BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

Effectiveness of monetary information in promoting the purchase of energy-efficient appliances: evidence from a field experiment at a major retailer in Spain

María del Mar Solà, Marta Escapa and Ibon Galarraga

December 2021

BC3 WORKING PAPER SERIES

2021-03

The Basque Centre for Climate Change (BC3) is a Research Centre based in the Basque Country, which aims at contributing to long-term research on the causes and consequences of Climate Change in order to foster the creation of knowledge in this multidisciplinary science.

The BC3 promotes a highly-qualified team of researchers with the primary objective of achieving excellence in research, training and dissemination. The Scientific Plan of BC3 is led by the Scientific Director, Dr. María José Sanz Sánchez.

The BC3 Working Paper Series is available on the internet at
http://www.bc3research.org/lits_publications.html

Enquiries (Regarding the BC3 Working Paper Series):

Prof. Sérgio H. Faria

Email: sh.faria@bc3research.org

www.bc3research.org

Note: If printed, please remember to print on both sides. Also, perhaps try two pages on one side.

Effectiveness of monetary information in promoting the purchase of energy-efficient appliances: evidence from a field experiment at a major retailer in Spain

María del Mar Solà[a*], Marta Escapa[a,b] and Ibon Galarraga[a,b,c]

The effectiveness of energy labels is crucial in nudging the adoption of energy-efficient products. Here we analyse how providing monetary information on the cost of energy affects can increase purchases of more energy-efficient appliances. To that end, a field experiment was carried out at a major Spanish retailer. The appliances under study are washing-machines, fridges, dishwashers and tumble-driers. Monetary information was provided in different ways: (i) directly by sales staff; and (ii) directly by sales staff and via a supplementary label. We find that the effectiveness of providing monetary information depends on both the appliances and the specific way in which information is provided. The monetary information provided by sales staff alone is effective in promoting purchases of A++ washing-machines, fridges and dishwashers but no effect is found for tumble-driers. Then providing monetary information by the sales staff together with the supplementary label is effective in increasing purchases of A++ washing-machines and dishwashers and A+++ tumble-driers, but no effect is found for fridges. Prior to the experiment, a rebate programme was in place for few months and this programme had an impact even after it ended. This "memory effect" should be considered when analysing the effectiveness of such rebate programmes.

Keywords: energy efficiency, monetary information, household appliances, field experiment, rebate programme.

Cite as: Solà M.M., M. Escapa and I. Galarraga (2021) Effectiveness of monetary information in promoting the purchase of energy-efficient appliances: evidence from a field experiment at a major retailer in Spain. *BC3 Working Paper Series 2021-03.* Basque Centre for Climate Change (BC3). Leioa, Spain.

---

* Corresponding Author. Email: mar.sola@bc3research.org

[a] Basque Centre for Climate Change (BC3), 48940 Leioa, Spain

[b] Department of Economic Analysis, University of the Basque Country, 48015 Bilbao, Spain

[c] Economics for Energy, Doutor Cadaval 2, 3E, 36202 Vigo, Spain

1. Introduction

Energy efficiency (EE) is crucial for achieving energy savings, especially in household energy consumption (Labandeira et al., 2020; Solà et al., 2020). EE, defined as improvements in the efficiency with which energy is used to provide a service, has several benefits (cost reduction), but these are not always enough to successfully nudge consumers towards energy-efficient choices. Even when EE may prove financially profitable for consumers, they may not always invest as much as may seem rational (Linares and Labandeira, 2010; Gerarden et al., 2017). This effect 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). There are several failures that could promote the EE gap; they can be grouped under the headings of market failures, behavioural failures and other personal factors. A recent review of the literature on the EE gap can be found in Solà et al. (2020).

In this paper, we focus on informational failures and instruments for tackling them. Such failures involve situations in which a lack of, or reduction in, information can negatively affect financial decisions. These include asymmetric and imperfect information (Yeomans and Herberich, 2014; Allcott and Sweeney, 2016; Davis and Metcalf, 2016), hidden and transaction costs (Sorrell et al., 2004; Ramos et al., 2015), myopia (Busse et al., 2013; Cohen et al., 2017; Gerarden et al., 2017) and uncertainty (Tversky and Kahneman, 1981; Greene, 2011; Ramos et al., 2015).

The most common policy instruments for addressing informational failures are energy labels (Galarraga et al., 2011b), smart meters and information feedback tools (Carroll et al., 2014; Hoffmann and Thommes, 2020) and energy audits (Anderson and Newell, 2004; Krutwig and Tanțău, 2018). Energy labels in particular are the single most widely used instrument for addressing information failures and reducing the EE gap (Solà et al., 2020). The information provided on labels differs depending on the product category (e.g. household appliances, cars, dwellings). In the case of household appliances, the EE label usually indicates EE level, energy consumption per annum (in kWh/year) and other technical attributes (size/capacity, noise level, etc.).

Labels are used extensively (also to identify appliances eligible for rebate programmes), so their effectiveness is important to successfully promote the adoption of energy-efficient appliances with a view to at least meeting the 32.5 % target for energy savings by 2030 (Energy Efficiency Directive (2018/2002). Consumers often misunderstand the energy consumption (in kWh/year) displayed on the label (Waechter et al., 2015), so recent studies have proposed using monetary information (Deutsch, 2010; Kallbekken et al., 2013; Allcott and Taubinsky, 2015; Carroll et al., 2016; Stadelmann and Schubert, 2018; Skourtos et al., 2021). Despite the growing body of research devoted to testing the effectiveness of using energy consumption information in monetary terms to successfully nudge consumers towards energy-efficient products, there is no clear consensus as yet.

