems rational (Gerarden et al. 2017; Jaffe et al. 2004; Linares and Labandeira 2010). Among other reasons, this may be because consumers do not value present costs (benefits) and future costs (benefits) in the same way. In fact, consumers often fail to properly account for future costs (Allcott and Wozny 2013; Train 1985). This is known as the energy efficiency gap or the energy

efficiency paradox: it refers to situations in which apparently beneficial investments are not made, and/or apparently non-beneficial ones are (Jaffe and Stavins 1994).

Economic literature has considered several explanations for the energy efficiency gap (Solà et al. 2020). These can be grouped into three categories: (1) market failures (including informational failures); (2) behavioural failures; and (3) other personal factors. *Market failures* are considered to mean the inefficient distribution of goods and services in a free market, *behavioural failures* mean failures related to individuals (e.g., inattention) and *other personal factors* mean other factors that cannot be classified under the first two headings (e.g., social norms).

Informational failures are situations in which a lack of or reduction in information could affect financial decisions. These include asymmetric and imperfect information (Allcott and Sweeney 2016; Davis and Metcalf 2016; Phillips 2012), hidden and transaction costs (Ramos et al. 2015; Sorrell et al. 2004), myopia (Busse et al. 2013; Cohen et al. 2017; Gerarden et al. 2017) and uncertainty (Greene 2011; Ramos et al. 2015; Tversky and Kahneman 1981).

Imperfect information arises when the two parties (the seller and the purchaser) do not have the same information or when they perceive the same information differently. Hidden and transaction costs represent the tendency of purchasers to fail to perceive running costs or other costs associated with a specific product. Myopia arises when willingness to pay for a product is not affected by changes in its future operating costs. Finally, uncertainty regarding future energy prices could also affect investments in energy efficiency.

Several policy instruments can be used to cope with the different failures. They are conventionally grouped under the following headings: command and control instruments (e.g., codes and standards), price instruments (e.g., taxes, subsidies and/or a combination of the two) and informational instruments (e.g., energy labels, smart meters and information feedback tools and energy audits).

In this paper, we focus on energy labels as the most commonly used instrument for addressing informational failures and reducing the energy efficiency gap. They do so by highlighting the energy efficiency level and the energy consumption of a product (Banerjee and Solomon 2003; Carroll et al. 2016; Heinzle and Wüstenhagen 2012; Lucas and Galarraga 2015). Energy labels often provide additional information such as water consumption or noise level. There are different energy efficiency labels for different product categories (e.g., cars, household appliances, etc.) and they usually contain similar but differentiated

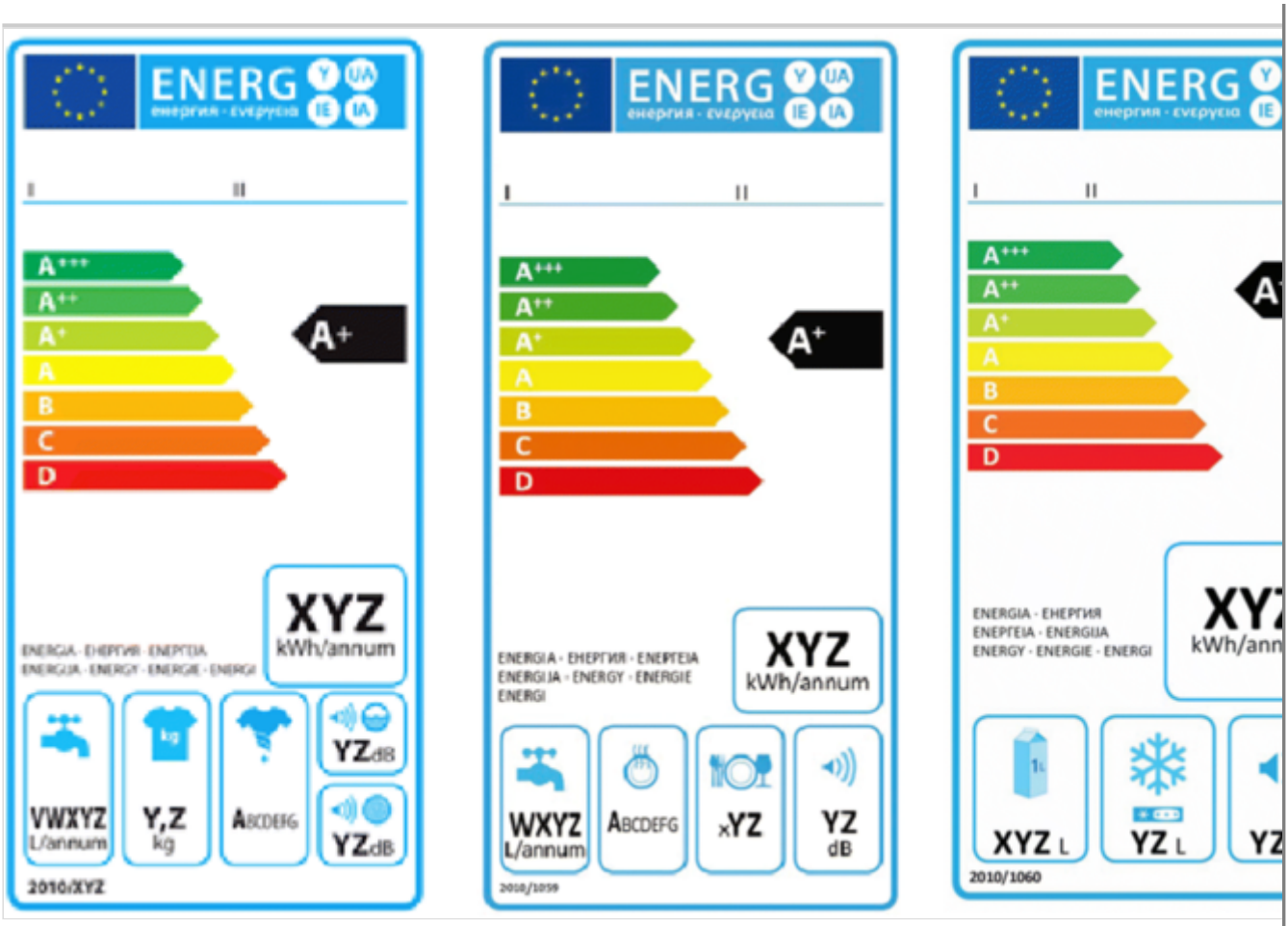
information. In particular, the energy efficiency label for appliances shows the energy efficiency level of the product, the energy consumption per year (kilowatt-hour per year) and other technical attributes. For instance, along with energy efficiency level and energy consumption, the label for washing machines also shows water consumption (in litres), capacity (in kilogrammes), spin-cycle efficiency and noise level in the washing and spin cycles (in decibels). In the case of cars, however, the voluntary and comparative energy efficiency labels feature an A–G scale and additional information on running costs, annual tax costs, additional attributes of the car, etc.

Understanding the effectiveness of the energy efficiency label is crucial to successfully nudging consumers towards more energy-efficient products. Some authors have called into question the effectiveness of energy efficiency labels in recent years (Stadelmann and Schubert 2018; Waechter et al. 2015, 2016). Several studies show a positive willingness to pay for energy-efficient products (Galarraga et al. 2020), but others argue that purchasers do not really properly understand the information displayed on labels (Waechter et al. 2016).

De Ayala et al. (2020) show that consumers often misunderstand the energy consumption information displayed on energy efficiency labels (see examples of EU labels in Figure 1). In particular, when focus group participants were asked to suggest potential improvements in the EU energy efficiency label, one of their suggestions was for energy consumption information to be provided in monetary terms (as well as or instead of the physical unit of kilowatt-hour per year). Participants argued that having information on the operating costs would help them to decide how much they were willing to pay for more energy-efficient appliances. Moreover, some focus group participants suggested that a reference point might be shown to enable energy consumption to be compared with a view to learning whether consumption was high or not.

Fig. 1

EU energy efficiency labels for washing machines, dishwashers and fridges



Several studies have analysed how providing monetary information can help consumers to better understand energy efficiency–related issues (e.g., energy consumption), but there is no clear consensus on this. Some studies show that providing monetary information may be helpful in encouraging the purchase of energy-efficient products (Kallbekken et al. 2013), but others find no significant impact (Carroll et al. 2016). In addition, the literature suggests that the effectiveness of monetary information could also change depending on the product category (Stadelmann and Schubert 2018).

The study reported here seeks to analyse how providing monetary information on the energy efficiency of household appliances could encourage the purchase of the most energy-efficient options (A^{+++}). This is done through a field experiment that provides information on energy savings at several retailers in Spain. To that end, information on energy savings over the lifetime of a product was displayed in monetary terms (in €) for three types of appliances: washing machines, fridges and dishwashers. The trial was conducted to analyse how effective providing such information may be in changing actual purchasing decisions at the point of sale. The information was displayed in three different formats: (1) using a monetary label; (2) by having sales staff that provided it; and (3) via a combination of (1) and (2). Twenty-six small retailers participated in the experiment. They were located at various points in the Comunidad

Autónoma Vasca (Autonomous Community of the Basque Country) and neighbouring regions, and belonged to the retailers Milar, Expert, Tien 21 and others. The trial was carried out in close collaboration with two chambers of commerce in Spain (Federación Mercantil de Gipuzkoa, FMG, http://www.fmg.es/; and Confederación Empresarial de Comercio de Bizkaia, CECOBI, http://www.cecobi.es/es/portada/).

The rest of the paper is structured as follows: the “Current Energy Efficiency Labels and Their Effectiveness” section reviews energy efficiency labelling and the literature that analyses its effectiveness. The “Design of the Field Trial” section presents the design of the experiment, i.e., the recruitment process, the design of the 3 different treatments and other tasks carried out during the experiment. The “Data” section sets out all the data collected and presents some descriptive statistics; the “Model Specification” section presents the model specification and the “Results and Discussion” section presents the results of the experiment. Finally, the “Conclusions and Policy Recommendations” section sets out conclusions and policy recommendations.

Current Energy Efficiency Labels and Their Effectiveness

European Energy Efficiency Label

Energy efficiency labels are information-based instruments used to let consumers know the energy efficiency level and annual energy consumption of a certain product. They may also show other technical characteristics such as noise level or water consumption, as per the EU Energy Labelling Directive (2010/30/EU).

Before 2010, EU labels classed the energy efficiency level of a product according to an A–G scale (with A as the most efficient level and G the least efficient). This scale was easy to understand for most (70–80%) consumers (Consumer Focus 2012), and many people took product energy ratings into account for white-line products (Heinzle 2012).

Due to technical and technological progress, this scale had to be updated, and in 2010, a new directive was passed to change it. The EU Energy Labelling Directive (2010/30/EU) for household appliances required energy labels to be displayed on energy-related appliances at the point of sale with a scale that ranged from A^{+++} to D, in different colours (green for highly energy-efficient appliances and red for less efficient ones). Labelling schemes are usually tested after 5 years to ensure their effectiveness. In fact, Ölander and Thøgersen (2014) show that an A^{+++}–D scale is likely to reduce the effectiveness of the energy

efficiency label because it leads to an anchoring effect. After a few years with this complex scale, a new regulation was passed in January 2017 to restore the original A to G energy scale. This regulation should be in force by 2021.

The energy efficiency label shows the energy efficiency level of an appliance, considering its energy consumption and many other factors such as capacity, water consumption and other technical attributes. Energy consumption information is currently displayed as the annual average in kilowatt-hour. Depending on the product category, average energy consumption may be estimated differently. For example, for washing machines, the average annual energy consumption is calculated during the cotton programme at 220 cycles per year (approx. four cycles per week) and in the case of dishwashers' consumption is calculated for the standard programme at 280 cycles per year.