Some studies show that providing consumers with monetary information helps to promote the purchase of energy-efficient products while tackling the EE gap. For instance, Kallbekken et al. (2013) run a field experiment in Norway to test the effectiveness of providing monetary information through the use of supplementary labels and training for sales staff. They consider two appliances and find that such information is effective for tumble-driers but not for fridge-freezers. Other interesting results on the effectiveness of labels for tumble-driers and vacuum cleaners can be found in Stadelmann and Schubert (2018). These authors run a field experiment to compare effectiveness in different scenarios (no label, EU Energy label and monetary energy label based on annual energy consumption) in Switzerland. They find that sales of efficient appliances increase with the presence of any of the labels. In the case of washing-machines, Deutsch (2010) shows in an online field experiment that when

monetary information is displayed there is a reduction in average energy consumption based on the label of 0.8 %. Solà et al. (2021) show through a field experiment conducted at small retailers in Spain that providing lifetime energy saving information is effective in promoting the purchase of highly efficient washing-machines and fridges, but they find no effect for dishwashers.

Other studies find that this type of information has no significant effect in promoting energy-efficient purchases. This is the case of the study by Carroll et al. (2016) in Ireland for tumble-driers. Their findings show that such information has no statistically significant effect. Nor is any effect detected in the field experiment by Stadelmann and Schubert (2018) for freezers mentioned above. The authors argue that this could be due to a lack of awareness of this type of labels.

In short, it is not entirely clear whether displaying monetary information is effective in enhancing the purchase of high-efficiency appliances and significant differences are found depending on the product category and country analysed. In an attempt to shed more light on these questions, this paper analyses whether providing information on the lifetime energy cost of household appliances sold in Spain could successfully nudge consumers towards purchasing the most energy-efficient options.

This is done through a field experiment undertaken with the support of a well-known major Spanish retailer: El Corte Inglés[1]. Information on energy costs over the lifetime of a product (appliance) is displayed in Euros (referred to from now on as monetary information). Four of the most widely used household appliances[2] were selected (washing-machines, fridges, dishwashers and tumble-driers) to study whether monetary information has different impacts on consumer decisions for different appliances. The information is displayed in two formats: 1) trained sales staff provide the information; and 2) trained sales staff provide the information and at the same time a supplementary label with monetary information is included on each appliance. The appliances chosen and the way in which information is provided are two of the main improvements over previous studies (Kallbekken et al., 2013; Carroll et al., 2016; Solà et al., 2021). This enables us to better understand the decision-making process for each appliance. Moreover, the experiment is run at a major retailer, so we were able to ensure that treatments were run similarly and with the same criteria.

A total of 29 El Corte Inglés stores in 9 regions of Spain took part in the experiment. In two of these regions (Aragón[3] and Madrid[4]), a rebate programme called RENOVE had been run a few months prior to the start date of the experiment. This rebate programme consisted of subsidising the replacement of old appliances by new, more energy-efficient models. RENOVE programmes are run by regional governments and differ from one region to another. The existence of the earlier RENOVE programmes in some regions only enabled us to test whether they might bias (or have an effect on) the experiment itself, i.e. whether there might be a long-run effect of the rebate programme even when it was no longer in place. We refer to this as a memory effect.

The rest of the paper is structured as follows: Section 2 presents the design of the field experiment. Section 3 shows the data and how they were collected. Section 4 explains the methodology used. Section 5 presents and discusses the results of the study. Finally, Section 6 concludes and provides some policy recommendations.

1 See the El Corte Inglés website: https://www.elcorteingles.es/

2 https://www.eea.europa.eu/data-and-maps/daviz/energy-consumption-for-electric-appliances-2#tab-chart_1

3 The subsidy was €150 for A+++ washing-machines, €150 for A+++ fridges and €145 for A+++ dishwashers. The total funding endowment of this RENOVE was €1,300,000

4 They gave subsidies of up to €70 for A+++ labelled washing-machines, up to €150 for fridges and up to €110 for dishwashers. The total funding endowment of this RENOVE was €2,780,000

2. Design of the field experiment

The 29 stores that participated in the experiment were selected based on geographical distribution across nine regions of Spain (for further details see Section 3).

The stores were classified into two groups: (i) treatment group (10 stores); and (ii) control group (19 stores). The stores in the treatment group were responsible for implementing the treatments while those in the control group maintained a business-as-usual scenario. The choice of which stores were assigned to the treatment and control groups was made by El Corte Inglés based on the characteristics of the stores and their distance from the central offices in Madrid. This decision was made to better monitor the stores actively participating in the experiment by having someone from the central offices visit them regularly to ensure that the exercise was running smoothly.

The experiment ran from 15th August to 24th December 2018. Treatment 1 consisted of providing consumers with monetary information via sales staff and Treatment 2 of providing monetary information via the sales staff and via a supplementary label (Table 1). The label used in this treatment shows lifetime energy cost (LEC) information in Euros for all the products under study (washing-machines, fridges, dishwashers and tumble-driers).

Table 1: Timeline of the experiment

Experiment design	Source of monetary information	Period
Control	Business as usual	15th August 2018 -24th December 2018
Treatment 1	Sales staff	15th August 2018 -30th October 2018
Treatment 2	Supplementary label + sales staff	1st November 2018- 24th December 2018

2.1 Training of sales staff

Two weeks before the start of the experiment, sales staff received a training session on EE-related topics (see Appendix B). This consisted of a researcher going to the central offices of the company and providing a training session for the heads of the appliance departments at all the stores in the treatments.

The training session explained the main concepts of the experiment and the timing. It also explained how monetary information had been estimated based on the annual energy consumption given on the EE label. Tables with the estimated monetary information were distributed.

Once the training session was over, sales staff were provided with full information in a printed book and a video with all the explanations needed, in an attempt to minimise potential misunderstandings and deviations. It was thus possible to ensure that all sales staff received the same information. In addition, the central offices of El Corte Inglés made regular telephone calls to each store to ensure that all the tasks (e.g. that all appliances should have a supplementary label) were carried out correctly and consistently.

2.2 Description of the treatments

In Treatment 1 monetary information was provided by trained sales staff. It started in mid-August and ended on 30th October. During this period the principal role of the trained sales staff was to provide monetary information to all consumers interested in any of the appliances under study.

Treatment 2 started on 1st November and ended on 24th December. In this period consumers received monetary information through two different channels: sales staff and a supplementary label

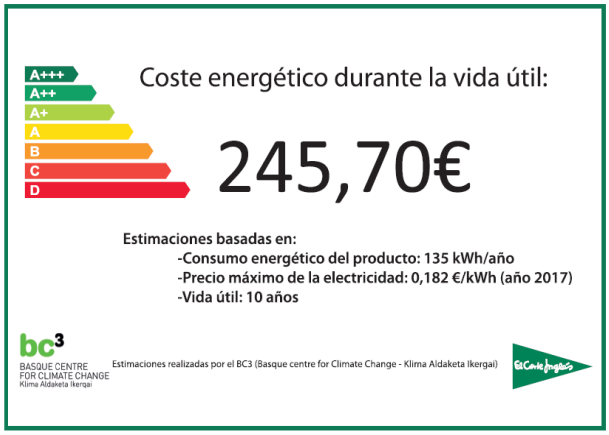

Figure 1: Supplementary label used in the field experiment (Translation: Energy cost over the useful lifetime of the product: €245.70. Estimations based on: energy consumption 135 kWh/year; maximum energy price €0.182/kWh (2017); lifetime: 10 years)

(Figure 1). Before this second treatment started, we received information about the appliances in stock at the stores involved in the treatment (product categories and models). With this data, we prepared a database including technical attributes such as the energy consumption of the products and models sold or available in stock, so as to produce the corresponding label for each appliance.

A total of 206 different labels were printed during this treatment (50 for washing-machines; 86 for fridges; 36 for dishwashers; 34 for tumble-driers).

Treatment 2 was supposed to start in mid-October so that each treatment would last two months, but there was a delay of 15 days due to problems in actually producing the supplementary labels.

2.3 Estimation of lifetime energy cost (LEC)

The monetary information provided during the experiment required the LEC to be estimated for each appliance. We used the following equation:

$$LEC_i = EC_i * ep_{2017} * L,$$

where EC_i is the annual energy consumption of each product i; ep_{2017} is the maximum energy price registered in 2017[5] and L is the lifetime of the appliance in years. Thus, we estimated the *LEC* for each appliance. For the lifetime of the products, suggestions made at our meetings with small retailers and experts led us to use a figure of 10 years for all appliances, which seems also to be the average in Spain (Organización de Consumidores y Usuarios, 2020).

The colour scale derived from the European EE label was placed on the left side of the supplementary label to link the information provided with the EU EE label (Figure 1). As pointed out by de Ayala et al. (2020), this colour scale is familiar and understandable for households. The logos of the research centre leading the experiment and the logo of the store were placed at the bottom of the label. This was considered a simple way to build trust by conveying the message that independent

5 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 price that consumers were actually paying.

specialists had made the calculations. Consumers were not informed that the supplementary labels were part of a field experiment or research project, so as not to bias the purchasing decision-making process.

3. Data collected and descriptive statistics

The 29 stores involved were distributed across the different regions of Spain as follows: Andalusia (2), Aragón (1), Madrid (12), Catalonia (4), Basque Country (1), Valencia (4), Galicia (2), Balearic Islands (1) and Murcia (2).

El Corte Inglés provided us with the following information: (1) store where the appliance was sold; (2) date of sale; (3) type of appliance sold; and (4) model of the product. We then merged the data with our technical attribute database. In the case of washing-machines, we collected information on capacity (in kg), type of embedding and water consumption (in L) for each model. For fridges, we collected information on fridge and freezer volumes (in L), type of embedding and type of fridge. In the case of dishwashers, information on width (450 mm or 600 mm), number of services, type of embedding and water consumption (in L) was collected. Finally, for tumble-driers we collected information on size (kg), type of embedding and spin speed (descriptive statistics shown in Table A1 Appendix A). Table 2 shows the sources for each type of data collected.