Effectiveness of Energy Efficiency Labels

Both the information provided and the way in which it is provided are very important in enhancing the effectiveness of the energy label and promoting energy efficiency. Several factors are really crucial for the effectiveness of energy efficiency labels: the energy efficiency scale, the colours used on the label, whether the scale is horizontal or vertical, etc. (Waechter et al. 2016). All these factors could affect the perception of consumers towards energy efficiency labels and thus affect their reliance on and the effectiveness of the policy (Waechter et al. 2016).

Several studies have analysed potential improvements in energy efficiency labels to increase purchases of appliances with higher energy efficiency levels. There is a growing body of research on how to improve labels so as to influence consumers' choices (Heinzle 2012; Heinzle and Wüstenhagen 2012; Noblet et al. 2006; Waechter et al. 2015). In this context, it seems very important to understand the effectiveness of the EU labelling system and current awareness and understanding of it on the part of consumers (Tigchelaar et al., 2011; Waechter et al. 2016, 2015).

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Substantial research has been conducted into the best way to provide energy consumption information at the point of sale. Table 1 below presents a summary of some relevant papers that have tested the effectiveness of energy efficiency scales and monetary information in different formats. For instance, some of them test the effectiveness of the EU energy labelling scale and compare the two systems (the A to G and the A^{+++}–D scales), with mixed results. Waechter et al. (2016) show that a short scale (A–C scale) could be more effective in terms of increasing energy efficiency awareness than the usual scale (A^{+++}–D scale),

removing the energy efficiency level categories no longer available on the market. In addition, A–G-rated appliances seem to be associated with a higher willingness to pay than those rated with an A^{+++}–D scale (Heinzle and Wüstenhagen 2012). However, Waide and Watson (2013) find a higher willingness to pay for more energy-efficient products using an A^{+++}–D scale. These results show that consumers are willing to pay €40 more for high-labelled refrigerators.

Table 1

Summary of literature on EU energy label effectiveness for household appliances

Articles	Information related to energy consumption	Effectiveness of the energy scale	Other	Result
Allcott and Knittel (2017) AQ3	Annual cost information			No effect
Allcott and Sweeney (2016)			Annual savings information vs. rebates	Effective if savings information is combined with information from sales staff
Asensio and Delmas (2016)			Year cost/savings information vs. health information	Health-related information is more effective
Bull (2012)			Information on losses avoided	Lifetime energy cost is effective
Carroll et al. (2016)	Five-year energy cost information			No significant impact
Deutsch (2010)	Life cycle cost information			Small reduction in energy use
Heinzle and Wüstenhagen (2012)		A^{+++}–A scale vs. A–D scale		A–D scale more effective
Heinzle (2012)			Operating costs vs. energy use	Operating costs is more effective
Kallbekken et al. (2013)	Lifetime energy cost information			Effective for tumble driers

Articles	Information related to energy consumption	Effectiveness of the energy scale	Other	Result
Min et al. (2014)	Annual operating cost information			No effect
Stadelmann and Schubert (2018)	Cost and savings information			Effective for tumble driers; no effect for freezers
Waechter et al. (2015)		Energy efficiency scale vs. energy consumption		No effect, consumers do not always choose the most energy-efficient product

Another relevant piece of information is whether consumers fully understand the label. In this sense, Waechter et al. (2015) test the understanding of energy efficiency and the way in which information is plotted on the label. They show that consumers understand the concept of energy efficiency and are aware of the energy efficiency label and its scale. Despite that awareness, consumers do not always choose the most energy-efficient products as they do not pay enough attention to energy consumption.

London Economics and Ipsos (2014) report an online experiment in several EU countries (Czech Republic, France, Italy, Norway, Poland, Romania and UK). That study tested different types of label (alphabetical closed scale, numerical closed scale, etc.). A benchmark that indicates the best available technology on the market is considered as a good reference point by consumers and helps to promote energy efficiency. The same study suggests that the label scale is better understood when it is represented by letters. Moreover, no difference is found when both the effectiveness of A–G and A^{+++}–D scales are compared.

Another way of plotting energy efficiency is via numerical scales, but less research has been conducted on this option. Egan and Waide (2005) show that consumers in China and Tunisia generally understand scales of these types, but find them less understandable than alphabetical scales.

Energy consumption is currently displayed as average annual energy consumption (kilowatt-hour per year), and some studies point out that providing running cost information (in €) could improve label effectiveness for appliances (Allcott and Taubinsky 2015; Carroll et al. 2016; Deutsch 2010; Kallbekken et al. 2013; Stadelmann and Schubert 2018).

For example, Kallbekken et al. (2013) run a field experiment with two product categories (fridge–freezers and tumble driers) to test the effect of providing monetary energy cost information through labels and through training staff to provide monetary information. Their results show a decrease in the average energy use of tumble driers sold of 4.9% for the combined treatment and 3.4% for the staff training treatment. A similar field experiment is reported by Allcott and Sweeney (2016), who find that information and sales incentives need to be treated jointly in order to influence purchases. Similarly, Carroll et al. (2016) run a field experiment with a 5-year energy consumption cost label for tumble driers, but find no statistically significant effects.

Stadelmann and Schubert (2018) run a field experiment to compare the effectiveness of labels in different scenarios (no label, EU energy label and monetary energy label based on annual energy consumption) for freezers, tumble driers and vacuum cleaners. They find that the presence of either label increases sales of efficient appliances. Moreover, when these labels are used, the average energy consumption (based on the consumption shown on the energy efficiency label) for tumble driers and vacuum cleaners decreases significantly, but for freezers, there is no significant change, apparently due to unawareness of the new monetary energy label.

Heinzle (2012) conducts a discrete choice experiment and finds that consumers will pay a higher price premium for televisions when 10-year monetary costs are displayed but a lower premium when 1-year cost information is displayed (compared to non-monetary energy efficiency information). Using an online field experiment for washing machines, Deutsch (2010) finds a small but significant reduction in energy use (0.8%) when consumers receive additional information on life cycle cost. In the UK, DECC (2014) finds a reduction of 0.7% in the average annual energy consumption as shown on the energy efficiency label of washer–dryers sold when lifetime energy cost information is given to customers. However, Min et al. (2014) show that providing estimated annual energy costs has no effect on consumers' decision-making for the purchase of lightbulbs. Similarly, Allcott and Knittel (2019) find that running cost information has no effect on car purchases in the USA.

Finally, Bull (2012) carries out a stated preference survey to test what additional information is most effective for investment in energy efficiency. He finds that information about running costs and emissions increases willingness to pay and that lifetime running cost information is more effective than per annum information.

Design of the Field Trial

A field trial was conducted between February and July 2018 in cooperation with 26 small retailers in Spain to test the effectiveness of providing monetary energy savings information at the point of sale. The retailers were drawn from different Spanish autonomous regions: the Autonomous Community of the Basque Country and the Regional Community of Navarre, Cantabria and Aragón. The appliances studied were washing machines, fridges and dishwashers.

The experiment was designed in the form of three sequential treatments in some stores and business as usual in the control stores. The three treatments were as follows: (i) adding a monetary label with lifetime energy savings information to the existing energy efficiency label (placement at visible point in physical stores); (ii) training the sales staff who provided the monetary information (but removing the aforesaid monetary label); and (iii) combining the monetary label with staff training. The three treatments were then compared to understand which might be the best strategy for effectively promoting the purchasing of energy-efficient appliances in Spain. Each treatment is explained more in detail in the "Adding a Monetary Label (Treatment One)," "Sales Staff Provide Monetary Information (Treatment Two)" and "Combination of Monetary Label with Information from Sales Staff (Treatment Three)" subsections.

The suitability of these treatments was determined following earlier studies by Kallbekken et al. (2013) and Carroll et al. (2016). Kallbekken et al. (2013) propose a treatment with a combination of a monetary label and information from sales staff, while Carroll et al. (2016) propose using only the monetary label. Other studies also consider using sales staff to provide information to consumers (Allcott and Sweeney 2016). Additional qualitative research conducted under the CONSEED project also helped to effectively design the treatments (de Ayala et al. 2020). This revealed that providing detailed explanations by sales staff is a key factor. In particular, the results showed that consumers may be aware of the existence of energy efficiency labels but may not fully understand or trust the information that they provide. Consumers tend to rely more on the information and advice provided by sales staff.

To cover all the evidence mentioned, we decided to test the effectiveness of providing monetary information through three sequential treatments: adding a monetary label (treatment 1), having sales staff provide monetary information (treatment 2) and a combination of the two (treatment 3). We decided to implement sequential treatments in order to ensure a significant number of observations per treatment. This enables us to see which treatment is potentially the best for promoting the adoption of highly energy-efficient appliances in

Spain. Table 2 gives a description and the timeline of each treatment in the experiment.

Table 2

Description of treatments

	Treatment 1	Treatment 2	Treatment 3	Control
Description	Monetary label showing lifetime energy savings in €	Information from sales staff	Monetary label showing lifetime energy savings in € + information from sales staff	Business as usual
Period	5th February–4th April 2018	5th April–3rd June 2018	4th June–31st July 2018	5th February–31st July 2018
Number of stores	14 stores in the treatment group from the Autonomous Country of the Basque Country (11), Cantabria (1), Aragón (1), Navarre (1)			12 stores in the control group from the Autonomous Country of the Basque Country (8), Aragón (2) and Navarre (2)

Retailers were recruited through two chambers of commerce and business federations: (1) the *Federación Mercantil de Gipuzkoa* (FMG) located in the Spanish province of Gipuzkoa and (2) the *Confederación Empresarial de Comercios de Bizkaia* (CECOBI) located in the province of Bizkaia. These are non-profit associations set up to defend the interests of companies and small retailers. They act as lobby groups with the public administration.

Kick-off meetings with these organisations were held in July and October 2017 to explain the main characteristics of the study and collect their feedback. A second meeting was held in October 2017 to share full details of the experiment (e.g., the different designs of the proposed field trial and its timeline). FMG then conveyed this information to all the small retailers in their network and recruited volunteer stores in Gipuzkoa to participate in the field trial. CECOBI also provided access to potential volunteer stores in the Autonomous Community of the Basque Country and the Regional Community of Navarre, Cantabria and Aragón (four of Spain's 17 autonomous regions).

Each participating retailer was visited in November 2017 for a face-to-face meeting to explain the field trial design in detail and respond to any questions or issues. Engaging with retailers proved crucial for the success of the field trial

because it enabled us both to build the necessary trust and to improve the design of the trial based on their expertise.

The small retailers participating were assigned to each group (treatment or control group) based on their geographical location (provinces), the size of cities (small, medium and large) and their sales volumes in previous months. This was done to ensure that the control and treatment groups were as similar as possible (see Table 7 in Appendix 1 for further details on retailer characteristics).

As a result, 12 retailers were assigned to the control group and 14 to the treatment group. In January 2018, we contacted all the retailers to explain their roles in the field trial, the timeline of the experiment and the different tasks that it would entail.

Adding a Monetary Label (Treatment One)

The first treatment started on February 5 and ended on April 4 (see Table 2). It consisted of placing a monetary label close to the mandatory energy efficiency energy label which must be affixed at a visible point on all household appliances in the corresponding stores. This label showed energy savings information in monetary terms (in €) for each specific appliance. Consumers thus had information on the energy consumption of the appliance as well as on likely energy savings in monetary terms. The savings for each appliance were calculated in comparison to the similar appliance with the highest annual energy consumption (see the “Estimating Lifetime Energy Savings” subsection for more details). It is important to note that sales staff did not receive any specific training and were not required to highlight the information displayed on the label. That is, they were instructed to behave just as they did before the monetary label was available.

Design of the Monetary Label

Following the advice from the two chambers of commerce consulted, preference was given to presenting information on *energy savings* rather than information on *energy costs* in the monetary label. The main reason for this was that small retailers preferred energy savings information to motivate sales with positive messages and to avoid any possible confusion with other cost concepts such as the price of the appliance.

On that basis, the monetary label shown in Figure 2 was designed for each appliance to be used in the field trial.

Fig. 2

Monetary label used in the field trial (in Spanish): example for a washing machine with an energy consumption of 135 kWh/year (English translation: “Lifetime energy savings: €212.94. Estimates based on: (i) energy consumption of the product: 135 kWh/year; (ii) highest energy consumption for a washing machine in this product category (8 kg): 252 kWh/year; (iii) maximum electricity price (2017): €0.182/kWh; and (iv) lifetime: 10 years”)

Estimating Lifetime Energy Savings

One of the main challenges was calculating the lifetime energy savings for each appliance.First, we created a database with all the stock available (fridges, washing machines and dishwashers) at each of the retailers taking part, specifying types of appliance, energy efficiency levels, energy consumption and other technical attributes.

Based on that database, the following formula was used to estimate the lifetime energy savings (*LES*) following Stadelmann and Schubert (2018):

$$LES = (MEC - EC) \times ep_{2017} \times L,$$

where *MEC* is the maximum energy consumption for that product category, *EC* is the energy consumption of a specific product, ep_{2017} is the maximum energy price in 2017 and *L* is the lifetime of the product. Thus, we estimated the *MEC* for each product category with similar characteristics. For example, to estimate lifetime energy savings for an 8-kg-load washing machine, the *MEC* chosen was the maximum energy consumption of a washing machine with that load capacity.

An important issue when estimating lifetime energy savings is the energy price considered. We considered the maximum energy price recorded in Spain in 2017[1]. For product lifetime, suggestions made at our meetings with small retailers and experts led us to use a figure of 10 years for appliances, as this seems to be the average in Spain (Organización de Consumidores y Usuarios 2020). Table 8 in Appendix 1 shows the average lifetime energy savings per product category under study.

The colour scale from the official European energy efficiency label was maintained to link the current EU energy efficiency label with the monetary label proposed (left-hand side of the monetary label in Figure 2) and because this scale seems to be understandable and familiar to households (de Ayala et al. 2020). The logos of the research centre leading the experiment and the various retailers taking part were shown at the bottom of the label. This was a way of demonstrating that the calculations and information provided were officially backed by a research organisation. In no case were consumers informed that the labels were part of a field experiment or research project, so as not to bias the purchasing decision-making process.

Sales Staff Provide Monetary Information (Treatment Two)

The second treatment ran from April 5 until June 3 (see Table 2). In this treatment, sales staff provided potential consumers with information related to energy savings for each appliance under study. The aim was to gain an understanding of the role of sales staff in guiding and nudging consumers' purchasing decisions towards more energy-efficient appliances. Staff training was designed to teach several aspects of energy efficiency in regard to the products under study, including the main concepts, and general knowledge of energy efficiency (see Appendix 2 for the whole list of topics taught). Other points taught included how energy efficiency levels are calculated and the assumptions under which the energy consumption of a product is calculated[2].

The sales staff were familiarised with how lifetime energy savings are estimated under each product category. During this treatment, the monetary label from

treatment one was not visible, i.e., information on lifetime energy saving was provided solely by the (trained) sales staff.

Combination of Monetary Label with Information from Sales Staff (Treatment Three)

The third treatment began on June 4 and ended on July 31 (see Table 2). It consisted of a combination of the two previous treatments, i.e., the monetary label and the explanations from sales staff (based on the training received). During this treatment, the retailers taking part again placed the monetary label next to the official one but also provided energy savings information to guide purchasing decisions based on the training received.

Support and Follow-up

To ensure that all sales staff and retailers were carrying out the tasks for each treatment and to try to avoid any mental fatigue on the part of salespeople, weekly telephone calls were made by the researchers. During the first treatment, they were reminded that the monetary label should be placed next to the official European energy efficiency label. Retailers were also asked about the appliances available in the shop so that we could prepare the corresponding monetary labels and send them via express delivery. The model of the product for which it was intended was written on the back of each label prepared, to ensure that labels were correctly placed in the store.

During the second treatment, retailers received a document prepared with all the information from the training and the calculations of lifetime energy savings made for each product category for consultation if necessary. We also spoke with the retailers via WhatsApp and by telephone to ensure that they provided the information in the correct way.

In the last treatment, we asked about stock numbers to reprint sufficient monetary labels. Regular calls were also made to ensure that all products had the monetary label in place (next to the official one) and to respond to any queries.

Data

In total, 26 retailers took part in the experiment: 14 of these were assigned to the treatment groups and 12 to the control group (see Table 2). The retailers are located in the northern part of Spain: 19 stores are in the Basque Autonomous Country and the regional communities of Aragón (three stores), Navarre (three stores) and Cantabria (one store).

The retailers provided us with the following information: date of sale, type of appliance sold, model of the product, price of the product and whether there was any price discount on the product at the time. We merged these data with an internal database with some technical attributes of each appliance (e.g., capacity of the product, water consumption). Our internal database contains the technical attributes of each appliance type and model. In the case of washing machines, we collected information on capacity (in kilogrammes), type of embedding and water consumption (in litres) for each model. For fridges, we collected information on fridge and freezer volumes (in litres), type of embedding and type of fridge. Finally, for dishwashers, information on width (450 mm or 600 mm), number of services, type of embedding and water consumption (in litres) was collected. Table 3 shows all the data collected together with the sources.

Table 3

Data and sources

Data collected	Source
Date of sale	Small retailer
Place of sale	Small retailer
Type of appliance sold	Small retailer or internal database
Brand of the appliance sold	Small retailer or internal database
Model of the appliance sold	Small retailer
Energy efficiency level of the appliance sold	Internal database
Energy consumption of the appliance sold	Internal database
Specific and technical attributes of the appliance sold	Internal database
Price of the product sold	Small retailer
Discount on the product sold	Small retailer
Socio-demographics: Gender Age range Post code	Small retailer

Short surveys were also designed to obtain key socio-demographic information on the consumers buying the appliances in question. These included questions on gender, home post code and age range (see the questionnaire used in Figure 4 in Appendix 1).

Customers' post codes enabled us to use the data on income per capita at the municipality level provided by regional statistics offices[3]. In the case of large cities, different post codes enabled us to obtain information on income per capita.

However, some data limitations were encountered. For instance, we were unable to obtain specific information on consumers such as the real income of each consumer or their previous purchasing experience (e.g., first-time buyers). Nor could data regarding brand loyalty or the individual preferences of consumers be gathered.

The internal database was prepared with information on the attributes of appliances for each model. In the case of washing machines, we collected information on the capacity (in kg), type of embedding and water consumption (in L) of each model; for fridges we collected information on fridge and freezer volumes (in L), type of embedding and type of fridge. Finally, for dishwashers we collected information on width (450 mm or 600 mm), number of services, type of embedding and water consumption (in L).

For the appliances sold in the stores, Figure 3 shows the percentages of products sold by the treatment and control groups per product category (washing machines, fridges and dishwashers) and energy efficiency level (A^{+++}, A^{++} and A^{+}). The vast majority of washing machines sold in the treatment and control groups were A^{+++}. In the treatment group, A^{+++} washing machines accounted for 92.64% of the total, and in the control group, for 91.05%. In the case of fridges, the proportion is different: the most energy-efficient level sold was A^{++} (44.48% in the treatment group and 55.43% in the control group). Finally, for dishwashers, A^{++} and A^{+} each accounted for 42.86%. The average selling price per product category and appliance is shown in Table 9 in Appendix 1.

Fig. 3

Percentage of appliances sold per energy efficiency level during the experiment in the control and treatment stores

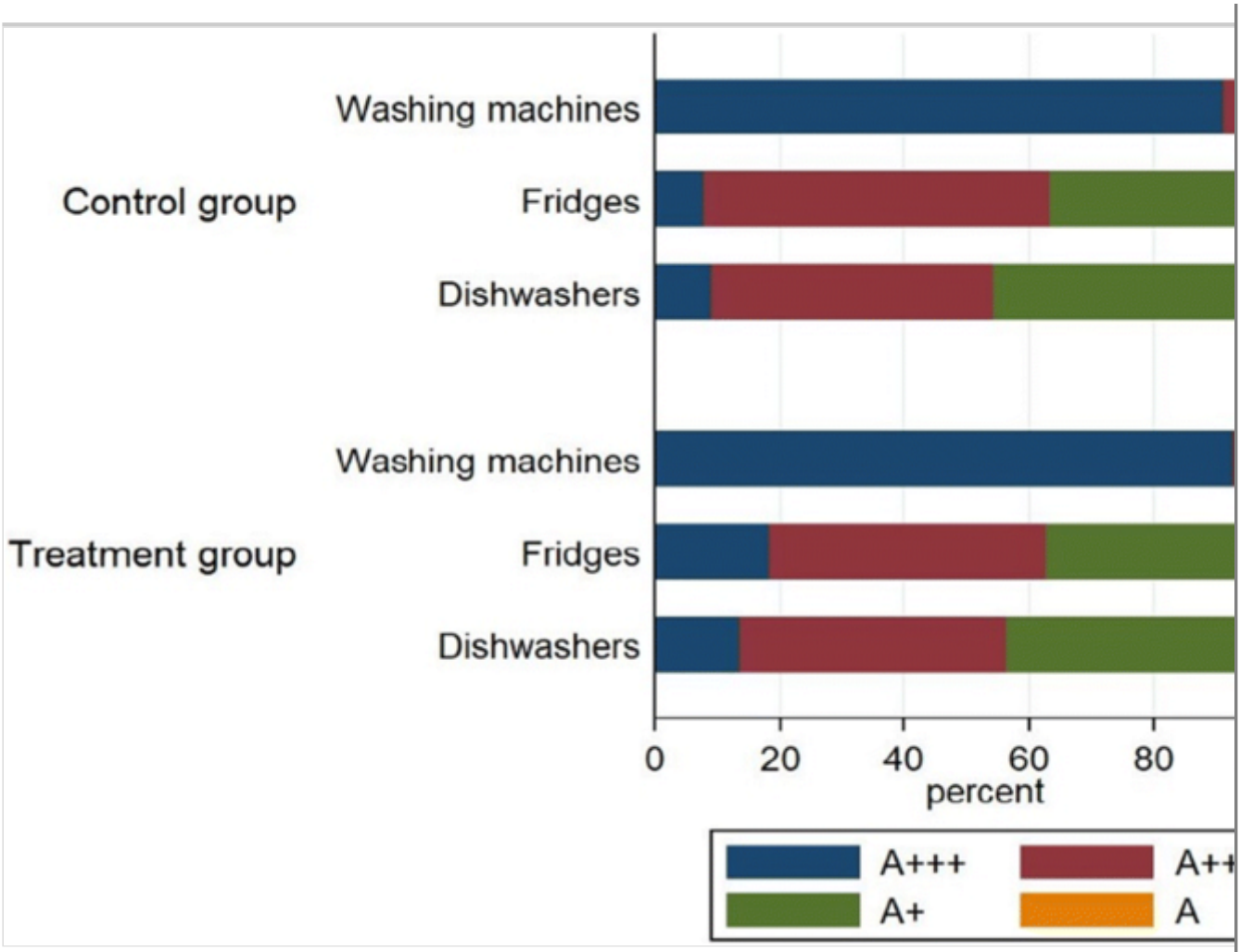

Table 4 shows the percentage of appliances sold during the experiment per product category, brand, gender and age range. The product sold most was washing machines, which accounted for 51.63% of the sales, followed by fridges (31.51%) and dishwashers (16.86%). As regards brands per appliance, for washing machines, two brands dominated: Bosch (16.39%) and AEG (13.51%). No other brand (e.g., Siemens, Samsung, Miele) accounted individually for as much as 10% of sales. For fridges, the biggest-selling brand was Bosch at 15.88% of sales, followed by Siemens (10.96%) and Liebherr (10.86%). Finally, for dishwashers, there were many brands which accounted for more than 10% of sales: Bosch was the biggest seller at 15.33%, closely followed by AEG (15.13%) and Balay (14.56%).