Table 2: Variables and sources

Data collected	Source
Date of sale	El Corte Inglés
Place of sale	El Corte Inglés
Type of appliance	El Corte Inglés
Brand of the appliance	El Corte Inglés
Model of the appliance	El Corte Inglés
EE level of the appliance sold	Database on technical attributes
Energy consumption of the appliance sold*	Database on technical attributes
Techinal attributes of the appliance sold	Database on technical attributes
Catalogue price of the product sold	El Corte Inglés website
Per capita income	INE database

The number of sales recorded during the term of the field experiment at El Corte Inglés was 67,345 units. The breakdown per product was as follows: 25,554 washing-machines, 17,911 fridges, 16,903 dishwashers and 6,977 tumble-driers. In percentage terms (Table 3), 38.4 % of the units sold were washing-machines, 26.9 % were fridges, 24.2 % were dishwashers and 10.5 % were tumble-driers.

To follow up how sales behaved in the treatment and control groups, the shares of A+++, A++ and A+ sold under Treatment 1, Treatment 2 and the control group for each appliance were calculated.

As shown in Table 3, for washing-machines A+++ products accounted for above 98 % of sales in both the treatment and control groups. For fridges A+++ products accounted over 40 %. For dishwashers and tumble-driers the figures were lower. For dishwashers A+++ products amounted to less than 20 % of the sales and for tumble-driers there were differences between the groups. In Treatment 2 the share of A+++ tumble-driers sold was over 30 %, while in Treatment 1 and the control group it was slightly higher than 20 %. Figure A1 (Appendix A) shows the distribution of energy consumption by product category and EE level.

For reasons of confidentiality and business strategy, El Corte Inglés did not provide the final selling price for every appliance sold. We decided to obtain the official catalogue prices shown on their website for each product. These official catalogue prices should be a good proxy of the real price, but we were unable to account for price variations due to business strategies (if any). In the case of washing-machines and fridges, the most expensive products were sold in Treatment 2, for dishwashers in the control group and for tumble-driers in Treatment 1 (average catalogue prices are shown in Table A2 in Appendix A).

Due to confidentiality issues, we did not obtain information on the income of each purchaser. To analyse the effect of income on consumers' purchase decisions in regard to more energy-efficient products, we use the average income in the area where each store is located as a proxy.

Table 3: % of appliances sold by EE level and period

		A^{+++}	A^{++}	A^{+}	A	B	C	D
Washing-machines (38.41%)	Control	98.63%	1.25%	0.13%	.	.	.	.
	Treatment 1	97.75%	1.90%	0.35%	.	.	.	.
	Treatment 2	98.53%	1.42%	0.05%	.	.	.	.
Fridges (26.92%)	Control	41.78%	51.80%	6.41%	.	.	.	0.01%
	Treatment 1	39.13%	52.94%	7.89%	.	.	.	0.05%
	Treatment 2	42.10%	51.91%	5.99%	.	.	.	.
Dishwashers (24.19%)	Control	18.49%	69.61%	11.89%	0.01%	.	.	.
	Treatment 1	20.04%	66.83%	13.13%	.	.	.	.
	Treatment 2	17.49%	69.24%	13.28%	.	.	.	.
Tumble-driers (10.48%)	Control	20.59%	55.89%	6.14%	.	13.76%	3.63%	.
	Treatment 1	22.70%	58.03%	6.64%	.	10.39%	2.25%	.
	Treatment 2	31.90%	57.74%	3.61%	.	5.82%	0.93%	.

4. Model specification

We use a multinomial logistic approach to measure the effectiveness of providing monetary information to consumers through different channels at the point of sale. This enables us to estimate the effect of the treatments on the probability of buying an energy-efficient appliance for each EE level. This approach means that we can control for external factors affecting both the treatment and control groups.

We present the following identifying equation for the multinomial logit estimation[6]:

$$\Pr(y|X) = \beta_0 + \beta_1 Treat1 + \beta_2 Treat2 + \sum_{i=1}^{m} \beta_i \, Attributes_i + \beta_{m+1} Income + \beta_{m+2} Renove + \beta_{m+3} Price + \varepsilon \quad (1)$$

This model can be expressed as $P(y|X)$, where y is the EE level and X contains explanatory variables where $Treat1$ is 1 if the sale takes place under Treatment 1, and thus β_1 captures whether

6 The multinomial logit model can be used when all the regressors are case-specific (Cameron et al., 2005), so the multinomial model specifies that $p_{ij} = \frac{\exp(x_i'\beta_j)}{\sum_{l=1}^{m}(x_i'\beta_l)}, j = 1, \ldots m$, where x_i are case-specific regressors. Clearly, this model ensures that $0 < p_{ij} < 1$. To ensure the correct model identification, β_j is set to zero for one of the categories, called the reference category or base, and the rest of the coefficients are interpreted with respect to that category.

Treatment 1 (monetary information provided by sales staff) increases or decreases the probability of buying highly energy-efficient appliances. Analogously, $Treat2$ is 1 if the sale takes place under Treatment 2 (monetary information provided by sales staff and a supplementary label), so β_2 captures whether Treatment 2 increases or decreases the probability of buying high-efficiency appliances. $Attributes$ capture those variables that describe specific characteristics of each appliance, e.g. capacity (in kg) and water consumption (in L) for washing-machines; height (in mm) for fridges; size (450mm or 600mm), number of services and water consumption (in L) for dishwashers; and type alone for tumble-driers.

As can be seen in Equation (1), we also include $Income$ (average per capita income in the area where the product is sold), $Renove$ (with a value of 1 if the place where the product was sold had run a RENOVE rebate scheme before the experiment started) and $Price$ (showing the official catalogue price of the product). We also introduce the variable $Renove$ into the regression to ensure that the RENOVE rebate programme has no impact on our experiment. Finally, note that $Price$ refers to the catalogue price of the product as stated earlier and may differ from the actual final sale price of the appliance.

We first run a model with treatment variables. Then we include the rest of the variables one by one and choose the model with the highest level of significance. Thus, for each type of appliance we estimate different models that reflect the probability of buying a highly energy-efficient appliance depending on the treatment, technical attributes, income, RENOVE and price. Specification (2) refers to the model for washing-machines, (3) for fridges, (4) for dishwashers and (5) for tumble-driers.

$$\Pr(y|x) = \beta_0 + \beta_1 Treat1 + \beta_2 Treat2 + \beta_3 Capacity + \beta_4 WaterConsumption + \beta_5 Income + \beta_6 Renove + \beta_7 Price + \varepsilon \quad (2)$$

$$\Pr(y|x) = \beta_0 + \beta_1 Treat1 + \beta_2 Treat2 + \beta_3 Height + \beta_4 VolumeFreezer + \beta_5 Income + \beta_6 Renove + \beta_7 Price + \varepsilon \quad (3)$$

$$\Pr(y|x) = \beta_0 + \beta_1 Treat1 + \beta_2 Treat2 + \beta_3 Width + \beta_4 NumberServices + \beta_5 WaterConsumption + \beta_6 Income + \beta_7 Renove + \beta_8 Price + \varepsilon \quad (4)$$

$$\Pr(y|x) = \beta_0 + \beta_1 Treat1 + \beta_2 Treat2 + \beta_3 TypeofTumbleDrier + \beta_4 Income + \beta_5 Renove + \beta_6 Price + \varepsilon \quad (5)$$

5. Results of the field experiment and the memory effect of the RENOVE rebate programme

5.1 Results of the field experiment

In this section we set out and discuss the results of the multinomial logistic analysis for each of the four appliances considered. The probabilistic models (2), (3), (4) and (5) were estimated using STATA version 16. The marginal effects for the treatments and the explanatory variables are shown in Table 4 (for washing-machines and fridges) and Table 5 (for dishwashers and tumble-driers). Table 6 summarises the effectiveness of each treatment and discuss these results and contextualise them in the relevant literature.

5.1.1 Treatment effect

The effectiveness of Treatment 1 (information provided by sales staff) and Treatment 2 (information provided by sales staff plus a supplementary label) differs from one product category and EE level to another.

In particular, Treatment 1 is effective and increases the probability of buying A++ washing-machines by 0.8 % but it decreases the probability of buying A+++ washing-machines compared to the control group. It does not therefore incentivise the purchase of highly efficient appliances. The main reason is that in the case of washing-machines A+++ products already account for a very high share of sales and the scope for improvement is really small. In fact, more than 98 % of the units sold in the control stores were A+++.

In the case of fridges and dishwashers, Treatment 1 is effective in increasing the probability of purchasing A++ (by 5.5 % for fridges and 5.15 % for dishwashers) but the probability of buying an A+++ product decreases (by 6.36 % for fridges and 2.5 % for dishwashers). This suggests that sales staff were unable to nudge customers towards purchasing of highly efficient fridges and dishwashers. The substantial differences in price between A+++ and A++ fridges and dishwashers could also explain this effect. A+++ fridges cost 27.68 % more than A++ and A+++ dishwashers cost 34.89 % more than A++. Treatment 1 is not statistically significant in terms of increasing sales of highly efficient tumble-driers, as can be seen in Table 5.

The effectiveness of Treatment 2 also differs depending on the appliance and the EE level. This treatment is effective in nudging purchaser towards A++ with increases of 1.2% for washing-machines and 2.9% for dishwashers, but the probability of buying an A+++ unit decreases by 1.2% for washing-machines and 3.2% for dishwashers. The latter result is again unexpected: it may be explained by the same reason indicated above. As shown in Table 5, providing monetary information via sales staff and a supplementary label increases the probability of buying A+++ tumble-driers by 4.01% compared to no intervention. This is an expected result.

Overall, Treatments 1 and 2 both appear to be statistically significant and therefore effective in promoting the purchase of A++ appliances (see Table 6). However, this is not the case for A+++ appliances, in particular for washing-machines, fridges and dishwashers. As noted, these are unexpected results. On potential explanations might be that sales staff fail to offer sufficient information to successfully nudge consumers towards A+++ purchases for reasons beyond our understanding. Other explanations might be related to other attributes of appliances that we are unable to control for in the experiment (e.g. simplicity of use). In addition, the treatments seemed to work well for some products but not for others.

In any case, this is consistent with the existing literature on the topic, which clearly shows that monetary information has heterogeneous effects depending on the type of appliance and/or country. Some studies find no evidence for the effectiveness of providing monetary information. Carroll et al. (2016) show no evidence for the effectiveness of 5-year energy cost information for tumble-driers. However, Kallbekken et al. (2013) report that monetary information is effective for tumble-driers but not for freezers, and similar results are obtained by Stadelmann and Schubert (2018). Our results for tumble-driers are in line with those of Kallbekken et al. (2013).