Table 4

Percentage of appliances sold per product category, brand, gender and age range

	Washing machines	**Fridges**	**Dishwashers**
Sales during the experiment			
Observations	1599	976	522
%	51.63%	31.51%	16.86%

	Washing machines	Fridges	Dishwashers
Sales during the experiment by brand			
1st brand	Bosch (16.39%)	Bosch (15.88%)	Bosch (15.33%)
2nd brand	AEG (13.51%)	Siemens (10.96%)	AEG (15.13%)
3rd brand		Liebherr (10.86 %)	Balay (14.56%)
Rest	Rest (<10%)	Rest (<10%)	Rest (<14%)
Gender of purchaser			
Male	658 (41.15%)	459 (47.03%)	248 (47.51%)
Female	934 (58.41%)	515 (52.77%)	273 (52.30%)
Both	7 (0.44%)	2 (0.20%)	1 (0.19%)
Age range of purchasers			
18–30 years	28 (1.76%)	21 (2.15%)	12 (2.30%)
31–45 years	388 (24.33%)	228 (23.36%)	138 (26.44%)
46–60 years	703 (44.01%)	396 (40.57%)	213 (40.80%)
More than 60 years	477 (29.91%)	331 (33.91%)	159 (30.46%)

The vast majority of purchasers were women. Moreover, the biggest proportion of purchases was made by consumers between 46 and 60 years old: 44.01% for washing-machines, 40.57% for fridges and 40.80% for dishwashers.

Model Specification

We use binary response models to analyse the data, so the dependent variable only takes a value of zero or one. These models are specified as follows:

Assume that $y^*$is a latent variable which follows $y^* = X\beta + e$, where X is the $1 \times K$ vector, β is a $K \times 1$ vector of parameters, e is independent of X and e~Normal (0,1).

However, instead of y^*, only a binary variable indicating the sign of y^* is observed:

$$y = \begin{cases} 1 & if\ y^* > 0 \\ 0 & if\ y^* \leq 0 \end{cases} \quad (1)$$

In binary response models, the interest lies in the response probability:

$$P(y=1 \mid X) = P(y^* > 0 \mid X) = P(e > -X\beta \mid X) = 1 - G(-X\beta)$$
$$= G(X\beta) \equiv p(x)$$

where *G* is the cumulative distribution function of a standard normal density function (called a probit model). *G* can also be the cumulative distribution of a logistic function (a Logit model).

For this study, the probit model can be expressed as $P(y = 1 \mid X)$, where *y* is the energy efficiency level and *X* contains explanatory variables referring to how monetary information is provided by *treatments* (see Table 2) plus the technical *attributes* specific to each appliance type (e.g., size, type of embedding and water consumption) and *socio-economic* characteristics (e.g., income).

The choice of the dependent variable *y* is based on the percentage of appliances sold per energy efficiency level during the experiment period. For washing machines, most sales were A^{+++}, while for fridges and dishwashers, most were A^{++} (see Figure 3). Given that the objective of this study is to nudge consumers towards high energy-efficient products, we seek to determine whether the treatments are successful in nudging purchasers towards A^{+++} choices for washing machines and fridges and towards A^{+++} and A^{++} for dishwashers (for more details on the distribution of energy efficiency levels per appliance see Figure 5 in the Appendix). We first run a model with explanatory variables but no interaction effects, and then another interacting some treatments with other explanatory variables (e.g., treatment 1 and price). Finally, we choose the one whose interaction effects are most significant for each appliance. Thus, for each type of appliance, we estimate different models that reflect the probability of buying a highly energy-efficient appliance depending on the treatments, technical attributes, socio-economic factors and some interaction effects. Specification (2) refers to the model for washing machines, (3) for fridges and (4) for dishwashers:

$$P(y=1 \mid X) = \beta_1 + \beta_2 Trat1 + \beta_3 Trat2 + \beta_4 Trat3 + \beta_5 Capacity \quad (2)$$
$$+ \beta_6 TypeofEmbedding + \beta_7 WaterConsumption + \beta_8 Price + \beta_9 Trat1$$
$$* Price + \beta_{10} Trat2 * \mathrm{P}rice + \beta_{11} Trat3 * Price + \beta_{12} Income$$
$$+ \beta_{13} Income^2 + \beta_{14} Trat1 * Income + \beta_{15} Trat2 * Income + \beta_{16} Trat3$$
$$* Income + e,$$

3

$$P\left(y=1 \mid X\right)=\beta_1+\beta_2\mathrm{Trat1}+\beta_3\mathrm{Trat2}+\beta_4\mathrm{Trat3}+\beta_5\mathrm{VolumeFridge}+\beta_6\mathrm{VolumeFreezer}+\beta_7\mathrm{Price}+\ \beta_8\mathrm{Trat1}*\mathrm{Price}+\beta_9\mathrm{Trat2}*\mathrm{Price}+\beta_{10}\mathrm{Trat3}*\mathrm{Price}+\beta_{11}\mathrm{Income}+\beta_{12}\mathrm{Income}^2+\beta_{13}\mathrm{Smallcity}+\beta_{14}\mathrm{Bigcity}+\beta_{15}\mathrm{AgeUnder30}+\beta_{16}\mathrm{AgeBetween30and45}+\beta_{17}\mathrm{AgeOver60}+e,$$

$$P\left(y=1 \mid X\right)=\beta_1+\beta_2\mathrm{Trat1}+\beta_3\mathrm{Trat2}+\beta_4\mathrm{Trat3}+\beta_5\mathrm{Width}+\beta_6\mathrm{NumberServices}+\beta_7\mathrm{WaterConsumption}+\ \beta_8\mathrm{Price}+\beta_9\mathrm{Trat1}*\mathrm{Price}+\beta_{10}\mathrm{Trat2}*\mathrm{Price}+\beta_{11}\mathrm{Trat3}*\mathrm{Price}+\beta_{12}\mathrm{Income}+\beta_{13}\mathrm{Income}^2+\beta_{14}\mathit{Smallcity}+\beta_{15}\mathit{Bigcity}+{+}\beta_{16}\mathrm{Trat1}*\mathrm{Income}+\beta_{17}\mathrm{Trat2}*\mathrm{Income}+\beta_{18}\mathrm{Trat3Income}+\beta_{19}\mathrm{AgeUnder30}+\beta_{20}\mathrm{AgeBetween30and45}+\beta_{21}\mathrm{AgeOver60}+e, \quad (4)$$

where *y* takes a value of 1 if the energy efficiency level is A^{+++} for washing-machines and fridges and A^{+++} and A^{++} for dishwashers, and zero otherwise. *Trat1* takes a value of one if the appliance was sold during treatment 1 and zero otherwise, *Trat2* takes a value of one if the appliance was sold during treatment 2 and zero otherwise and *Trat3* takes a value of 1 if the appliance was sold during treatment 3 and zero otherwise.

The attributes included for washing machines (see Eq. (2)) are as follows: *Capacity* is a numerical variable that captures the capacity of each washing machine sold during the experiment. *TypeofEmbedding* takes a value of one if the washing machine has free installation and 0 otherwise. *WaterConsumption* and *Price* are numerical variables that indicate the water consumption and price respectively of each washing machine sold during the period under study.

As Eq. (3) shows, in the case of fridges, just three numerical variables represent the technical attributes: *VolumeFridge* (the volume of the fridge), *VolumeFreezer* (the volume of the freezer) and *Price* (price of the fridges sold during the experiment).

In the case of dishwashers (see Eq. (4)), four technical attributes were considered: *Width* (a value of 1 if the dishwasher is 600 mm wide and 0 otherwise), *NumberServices* (a numerical variable reflecting the number of services by the dishwasher), *WaterConsumption* and *Price* (numerical variables indicating the water consumption and price of the dishwasher sold, respectively).

The socio-economic variables included in Eqs. (2), (3) and (4) are as follows: *Income* (the average income for the post code area of the purchaser of the appliance in question), the size of the city where the purchaser lives and their age. City size is captured via two variables (criteria shown in Table 7 in Appendix 1): *Smallcity* (a value of one if the city is small) and *Bigcity* (a value of one if the city is big). The age of purchasers is factored in via *AgeUnder*30 (a value of 1 if the purchaser of the appliance is less than 30 years old), *AgeBetween*30*and*45 (1 if the purchaser is aged between 30 and 45) and *AgeOver*60 (1 if the purchaser is over 60). The socio-economic variables included in Eqs. (2), (3) and (4) are the ones that fits better the model.

The rest of the variables are interactions of the variables defined above. For instance, $Trat1 * Price$ is the interaction of the variables *Trat1* and *Price*. This interacted variable is interpreted as the impact of the price during treatment 1 (information on energy savings is provided through a monetary label) on the probability of buying a high energy-efficient appliance. Similarly, $Trat2 * Price$ is interpreted as the impact of the price during treatment 2 (information on energy savings is given by sales staff) on the probability of buying a highly efficient appliance. The rest of the interacted variables are defined and interpreted in the same way. All the variables used were standardized in order to avoid multicollinearity (Aiken and West 1991).

Table 10 in Appendix 1 presents the descriptive statistics for the explanatory variables included in the three specifications (Eqs. (2), (3) and (4)).

Results and Discussion

The three probabilistic models (2), (3) and (4) were estimated using STATA version 16. Table 5 presents the marginal effects of the explanatory variables for all the appliances on the probability of purchasers acquiring an appliance labelled with high energy efficiency, A^{+++} (for washing machines and fridges) and A^{+++} and A^{++} for dishwashers.

Table 5

Marginal effects for washing machines, fridges and dishwashers

Washing machines		**Fridges**		**Dishwashers**	
Variables	**Marginal effects**	**Variables**	**Marginal effects**	**Variables**	**Margina effects**
Treatments		Treatments		Treatments	
Control	--Ref--	Control	--Ref--	Control	--Ref--

Washing machines		Fridges		Dishwashers	
Variables	**Marginal effects**	**Variables**	**Marginal effects**	**Variables**	**Margina effects**
Treatment 1 (=1 if the sale is under treatment 1)	0.0316* (0.0166)	Treatment 1 (=1 if the sale is under treatment 1)	0.0998 (0.149)	Treatment 1 (=1 if the sale is under treatment 1)	−0.651 (0.574)
Treatment 2 (=1 if the sale is under treatment 2)	−0.0985 (0.136)	Treatment 2 (=1 if the sale is under treatment 2)	0.486** (0.204)	Treatment 2 (=1 if the sale is under treatment 2)	−0.333 (0.854)
Treatment 3 (=1 if the sale is under treatment 3)	−0.489 (0.303)	Treatment 3 (=1 if the sale is under treatment 3)	0.371* (0.208)	Treatment 3 (=1 if the sale is under treatment 3)	0.212 (0.425)
Attributes		Attributes		Attributes	
Capacity (kg)	0.0349*** (0.00763)	Capacity-Volume of the fridge (L)	0.00184*** (0.000334)	Width (=1 if the size is 600 mm)	0.548** (0.251)
Type of embedding (=1 if free installation)	0.145*** (0.0381)	Capacity-Volume of the freezer (L)	0.000671 (0.000776)	Number of services	0.149** (0.0652)
Water consumption (L)	−2.82e−05*** (6.19e−06)	Price (€)	0.000316*** (7.40e−05)	Water consumption (L)	−0.00191* (0.000233)
Price (€)	3.92e−05 (3.06e−05)	Treatment 1 * price	−7.57e−05 (9.35e−05)	Price (€)	0.000350 (0.000521)
Treatment 1 * price	−7.35e−05* (4.30e−05)	Treatment 2 * price	−0.000245*** (8.15e−05)	Treatment 1 * price	0.00109 (0.00105)
Treatment 2 * price	3.23e−05 (4.30e−05)	Treatment 3 * price	−0.000195** (9.10e−05)	Treatment 2 * price	0.000286 (0.000883)
Treatment 3 * price	2.14−05 (4.65e−05)			Treatment 3 * price	0.00141* (0.000823)
Socio-economic factors		Socio-economic factors		Socio-economic factors	