5.1.2 Attributes

It is clear that attributes are important factors for the decision-making process. In the case of washing-machines, two attributes were included in the analysis: capacity and water consumption. Both are statistically significant. In the case of capacity (in kg) we find that the higher the capacity is, the greater

the probability of buying A+++ washing-machines is. Water consumption increases the probability of buying A++ washing-machines but decreases that of buying A+++ appliances. These results are expected: in general, the higher capacity is, the higher the EE level of products is, and a higher EE level means lower water consumption.

In the case of fridges, two attributes are considered: height and freezer capacity. The taller the fridge is, the greater the probability of buying an A+++ model is, but the lower the probability of buying an A++ model is. This evidence is somewhat intuitive: bigger fridges usually have high EE levels. In the case of the freezer volume, the greater the volume is, the greater the probability of buying an A++ fridge is, and the lower the probability of buying an A+++. Even if the impact of the freezer volume is small, it could be somewhat intuitive, as higher freezer volumes mean greater energy consumption, and this could affect the EE level of the product[7].

For dishwashers we included three attributes: width, number of services and water consumption. Table 4 shows that the number of services is effective in promoting the purchase of highly energy-efficient dishwashers. The more services can be obtained, the greater the probability of buying an A+++ dishwashers is, with increases of up to 9.5% compared to the control group (no intervention). This result is intuitive in the sense that bigger products usually have higher efficiency levels. But this same variable decreases the probability of buying A++ dishwashers. In the case of water consumption, greater water consumption means a lower probability of buying an A+++ dishwasher.

In the case of tumble-driers, we only included type as an explanatory variable. Our database contains three different types of tumble-drier: heat-pump, condensation and evacuation. As can be seen in Table 5, heat-pump tumble-driers are taken as the benchmark. Choosing a condensation tumble-drier decreases the probability of buying an A++ appliance. A similar effect is found for evacuation tumble-driers. In fact, a decrease in the probability of buying an A++ appliance can be observed.

As can be seen, attributes are relevant factors in decision-making processes. In particular, the higher the capacity and the greater the water consumption, the more likely it is that the consumer will decide to invest in highly energy-efficient appliances (A+++ appliances). This is in line with previous results in the literature, as the great majority of studies show that consumers care about the technical characteristics of products (Galarraga et al., 2011a, 2011b; de Ayala et al., 2020).

5.1.3 Price effect

Price has heterogeneous effects on consumer decision-making. In this study we find two different effects: for washing-machines, the higher the price, the higher the probability of buying A++ washing-machines and the lower the probability of buying A+++ washing-machines is. The contrary effect is found for fridges, dishwashers and tumble-driers, i.e. the higher the price, the higher the probability of buying A+++ products and lower the probability of buying A++ products.

The effect found for fridges, dishwashers and tumble-driers can easily be understood by looking at the average selling prices for each product (Table A2 in Appendix A). In fact, the average selling price for A++ fridges is € 847.63 while the average catalogue price of A+++ fridges is € 1082.27. Similar differences can be seen for dishwashers (an average catalogue price of € 522.75 for A++ and € 745.65 for A+++) and tumble-driers (€ 773.89 for A++ and € 1038.03 for A+++). In the case of washing-machines, this effect can be explained by the fact that the difference in LEC between A+++ and A++ washing-machines does not offset the difference in price between them (the price for A+++ is

7 The EE level of the product is determined by the EE index, which considers several attributes of the product (energy consumption, volume, etc).

€ 78.36 higher than for A++). In fact, the difference in LEC between A+++ and A++ washing-machines is € 63.59, so the difference in price means that it is not worth investing in high-efficiency washing-machines.

Overall, our results show that the price of products is a major factor to be considered in purchasing decisions, as many other papers have shown earlier. The literature also shows a positive willingness to pay for highly efficient products (Galarraga et al., 2011a, 2011b; de Ayala et al., 2020) and our results corroborate this.

5.1.4 Income effect

As is shown in Tables 4 and 5, the "income" variable is not statistically significant for washing-machines and dishwashers, but is significant for fridges and tumble-driers. It is important to note that this variable does not reflect the real income of consumers but merely the average income in the area where the product was sold. For fridges, results show that in higher-income locations the probability of buying an A++ fridge is greater, but that of buying an A+++ fridge is lower. By contrast, for tumble-driers the probability of buying a C labelled appliance increases in those areas where income is higher.