Washing machines		Fridges		Dishwashers	
Variables	**Marginal effects**	**Variables**	**Marginal effects**	**Variables**	**Margina effects**
Income (€)	−5.16e−07 (3.46e−06)	Income (€)	1.11e−05 (1.46e−05)	Small city (=1 if the sale occurred in a small city)	0.0540 (0.128)
Income^2 (€)	0 (8.31e−11)	Income^2 (€)	−3.01e−10 (3.33e−10)	Big city (=1 if the sale occurred in a big city)	−0.0239 (0.0936)
Treatment 1 * income	−1.09e−06 (1.82e−06)	Small city (=1 if the sale occurred in a small city)	−0.0197 (0.0269)	Income (€)	−5.75e−06 (6.05e−05)
Treatment 2 * income	1.29e−06 (1.49e−06)	Big city (=1 if the sale occurred in a big city)	0.0294 (0.0181)	Income ^{2} (€)	1.69e−10 (1.33e−09)
Treatment 3 * income	3.99e−06** (1.69e−06)	Age under 30 (=1 if the consumer is less than 30 years old)	0.0155 (0.0672)	Treatment 1 * income	1.69e−06 (2.76e−05)
		Age 30–45 (=1 if the consumer is between 30 and 45 years old)	−0.0252* (0.0153)	Treatment 2 * income	8.07e−06 (2.80e−05)
		Age over 60 (=1 if the consumer is more than 60 years old)	−0.0241 (0.0162)	Treatment 3 * income	−4.47e−05 (2.43e−05)
				Age under 30 (=1 if the consumer is less than 30 years old)	−0.0102 (0.377)

Washing machines		Fridges		Dishwashers	
Variables	**Marginal effects**	**Variables**	**Marginal effects**	**Variables**	**Margina effects**
				Age 30–45 (=1 if the consumer is between 30 and 45 years old)	−0.116 (0.113)
				Age over 60 (=1 if the consumer is more than 60 years old)	−0.173* (0.101)
Number of observations = 1350 LR chi2(14) = 195.03 Prob > chi2 = 0.0000 Log likelihood = −200.57817 Pseudo R^2 = 0.3271		Number of observations = 827 LR chi2(15) = 257.88 Prob > chi2 = 0.0000 Log likelihood = −211.76056 Pseudo R^2 = 0.3785		Number of observations = 421 LR chi2(19) = 409.59 Prob > chi2 = 0.0000 Log likelihood = −81.001876 Pseudo R^2 = 0.7166	

Effect of Treatments

Table 5 presents the marginal effects of the different treatments and the explanatory variables on the probability of buying a high energy-efficient appliance. The effectiveness of treatments varies from one product category to another. For washing machines, treatment 1 (the monetary label) is effective in terms of promoting the purchase of high energy-efficient appliances (i.e., A^{+++} washing machines). That is, the presence of the monetary label seems to increase the probability of buying an A^{+++} washing machine by 3.16% compared to the control group (no intervention). As can be seen in Table 5, treatment 2 (information given by sales staff) and treatment 3 (information given by the monetary label and by sales staff) seem not to be statistically significant in increasing the purchase of A^{+++} washing machines.

For fridges, treatment 2 (intervention of sales staff) and treatment 3 (intervention of sales staff combined with the monetary label) seem to increase the probability of investing in high energy-efficient fridges (A^{+++}) with respect to the control group (no intervention, business as usual). In addition, note that treatment 2 seems to be more effective than treatment 3 (by 11.5%). This finding may be counterintuitive, as treatment 3 might be expected to be more effective than treatment 2. One possible explanation for this may be the so-called “mental

fatigue." Although stores were regularly reminded by telephone of how they should provide customers with information on energy savings, small retailers may have tired of interacting in the way suggested by the research design as the experiment ran for 9 months.

Finally, in the case of dishwashers, none of the treatments seems to be effective in promoting the purchase of high energy-efficiency dishwashers (A^{+++} and A^{++}). One explanation could be that consumers are not so worried about energy efficiency in the case of dishwashers as they are for fridges and washing machines. This makes sense if the way in which each appliance is generally used is taken into account. A second explanation could be that not all households have dishwashers as they do not consider them to be a necessary appliance. In fact, the number of dishwashers purchased during the field trial is significantly lower (16.86%) than the numbers of washing machines (51.63%) and fridges (31.51%).

The effectiveness of treatments thus differs according to the product category. Treatment 1 (monetary label) is effective for washing machines, while treatment 2 (sales staff) and treatment 3 (combined treatment) are effective for fridges, and none of the treatments is effective for dishwashers. These heterogeneous results are consistent with the literature on the effectiveness of monetary information in promoting the purchase of highly efficient appliances. Kallbekken et al. (2013) report that monetary information was effective for tumble driers but not for freezers. Stadelmann and Schubert (2018) obtained similar findings for the same products and Carroll et al. (2016) found no significant effect for tumble driers.

Attributes

Some differences were observed among the appliances under study in terms of attributes. The results for washing machines show that the type of embedding and the capacity (kilogrammes) of machines increase the probability of buying an A^{+++} machine and can thus be seen as determinant in influencing the purchasing decision. By contrast, the greater the water consumption of a washing machine is, the less likely it is that a high energy-efficiency machine will be purchased. At this point, it is important to remember that the energy efficiency level of a specific washing machine takes into account not only its energy consumption but also other attributes such as water consumption.

When treatment 1 is combined with price for washing machines, the resulting variable is statistically significant and negative. This may indicate that in the presence of treatment 1 (the monetary label), the price may reduce the probability of consumers buying a high energy-efficiency (A^{+++}) washing

machine. That is, the higher the price, the smaller the probability of investing in an A^{+++} when the monetary label is displayed (treatment 1) for washing machines.

For fridges, the analysis shows that volume (in litres) and price (in €) seem to have positive impacts on the probability of buying a highly energy-efficient unit (A^{+++}). This is in line with the descriptive statistics on prices: the average price of A^{+++} fridges is €956.52 while the average price for A^{++} is €704.81 (see Table 9 in Appendix 1 for more details of the average prices for each product category).

In the case of dishwashers, the size of the product, the number of services and the water consumption attributes are significant. In particular, the width of the product (450 mm or 600 mm) and the number of services have a positive sign, i.e., the bigger the product or the more services it provides the more likely people are to buy a high energy-efficiency dishwasher. Water consumption has a negative impact, i.e., the higher it is, the lower the probability of buying a high energy-efficiency (A^{+++} and A^{++}) is. A surprising result is that price is not statistically significant despite a substantial difference between the average price of A^{+++} and A^{++} dishwashers (€705.71 and €483.24, respectively). The interacted variable of treatment 3 combined with price also has a positive impact. This means that the price during treatment 3 (the combination of the monetary label and information from sales staff) has a positive impact on the probability of buying an A^{+++} dishwasher. In other words, the higher the price during treatment 3, the more likely people are to buy an A^{+++} dishwasher. This indicates that high-efficiency appliances are usually the most expensive ones.

Our results are in line with the literature. For washing machines, attributes such as price, spin speed, depth and capacity are relevant in the decision-making process (Galarraga et al. 2012), while for fridges, efficiency, volume, embedding, colour and defrosting capacity seem to be significant (Galarraga et al. 2011b). For dishwasher brand, efficiency level, drying efficiency, number of services and width seems to be the most important factors (Galarraga et al. 2011a).

Socio-economic factors

The various socio-economic variables have different impacts from one appliance to another. For example, the effects of age are heterogeneous. For fridges, people aged between 30 and 45 tend to invest less in high energy-efficient fridges; if the buyer is over 60 years old, the probability of buying a high energy-efficient dishwasher seems to decrease. It is not rare to find this age effect, under which

older people (especially those beyond a certain age) may tend to invest less in EE. Age could play a significant role in deciding whether to invest in energy efficiency or not, maybe because older buyers are less certain that they will recover their initial investment. Age plays a significant role in energy efficiency investment and in fact, according to the literature, willingness to pay for energy efficiency declines when the consumer is over 55 (Zarnikau 2003). The rest of the socio-demographic variables included in the regressions, e.g., small city and big city, are not found to be significant in the analysis. This may indicate that investment in energy-efficient dishwashers is not affected by where consumers live.

The interaction between treatment 3 and income is statistically significant but differs in its sign between washing machines and dishwashers. When treatment 3 (the combination of the monetary label and information from sales staff) is applied, higher income purchasers are found to be more likely to buy an A^{+++} washing machine. The effect is small, but income seems to determine whether people invest in energy-efficient washing machines. The same interacted variable has a negative impact in the case of dishwashers, i.e., the higher the income of consumers is, the less likely they are to buy an A^{+++} dishwasher.

The literature reports that there is a strong correlation between income and energy efficiency investment (Zarnikau 2003). In fact, liquidity and credit constraints could affect investment in high energy-efficiency products, as in general purchasing highly efficient appliances requires an additional investment that may not be affordable for all consumers (Filippini et al. 2020). In our study, we find that A^{+++} fridges are on average €251.71 more expensive than A^{++} fridges. This could explain why people aged between 30 and 45 invest less in highly efficient fridges. Consumers in this age are at childbearing age and probably have less income available to invest in energy efficiency (Filippini et al. 2020; Zarnikau 2003). This could help explain the so-called energy efficiency gap.

Comparison Between Performance of Models

The huge difference between the R^2 of washing machines and fridges on the one hand and that of dishwashers on the other is particularly interesting. A look at the literature reveals that the variables affecting willingness to pay for energy efficiency in washing machines, fridges and dishwashers are quite different. According to Galarraga et al. (2012), the most significant variables affecting willingness to pay for energy efficiency (and thus decision-making) in washing machines are those shown in Table 6. As can be seen in this table, the variables in italics (spin speed, width, depth and colour) cannot be controlled in this study.

Similarly, in the case of fridges, Gal arraga et al This reference is the one related to: Galarraga, González-Eguino, Markandya, 2011. Willingness to pay and price elasticities of demand for energy-efficient appliances: Combining the hedonic approach and demand systems. Energy Econ., Supplemental Issue: Fourth Atlantic Workshop in Energy and Environmental Economics 33, Supplement 1, S66–S74. https://doi.org/10.1016/j.eneco.2011.07.028 . (2011a, b) Galarraga et al (2011b) control colour and defrosting but we are unable to. For dishwashers, the only variables controlled in Galarraga et al. Galarraga et al. (2011a)

This reference is: Galarraga, Heres, D.R., Gonzalez-Eguino, M., 2011b. Price premium for high-efficiency refrigerators and calculation of price-elasticities for close-substitutes: a methodology using hedonic pricing and demand systems. J. Clean. Prod. 19, 2075–2081. https://doi.org/10.1016/j.jclepro.2011.06.025 (2011a, b) but not in our study are depth, drying efficiency and colour. In the end, these uncontrolled variables could explain the differences in the R^2 of washing machines, fridges and dishwashers. These uncontrolled variables for washing machines and fridges might be expected to help explain our model better, but those for dishwashers are not so important for explaining it. In the end, these differences in R^2 show that we have captured the relevant variables for decision-making quite well for dishwashers, but may be missing some interesting attributes for decision-making in regard to washing machines and fridges.

Table 6

Comparison between the significant attribute variables in the literature and in this study

Washing machines		Fridge		Dishwasher	
Galarraga et al. (2012)	**This paper**	**Galarraga et al. (2012)**	**This paper**	**Galarraga et al. (2011a, b)**	**This paper**
Energy efficiency level	Energy efficiency level	Energy efficiency level	Energy efficiency level	Energy efficiency level	Energy efficiency level
	Brand	Brand	Brand	Brand	Brand
Capacity (kg)	Capacity (kg)		Height	*Height*	
Type	Type		Type	Width	Width
Type of embedding	Type of embedding	Type of embedding	Type of embedding	*Depth*	

Washing machines		Fridge		Dishwasher	
Galarraga et al. (2012)	**This paper**	**Galarraga et al. (2012)**	**This paper**	**Galarraga et al. (2011a, b)**	**This paper**
	Water consumption	Volume	Volume (fridge and freezer)	*Drying efficiency*	
Spinning					Type of embedding
Width		*Defrosting*			Water consumption
Depth		*Colour (e.g., colour steel)*		Number of services	Number of services
Colour (e.g., white)				*Colour (e.g., steel)*	
				Anti-fingerprint	

AQ4

AQ5

Limitations and Caveats

One of the main benefits of running a field experiment is that it makes it possible to test in the real world, with real purchasers and real purchases, whether or not a new policy or instrument is effective. However, one of the main disadvantages is that many factors could be *uncontrollable* due to the design of the experiment, the human factor or factors related to retailers.

One of the main caveats of this study is that we were unable to control several factors due to the design of the experiment. We only have observations from the period of the experiment, so we have no hint as to potential sales trends throughout the year. Average sales in certain months (e.g., Easter holidays) might be expected to be lower in inland towns but higher in coastal resorts. In this study, we have tested for time effects during each treatment in the period of the experiment, but no significant results were found for any of the appliances. Another relevant factor that is not controlled is potential mental fatigue among sales staff and retailers during the field experiment.

Other limitations stem from the impossibility of obtaining certain information related to purchasers. During the initial stages of the design phase, we

considered collecting substantial information from buyers such as income level, education, whether they were first-time buyers, etc. However, the retailers and chambers of commerce strongly argued against it on the grounds that their average customer was usually reluctant to provide such information (sometimes because many customers belong to the same small community) and sales staff in small stores were very reluctant to collect it (mainly arguing lack of time and resources). Therefore, as a compromise, we finally decided to only ask for post codes and to obtain aggregate information from the statistical office. In addition to the aforementioned limitations, consumers' preferences are not captured in this field trial due to the fact that we could not conduct a post-sale survey. A hypothetical post-sale survey could have asked about brand loyalty, learned whether customers were first-time buyers or even asked if they had correctly understood the lifetime energy savings information.

We also assume some caveats such as the fact that we do not really know whether purchasers actually received the information related to an appliance in one treatment and purchased the product in another treatment. Another *uncontrolled* fact is that we could not ensure that sales staff always provided the lifetime energy savings information during treatment 2 and treatment 3.

Other caveats are related to the internal management of the retailers. For instance, some retailers have few appliances on display due to a lack of space.

Conclusions and Policy Recommendations

Increasing the adoption of energy-efficient technologies is one of the major challenges in the coming years if EU energy efficiency targets are to be met. Providing consumers with monetary information on energy savings from energy efficiency has been proposed in order to increase the purchase of energy-efficient appliances. However, some studies have shown discrepancies in the effectiveness of this type of information.

This paper seeks to use behavioural economics to analyse the effectiveness of providing monetary information to consumers so as to promote the purchase of energy-efficient appliances in Spain. To that end, a field trial was carried out with 26 small retailers in Spain for three different appliances: washing machines, fridges and dishwashers. Lifetime energy savings information in the form of a monetary label was provided in addition to the existing energy efficiency label.

Three different treatments were tested. The first consisted of providing lifetime energy savings information via a monetary label. During this treatment, consumers had access to lifetime energy savings information only through the monetary label and sales staff were required not to give such information. The

second treatment consisted of training sales staff to provide monetary information but not providing a monetary label, i.e., consumers received lifetime energy savings information only from sales staff. Finally, the two treatments were combined so that there was a monetary label and information was also given by sales staff.

The decision-making process for each appliance can differ. Different variables may be more important for different appliances (washing machines, fridges and dishwashers).

Our findings suggest that monetary labels presenting lifetime energy savings information may be effective in promoting the purchase of high energy-efficiency (A^{+++}) washing machines. However, when the label is combined with information from sales staff, it ceases to be effective. These results seem counterintuitive. Possible explanations may include *mental fatigue* on the part of sales staff in the last few months of the field trial. Sales staff may also have had little incentive to encourage people to purchase A^{+++} washing machines, as most of the machines available at most retailers were already A^{+++}. Different results were obtained for fridges: both treatment 2 (information on energy savings given by sales staff) and treatment 3 (information on energy savings given by a monetary label and by sales staff) were found to increase the probability of buying a high energy-efficiency (A^{+++}) fridge compared to the control group. Moreover, treatment 2 (intervention of sales staff) seems to have been more effective than treatment 3 (combination of intervention of sales staff and monetary label). This may also reflect the *mental fatigue* mentioned above. None of the treatments seems to have been effective in promoting the purchase of energy-efficient dishwashers. This is also a rather surprising result. Initially, consumers might be expected to behave and make decisions similarly when purchasing washing machines and dishwashers, but that is not what our field experiment showed. One possible explanation is that washing machines can be considered as a primary appliance in households while dishwashers are not. In fact, during the field experiment, three times as many washing machines were sold (1350) as dishwashers (421). Moreover, people seem to care more about the energy efficiency level of fridges because they are connected 24/7.

In all the appliances studied, the technical attributes for product size were found to be significant and increase the probability of buying a high energy-efficiency appliance. Heterogeneous effects were found in the interacted variables (e.g., treatment and price) depending on the product category. This may indicate that the effectiveness of the energy savings information combined with technical attributes could impact investment decisions differently depending on the product category.

As regards socio-economic factors, heterogeneous impacts were observed for age. This may indicate that decisions by consumers could change depending on their ages and on the appliance in question. One possible explanation may lie in socio-demographic factors in Spain: people aged between 30 and 45 may have families and other responsibilities which leave them with less disposable income to invest in energy efficiency. Income effects also differ for each product category, which could indicate that income is a determinant variable in decision-making for washing machines and dishwashers.

Our findings suggest that providing lifetime energy savings information can be useful in promoting the purchase of high energy-efficient (A^{+++}) appliances in Spain, especially for washing machines and fridges. The results of this study indicate that monetary information could be useful for particular appliances but not for all household appliances. To promote energy-efficient purchases, different monetary labels could be proposed for each appliance type, taking into account the peculiarities of each product category, consumer preferences and habits towards each one, the socio-economic profile of consumers, the country of implementation and the way in which monetary information is provided.

However, efficient appliances and especially the preferences of households regarding different types of appliances, which seem to be key in understanding consumer decision-making for the purchase of appliances. In particular, more research is needed to analyse the impact of income on the purchase of household appliances and to understand how important consumers consider each household appliance to be. Moreover, for future experimental studies, it would be interesting to control for possible time effects in the experiment, potential staff fatigue and psychological effects of providing one type of information or the other (lifetime energy savings vs. lifetime energy cost).

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Declarations

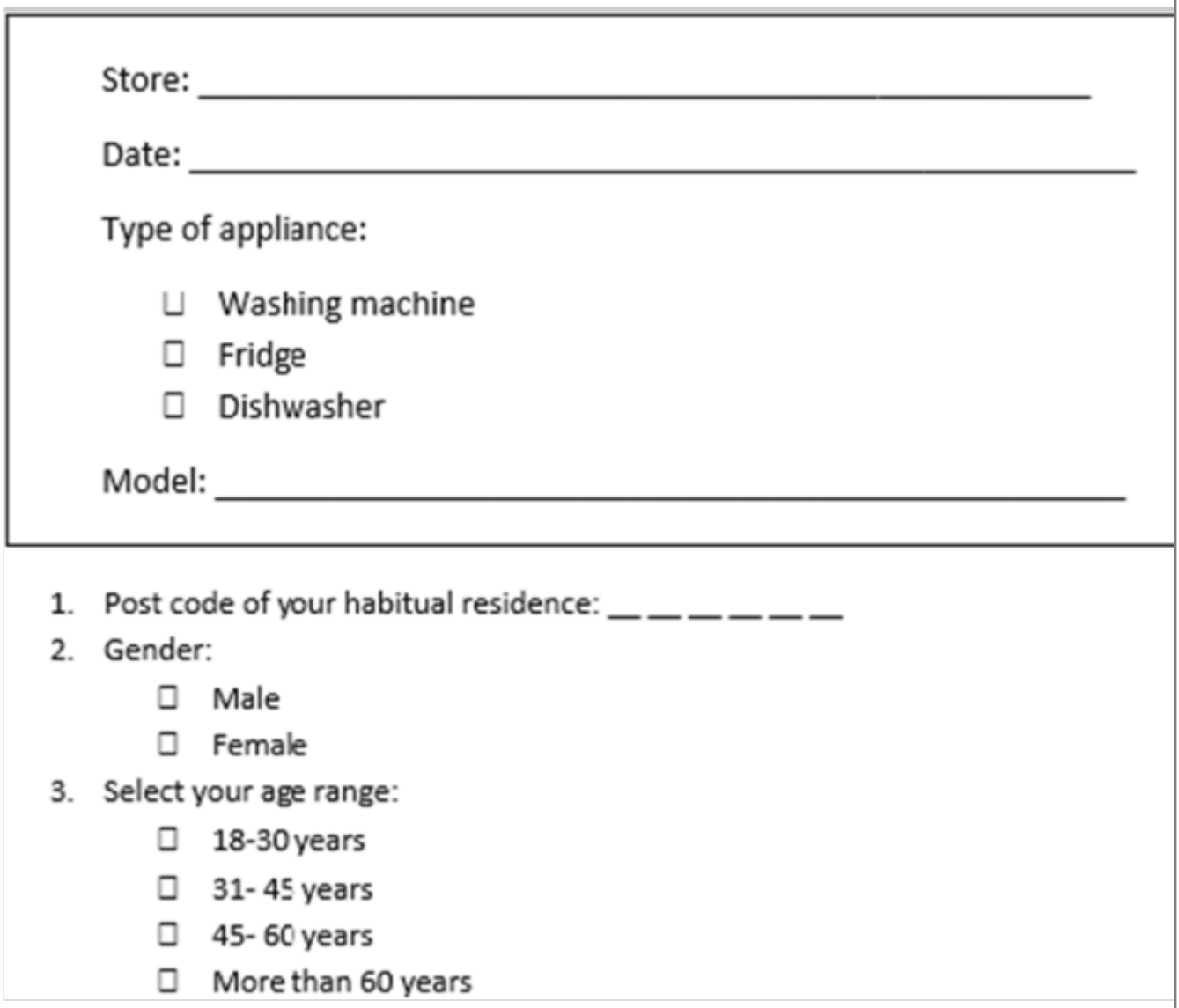
Conflict of Interest The authors declare no competing interests.