Table 4: Results of the multinomial logit model for washing-machines and fridges

Washing-machines			**Fridge**		
Energy efficiency level	Marginal effects	z	**Energy efficiency level**	Marginal effects	z
Treatment effect			***Treatment effects***		
Control	-- Ref --		**Control**	-- Ref --	
Treatment 1 (=1 if the sale is under treatment 1)			**Treatment 1 (=1 if the sale is under treatment 1)**		
A+	0.0003556 (0.0011761)	0.30	A+	0.0079952 (0.0056958)	1.40
A++	0.0083867** (0.004151)	2.02	A++	0.0556437*** (0.0180148)	3.09
A+++	-0.0087422** (0.0042299)	-2.07	A+++	-0.0636389*** (0.0173607)	-3.67
Treatment 2 (=1 if the sale is under treatment 2)			**Treatment 2 (=1 if the sale is under treatment 2)**		
A+	-0.0003483 (0.000838)	-0.42	A+	-0.0003099 (0.0065551)	-0.05
A++	0.0127624** (0.0052454)	2.43	A++	-0.0146885 (0.0195088)	-0.75
A+++	-0.0124141** (0.0052672)	-2.36	A+++	0.0149984 (0.0187263)	0.80
Attributes			***Attributes***		
Capacity (kg)			**Height (mm)**		
A+	-0.0018062*** (0.000374)	-4.83	A+	-0.0005734*** (0.0000393)	-14.59
A++	-0.0273314*** (0.0013977)	-19.55	A++	-0.0001075 (0.0000676)	-1.59
A+++	0.0291375*** (0.0014023)	20.78	A+++	0.0006809*** (0.0000577)	11.80
			Capacity- Freezer volume (L)		
			A+	-0.0022889*** (0.0001174)	-19.49
			A++	0.0069364*** (0.0004175)	16.61
			A+++	-0.0046476*** (0.000411)	-11.31
Water consumption (L)					
A+	-9.12e-07*** (2.56e-07)	-3.56			
A++	0.0000195*** (1.70e-06)	11.46			
A+++	-0.000186*** (1.71e-06)	-10.90			
Income (in the area where the store is located)			***Income (in the area where the store is located)***		
A+	1.05e-08 (2.49e-08)	0.42	A+	-2.16e-07 (2.02e-07)	-1.07
A++	1.12e-07 (9.94e-08)	1.13	A++	1.28e-06** (6.36e-07)	2.02
A+++	-1.22e-07 (1.02e-07)	-1.20	A+++	-1.07e-06* (6.16e-07)	-1.73
RENOVE (=1 if the sale took place at a store where a RENOVE had been run prior to the experiment)			***RENOVE (=1 if the sale took place at a store where a RENOVE had been run prior to the experiment)***		
A+	-0.0006617 (0.0009096)	-0.73	A+	-0.0009739 (0.0052676)	-0.18
A++	-0.0074971*** (0.0029122)	-2.57	A++	-0.0441832*** (0.0157002)	-2.81
A+++	0.0081587*** (0.002993)	2.73	A+++	0.0451571*** (0.0150462)	3.00

Price (€)			*Price (€)*		
A+	1.24e-06 (1.64e-06)	0.75	A+	0.0000874*** (5.72e-06)	15.28
A++	0.0000483*** (3.54e-06)	13.64	A++	-0.0008021*** (0.0000214)	-37.56
A+++	-0.0000495*** (3.75e-06)	-13.20	A+++	0.0007146*** (0.0000196)	36.53
Number of obs = 24,311 LR chi2(14) = 1634.63 Prob > chi2 = 0.0000 Log likelihood = -1162.5471 Pseudo R2 = 0.4128			Number of obs = 11,097 LR chi2(14) = 4451.33 Prob > chi2 = 0.0000 Log likelihood = -6674.4406 Pseudo R2 = 0.2501		
Standard errors are shown in parentheses					
***, ** and * indicate significance at the 1%, 5% and 10% levels.					

Table 5: Results of the multinomial logit model for dishwashers and tumble-driers

Dishwashers			*Tumble-driers*		
Energy efficiency level	**Marginal effects**	**z**	**Energy efficiency level**	**Marginal effects**	**z**
Treatment effect			***Treatment effects***		
Control	--Ref--		**Control**	--Ref--	
Treatment 1 (=1 if the sale is under treatment 1)			**Treatment 1 (=1 if the sale is under treatment 1)**		
A+	-0.026459*** (0.0088507)	-2.99	C	0.0057116* (0.0032344)	1.77
A++	0.0515029*** (0.0163497)	3.15	B	0.0094579 (0.0094838)	1.00
A+++	-0.0250439* (0.0139055)	-1.80	A+	0.024586 (0.0149476)	1.64
			A++	-0.0109264 (0.0266957)	-0.41
			A+++	-0.0288291 (0.0207495)	-1.39
Treatment 2 (=1 if the sale is under treatment 2)			**Treatment 2 (=1 if the sale is under treatment 2)**		
A+	0.0030282 (0.0086077)	0.35	C	-.00007728 (0.0014247)	-0.54
A++	0.0291352* (0.0167824)	1.74	B	-0.0146048* (0.0074807)	-1.95
A+++	-0.0321634** (0.0145335)	-2.21	A+	0.0266537* (0.0147529)	1.81
			A++	-0.0513382** (0.0252249)	-2.04
			A+++	0.0400621** (0.0197026)	2.03
Attributes			***Attributes***		
Width (=1 if the size is 600 mm)			**Type of tumble-drier**		
A+	-0.0003214*** (0.000099)	-3.25	Heat pump	--Ref--	
A++	0.0002582 (0.0002049)	1.26	Condensation		
A+++	0.0000632 (0.0001827)	0.35	C	-0.050445 (0.251411)	-0.20
Number of services			B	0.5895717*** (0.045088)	13.08
A+	-0.0583666*** (0.0030191)	-19.33	A+	-0.0356428 (0.0970795)	-0.37
A++	-0.0322111*** (0.0044579)	-7.23	A++	-0.453649*** (0.1609832)	-2.82
A+++	0.0905777*** (0.0033735)	26.85	A+++	-0.0498348 (0.0394832)	-1.26
Water consumption (L)			Evacuation		
A+	0.0002408*** (9.15e-06)	26.32	C	-0.0401481 (0.251554)	-0.16
A++	0.0000896*** (0.0000166)	5.41	B	0.5412806 (3.242479)	0.17
A+++	-0.0003305*** (0.000014)	-23.62	A+	-0.0359273 (0.097078)	-0.37
			A++	-0.6543956*** (0.1545897)	-4.23
			A+++	0.1891904 (3.242478)	0.06
Income (in the area where the store is located)			***Income (in the area where the store is located)***		
A+	-4.38e-07 (3.12e-07)	-1.40	C	1.22e-07 (8.62e-08)	1.41
A++	6.28e-07 (5.89e-07)	1.07	B	6.09e-07** (2.55e-07)	2.39
A+++	-1.89e-07 (5.06e-07)	-0.37	A+	-1.73e-07 (2.24e-07)	-0.77
			A++	-6.41e-08 (6.67e-07)	-0.10
			A+++	-4.94e-07 (5.87e-07)	-0.84
RENOVE (=1 if the sale took place at a store where a RENOVE had been run prior to the experiment)			***RENOVE (=1 if the sale took place at a store where a RENOVE had been run prior to the experiment)***		
A+	-0.0054285 (0.0073085)	-0.74	C	-0.0013913 (0.0010103)	-1.38
A++	-0.0523405***	-3.77	B	-0.0102351	-1.61