Appendix 1

AQ6

Fig. 4

Short questionnaire used for consumers in the household appliances field trial (English version)



Store: _____

Date: _____

Type of appliance:

- ☐ Washing machine
- ☐ Fridge
- ☐ Dishwasher

Model: _____

1. Post code of your habitual residence: _ _ _ _ _ _
2. Gender:
   - ☐ Male
   - ☐ Female
3. Select your age range:
   - ☐ 18-30 years
   - ☐ 31- 45 years
   - ☐ 45- 60 years
   - ☐ More than 60 years

Fig. 5

Distribution of the household appliances sold during the field trial

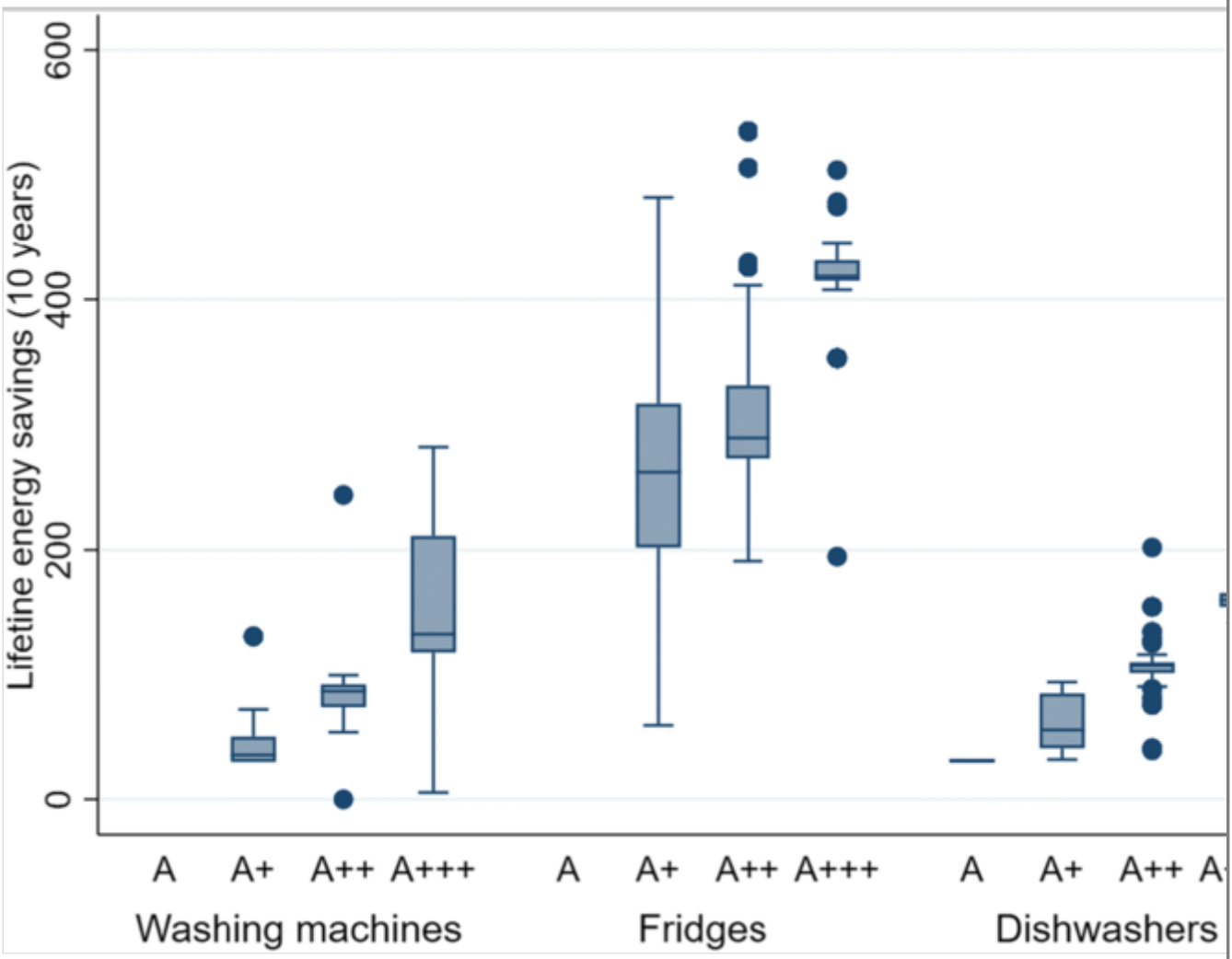


Table 7

Characteristics of retailers

Ret	City	Province	Inhabitants	Size of city	Washing machine	Fridge	Dishwasher
Ret 1	Gernika	Bizkaia	16,869	M	139	109	43
Ret 2	Barakaldo	Bizkaia	100,313	L	136	73	29
Ret 3	Bilbao	Bizkaia	345,122	L	373	165	127
Ret 4	Bilbao	Bizkaia	345,122	L	225	218	106

S (small), less than 10,000; *M* (medium), between 10,000 and 100,000; *L* (large), more th

Ret	City	Province	Inhabitants	Size of city	Washing machine	Fridge	Dishwasher
Ret 5	Durango	Bizkaia	29,031	M	132	70	63
Ret 6	Mungia	Bizkaia	17,298	M	203	121	87
Ret 7	Sopela	Bizkaia	13,047	M	24	18	12
Ret 8	Getxo	Bizkaia	78,554	M	70	65	40
Ret 9	Colindres	Cantabria	8331	S	200	148	64
Ret 10	Ordizia	Gipuzkoa	9998	S	209	152	70
Ret 11	Tolosa	Gipuzkoa	19,386	M	224	79	97
Ret 12	Zumarraga	Gipuzkoa	9918	S	188	121	63
Ret 13	Azkoitia	Gipuzkoa	11,587	M	227	107	37
Ret 14	Ermua	Gipuzkoa	15,951	M	164	137	69
Ret 15	Eibar	Gipuzkoa	27,380	M	135	81	26
Ret 16	Zumaia	Gipuzkoa	9979	S	224	79	97
Ret 17	Donostia	Gipuzkoa	186,064	L	1232	613	283
Ret 18	Bergara	Gipuzkoa	14,743	M	80	80	80
Ret 19	Donostia	Gipuzkoa	186,064	L	24	18	12
Ret 20	Zumarraga	Gipuzkoa	9918	S	122	62	34
Ret 21	Ainsa	Huesca	2173	S	73	50	30
Ret 22	Huesca	Huesca	52,282	M	349	317	167
Ret 23	Elizondo	Navarra	3563	S	133	59	31

S (small), less than 10,000; *M* (medium), between 10,000 and 100,000; *L* (large), more th

Ret	City	Province	Inhabitants	Size of city	Washing machine	Fridge	Dishwasher
Ret 24	Sangüesa	Navarra	5002	S	146	71	47
Ret 25	Estella	Navarra	13,668	M	263	115	63
Ret 26	Tarazona	Zaragoza	10,713	M	81	62	39
S (small), less than 10,000; *M* (medium), between 10,000 and 100,000; *L* (large), more th							

Table 8

Average lifetime energy savings per product category and technical characteristics

Appliance		Average LES
Washing machine	6 kg	105.70€
	7 kg	126.95€
	8 kg	175.64€
	9 kg	116.80€
	10 kg	110.56€
Fridge		305.65€
Dishwasher	450 mm	86.78€
	600 mm	95.42€
LES are not comparable among them (LES are estimated for each product category and technical characteristics)		

Table 9

Average prices per product category, energy efficiency level and treatment group

	A^{+++}	A^{++}	A^{+}	A	Overall
Washing machine					
Treatment 1	471.96€ *N* = 238	410.85€ *N* = 20	565€ *N* = 1	·	472.28€ *N* = 253
Treatment 2	494.49€ *N* = 327	422.20€ *N* = 20	594€ *N* = 2	·	490.92€ *N* = 349

	A^{+++}	A^{++}	A^{+}	A	Overall
Treatment 3	479.85€ *N* = 217	477.46€ *N* = 15	·	·	472.28€ *N* = 253
Control	438.16€ *N* = 584	441.05€ *N* = 38	296.05 *N* = 17	·	434.55€ *N* = 639
Overall	464.16€ *N* = 1366	436.37€ *N* = 93	339.30€ *N* = 20	·	460.72€ *N* = 1479
Fridge					
Treatment 1	1136.93€ *N* = 31	759.62€ *N* = 64	436.60€ *N* = 59	·	710.57€ *N* = 154
Treatment 2	977.38€ *N* = 37	795.01 *N* = 76	446.31€ *N* = 68	·	701.29€ *N* = 181
Treatment 3	827.89€ *N* = 25	685.05€ *N* = 97	421.76€ *N* = 75	·	602.94€ *N* = 197
Control	847.93€ *N* = 29	662.49€ *N* = 195	465.76€ *N* = 125	·	607.47€ *N* = 349
Overall	956.52€ *N* = 122	704.81€ *N* = 432	446.40€ *N* = 327	·	643.75€ *N* = 881
Dishwasher					
Treatment 1	755.60€ *N* = 5	545.81€ *N* = 34	481.09€ *N* = 26	459€ *N* = 1	534.89€ *N* = 66
Treatment 2	792.43€ *N* = 19	495.93€ *N* = 36	418.78€ *N* = 32	334€ *N* = 1	530.05€ *N* = 88
Treatment 3	748.35€ *N* = 11	472.21€ *N* = 41	448.16€ *N* = 40	·	494.77€ *N* = 92
Control	587.40€ *N* = 20	461.27€ *N* = 97	427.24€ *N* = 85	·	459.44€ *N* = 202
Overall	705.71€ N = 55	483.24€ N = 208	437.98€ N = 183	396.50€ N = 2	491.68€ N = 448

Table 10

Descriptive statistics of variables used in the models

	Number of observations	Mean	Standard deviation	Min	Max
Washing machines					
Energy savings (€)	1599	149.965	52.13268	0	282.1
Efficiency (=1 if appliance is A^{+++})	1599	0.91995	0.2714555	0	1

	Number of observations	Mean	Standard deviation	Min	Max
Price (€)	1479	460.7262	180.7984	186	1508.87
Size of washing machine	1599	7.595997	0.7115243	6	10
Type of embedding (=1 if free installation)	1599	0.873671	0.3323237	0	1
Water consumption (in L)	1576	9948.778	765.5639	7400	12,900
Fridges					
Energy savings (€)	972	305.6589	75.16341	60.06	535.08
Efficiency (=1 if appliance is A^{+++})	975	0.1435897	0.3508532	0	1
Price (€)	881	643.7569	275.6021	198	2345
Volume of fridge (in L)	975	221.0185	40.16718	98	380
Volume of freezer (in L)	967	80.34023	16.95284	16	119
Small town (=1 if seller is from a small town)	976	0.1956967	0.3969395	0	1
Big city (=1 if seller is from a big city)	976	0.4723361	0.4994901	0	1
Dishwashers					
Energy savings (€)	522	93.00828	36.77416	30.94	202.02
Efficiency (=1 if appliance is A^{+++})	522	0.1168582	0.3215594	0	1
Price (€)	448	491.6848	175.3597	202.75	1399
Size (=1 if the size is 600 mm)	522	0.7203065	0.4492791	0	1
Number of services	522	12.22031	1.963029	9	16
Water consumption (in L)	522	2944.954	380.4774	2100	4200
Small town (=1 if seller is from a small town)	522	0.2318008	0.4223872	0	1
Big city (=1 if seller is from a big city)	522	0.4176245	0.4936407	0	1

Appendix 2

The training of sales staff consisted of seven different points. This was done to cover all possible levels of knowledge of energy efficiency issues and household appliances. The structure was the following:

1. Introduction. Basic knowledge of EE. What is EE? Different energy efficiency levels.

2. How are the energy efficiency levels of the appliances under study (washing machines, fridges and dishwashers) calculated?

3. Why are there appliances which have the same energy efficiency level but different energy consumptions?

4. What are the main assumptions made in estimating average energy consumption under the EU energy efficiency label?

5. How are monetary lifetime energy savings estimated for each appliance (washing machine, fridge, dishwasher)?

6. What energy price is used for these estimations?

7. What lifetime is used in estimating monetary lifetime energy savings?

References

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions* (p. xi, 212). Thousand Oaks: Sage Publications, Inc.

Allcott, H., & Knittel, C. (2019). Are consumers poorly informed about fuel economy? Evidence from two experiments. *American Economic Journal: Economic Policy, 11*(1), 1–37. https://doi.org/10.1257/pol.20170019.

Allcott, H., & Sweeney, R. L. (2016). The role of sales agents in information disclosure: Evidence from a field experiment. *Management Science, 63*(1), 21–39. https://doi.org/10.1287/mnsc.2015.2327.

Allcott, H., & Taubinsky, D. (2015). Evaluating behaviorally motivated policy: Experimental evidence from the lightbulb market. *American Economic Review, 105*(8), 2501–2538. https://doi.org/10.1257/aer.20131564.

Allcott, H., & Wozny, N. (2013). Gasoline prices, fuel economy, and the energy paradox. *The Review of Economics and Statistics, 96*(5), 779–795. https://doi.org/10.1162/REST_a_00419.

Banerjee, A., & Solomon, B. D. (2003). Eco-labeling for energy efficiency and sustainability: A meta-evaluation of US programs. *Energy Policy, 31*(2), 109–123. https://doi.org/10.1016/S0301-4215(02)00012-5.

Bull, J. (2012). Loads of green washing—Can behavioural economics increase willingness-to-pay for efficient washing machines in the UK? *Energy Policy, 50*, 242–252. https://doi.org/10.1016/j.enpol.2012.07.001.

Busse, M. R., Knittel, C. R., & Zettelmeyer, F. (2013). Are consumers myopic? Evidence from new and used car purchases. *American Economic Review, 103*(1), 220–256. https://doi.org/10.1257/aer.103.1.220.

Carroll, J., Denny, E., & Lyons, S. (2016). The effects of energy cost labelling on appliance purchasing decisions: Trial results from Ireland. *Journal of Consumer Policy, 39*(1), 23–40. https://doi.org/10.1007/s10603-015-9306-4.

Cohen, F., Glachant, M., & Söderberg, M. (2017). Consumer myopia, imperfect competition and the energy efficiency gap: Evidence from the UK refrigerator market. *European Economic Review, 93*, 1–23. https://doi.org/10.1016/j.euroecorev.2017.01.004.

Consumer Focus. (2012). *Consumer focus: Annual report and accounts 2012/13*. Londons: Stationarey Office.

Davis, L. W., & Metcalf, G. E. (2016). Does better information lead to better choices? Evidence from energy-efficiency labels. *Journal of the Association of Environmental and Resource Economists, 3*(3), 589–625. https://doi.org/10.1086/686252.

de Ayala, A., Foudi, S., Solà, M. M., López-Bernabé, E., & Galarraga, I. (2020). Consumers' preferences regarding energy efficiency: A qualitative analysis based on the household and services sectors in Spain. *Energy Efficiency, 14*(1), 3. https://doi.org/10.1007/s12053-020-09921-0.

DECC. (2014). *Evaluation of the DECC and John Lewis energy labelling trial—GOV.UK*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3502

Deutsch, M. (2010). Life cycle cost disclosure, consumer behavior, and business implications. *Journal of Industrial Ecology, 14*(1), 103–120. https://doi.org/10.1111/j.1530-9290.2009.00201.x.

Egan, C., & Waide, P. (2005). A multi-country comparative evaluation of labelling research. *Energy Savings: What Works and Who Delivers? Eceee Summer Study Proceedings. V. 1-3*. http://inis.iaea.org/Search/search.aspx?orig_q=RN:36110833

European Commission. (2008). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions—20 20 by 2020—Europe's climate change opportunity*. http://eur-lex.europa.eu/legal-content/ga/TXT/?uri=CELEX:52008DC0030

Eurostat. (2018). *Greenhouse gas emission statistics—Air emissions accounts statistics explained*. https://ec.europa.eu/eurostat/statistics-explained/pdfscache/30599.pdf

Filippini, M., Kumar, N., & Srinivasan, S. (2020). Energy-related financial literacy and bounded rationality in appliance replacement attitudes: Evidence from Nepal. *Environment and Development Economics, 25*(4), 399–422. https://doi.org/10.1017/S1355770X20000078.

Galarraga, González-Eguino, & Markandya, A. (2011a). Willingness to pay and price elasticities of demand for energy-efficient appliances: Combining the hedonic approach and demand systems. *Energy Economics, 33*(Supplement 1), S66–S74. https://doi.org/10.1016/j.eneco.2011.07.028.

Galarraga, Heres, D. R., & Gonzalez-Eguino, M. (2011b). Price premium for high-efficiency refrigerators and calculation of price-elasticities for close-substitutes: A methodology using hedonic pricing and demand systems. *Journal of Cleaner Production, 19*(17–18), 2075–2081. https://doi.org/10.1016/j.jclepro.2011.06.025.

Galarraga, I., Lucas, J., & González-Eguino, M. (2012). Evaluación económica del etiquetado de eficiencia energética: El caso de las lavadoras en España. *Papeles de economía española, 134*, 211–221.

Galarraga, Kallbekken, S., & Silvestri, A. (2020). Consumer purchases of energy-efficient cars: How different labelling schemes could affect consumer

response to price changes. *Energy Policy, 137*, 111181. https://doi.org/10.1016/j.enpol.2019.111181.

Gerarden, T. D., Newell, R. G., & Stavins, R. N. (2017). Assessing the energy-efficiency gap. *Journal of Economic Literature, 55*(4), 1486–1525. https://doi.org/10.1257/jel.20161360.

Greene, D. L. (2011). Uncertainty, loss aversion, and markets for energy efficiency. *Energy Economics, 33*(4), 608–616. https://doi.org/10.1016/j.eneco.2010.08.009.

Heinzle, S. L. (2012). Disclosure of energy operating cost information: A silver bullet for overcoming the energy-efficiency gap? *Journal of Consumer Policy, 35*(1), 43–64. https://doi.org/10.1007/s10603-012-9189-6.

Heinzle, S. L., & Wüstenhagen, R. (2012). Dynamic adjustment of eco-labeling schemes and consumer choice – the revision of the EU energy label as a missed opportunity? *Business Strategy and the Environment, 21*(1), 60–70. https://doi.org/10.1002/bse.722.

Jaffe, A., & Stavins, R. (1994). The energy-efficiency gap What does it mean? *Energy Policy, 22*(10), 804–810. https://doi.org/10.1016/0301-4215(94)90138-4.

Jaffe, A., Newell, R., & Stavins, R. (2004). *Economics of energy efficiency*. *Encyclopedia of Energy, 2*, *79–90*.

Kallbekken, S., Sælen, H., & Hermansen, E. A. T. (2013). Bridging the energy efficiency gap: A field experiment on lifetime energy costs and household appliances. *Journal of Consumer Policy, 36*(1), 1–16. https://doi.org/10.1007/s10603-012-9211-z.

Linares, P., & Labandeira, X. (2010). Energy efficiency: Economics and policy. *Journal of Economic Surveys, 24*(3), 573–592. https://doi.org/10.1111/j.1467-6419.2009.00609.x.

London Economics, & Ipsos. (2014). *Study on the impact of the energy label – and potential changes to it – on consumer understanding and on purchase decisions* (ENER/C3/2013-428 Final Report).

Lucas, J., & Galarraga, I. (2015). Green energy labelling. In *Green Energy and Efficiency* (pp. 133–164). Cham: Springer. https://doi.org/10.1007/978-3-

319-03632-8_6.

Min, J., Azevedo, I. L., Michalek, J., & de Bruin, W. B. (2014). Labeling energy cost on light bulbs lowers implicit discount rates. *Ecological Economics, 97*(C), 42–50.

Noblet, C. L., Teisl, M. F., & Rubin, J. (2006). Factors affecting consumer assessment of eco-labeled vehicles. *Transportation Research Part D: Transport and Environment, 11*(6), 422–431. https://doi.org/10.1016/j.trd.2006.08.002.

Ölander, F., & Thøgersen, J. (2014). Informing versus nudging in environmental policy. *Journal of Consumer Policy, 37*(3), 341–356. https://doi.org/10.1007/s10603-014-9256-2.

Organización de Consumidores y Usuarios. (2020). *Electrodomésticos: Las marcas más duraderas y fiables*. Oklahoma City: OCU https://www.ocu.org/electrodomesticos/frigorificos/noticias/electrodomesticos-marcas-mas-duraderas.

Phillips, Y. (2012). Landlords versus tenants: Information asymmetry and mismatched preferences for home energy efficiency. *Energy Policy, 45*, 112–121. https://doi.org/10.1016/j.enpol.2012.01.067.

Ramos, A., Gago, A., Labandeira, X., & Linares, P. (2015). The role of information for energy efficiency in the residential sector. *Energy Economics, 52*(*Supplement 1*), S17–S29. https://doi.org/10.1016/j.eneco.2015.08.022.

Solà, M. M., de Ayala, A., Galarraga, I., & Escapa, M. (2020). Promoting energy efficiency at household level: A literature review. *Energy Efficiency, 14*(1), 6. https://doi.org/10.1007/s12053-020-09918-9.

Sorrell, S., Scott, S., & Schleich, J. (2004). In E. O'Malley (Ed.), *The economics of energy efficiency: Barriers to cost-effective investment*. Cheltenham: Edward Elgar Pub.

Stadelmann, M., & Schubert, R. (2018). How do different designs of energy labels influence purchases of household appliances? A Field Study in Switzerland. *Ecological Economics, 144*, 112–123. https://doi.org/10.1016/j.ecolecon.2017.07.031.

Train, K. (1985). Discount rates in consumers' energy-related decisions: A review of the literature. *Energy, 10*(12), 1243–1253. https://doi.org/10.1016/0360-5442(85)90135-5.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211*(4481), 453–458. https://doi.org/10.1126/science.7455683.

Waechter, S., Sütterlin, B., & Siegrist, M. (2015). Desired and undesired effects of energy labels—An eye-tracking study. *PLoS One, 10*(7), e0134132. https://doi.org/10.1371/journal.pone.0134132.

Waechter, S., Sütterlin, B., Borghoff, J., & Siegrist, M. (2016). Letters, signs, and colors: How the display of energy-efficiency information influences consumer assessments of products. *Energy Research & Social Science, 15*, 86–95. https://doi.org/10.1016/j.erss.2016.03.022.

Waide, W., & Watson, R. (2013). *Energy labelling: The New European Energy Label: Assessing consumer comprehension and effectiveness as a market transformation tool | Copenhagen Centre on Energy Efficiency—Knowledge Management System*. Copenhagen Centre on Energy Efficiency. http://kms.energyefficiencycentre.org/publication-report/energy-labelling-new-european-energy-label-assessing-consumer-comprehension-and

Zarnikau, J. (2003). Consumer demand for 'green power' and energy efficiency. *Energy Policy, 31*(15), 1661–1672. https://doi.org/10.1016/S0301-4215(02)00232-X.

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[1] Red Eléctrica Española publishes all the data for PVPC (*Precio Voluntario para el Pequeño Consumidor* – Voluntary Price for Small-scale Consumers) on the Spanish market on this website: https://www.esios.ree.es/es/pvpc. We chose the highest energy price recorded because it was closer to the real price that consumers were paying

[2] To measure the energy consumption of an appliance, certain baseline assumptions were made. In the case of the three products under study, the assumptions were as follows: washing machine, 220 cycles per year and cotton programme (45° and 60°); dishwasher, 280 cycles per year and standard programme (65°); fridge, 24/7 use

[3] Income information on each municipality is available from the following sources: for the regional community of Aragón (IAEST), for the Regional Community of Navarre (Instituto de Estadística de Navarra); for the Cantabria región (Instituto Cántabro de Estadística); and for the Autonomous Community of the Basque Country (Instituto Vasco de la Estadística)