	(0.0138966)			(0.0063395)	
A+++	0.057769*** (0.0119158)	4.85	A+	-0.0188231 (0.0141577)	-1.33
			A++	0.0295853 (0.0222896)	1.33
			A+++	0.0008642 (0.0166698)	0.05
Price (€)			***Price (€)***		
A+	-0.0000733*** (0.0000175)	-4.18	C	-0.0000794*** (0.0000268)	-2.97
A++	-0.0007048*** (0.0000253)	-27.87	B	0.0000248 (0.0000282)	0.88
A+++	0.0007781*** (0.0000187)	41.55	A+	-0.0001563*** (0.0000225)	-6.96
			A++	-0.0013814*** (0.0000383)	-36.04
			A+++	0.0015924*** (0.0000287)	55.49
Number of obs = 9,418 LR chi2(16) = 9068.78 Prob > chi2 = 0.0000 Log likelihood = -4355.2233 Pseudo R2 = 0.5101			Number of obs = 5,881 LR chi2(28) = 7726.48 Prob > chi2 = 0.0000 Log likelihood = -2315.0561 Pseudo R2 = 0.6253		
Standard errors are shown in parentheses					
***, ** and * indicate significance at the 1%, 5% and 10% levels.					

Table 6: Summary of the results of the treatment effect

		Treatment 1	Treatment 2
Washing-machines	A+++	↓	↓
	A++	↑	↑
	A+	.	.
Fridges	A+++	↓	.
	A++	↑	.
	A+	.	.
Dishwashers	A+++	↓	↓
	A++	↑	↑
	A++	↓	.
Tumble-driers	A+++	.	↑
	A++	.	↓
	A+	.	↑
	B	.	↓
	C	↑	.

5.2 Memory effect of a RENOVE rebate programme

In some regions a RENOVE programme had been run before the field experiment took place. This gave us the opportunity to analyse whether such programmes had any impact on the purchase of highly efficient appliances once they had ended. We found such a "memory effect" for washing-machines, fridges and dishwashers. Tables 4 and 5 show that having a RENOVE before the experiment increases the probability of buying A+++ appliances and reduces for A++ products. In particular, the probability of buying an A+++ washing-machine is up by 0.8 %, for A+++ fridges by 4.5 % and for A+++ dishwashers by 5.7 %. In the case of A++ appliances, our findings suggest that RENOVE programmes reduce the probability of purchase by 0.7 % for washing-machines, 4.4 % for fridges and 5.2 % for dishwashers. No effect was found for tumble driers. Our findings thus suggest that RENOVE programmes do indeed have what we refer to as a "memory effect" after they are over.

These results show that RENOVE programmes run prior to our experiment had an influence on it. This opens up new research questions to be explored. Further analysis of this issue is highly relevant for at least, two reasons: (i) as far as we are aware, there is no mention and no evidence in the

literature of such effects or anything similar; and (ii) if we are to defend the validity of our field experiment we need to state clearly whether our results might be biased or not.

The design of our experiment enables us to test this memory effect in a business-as-usual environment, thanks to the control stores. Sales at the control group can be used to check whether the rebate programme really generates a memory effect. Three out of the 19 control stores had run RENOVE programmes before the experiment.

The appliances subsidised by under RENOVE were washing-machines, fridges and dishwashers but the memory effect is also tested for tumble-driers. We believe that including tumble-driers is useful to ensure that there is no cross-appliance memory effect, i.e. we strive to ensure that the fact that some appliances are subsidised does not influence consumers to purchase other high-efficiency appliances which are not directly subsidised[8].

The RENOVE only encourages sales of the most energy-efficient appliances (A+++), so we propose a probit model to test the memory effect (Cameron et al., 2005). The dependent variable y takes a value of 1 when the appliance is A+++ and zero otherwise. Thus, we seek to determine whether there is a memory effect and if so whether it nudges purchasers towards the most energy-efficient choices (those subsidised) even after the end of the programme. Specification (6) is for washing-machines, (7) for fridges, (8) for dishwashers and (9) tumble-driers:

$$P(y = 1 \mid X) = \beta_1 + \beta_2 Capacity + \beta_3 TypeofEmbedding + \beta_4 WaterConsumption + \beta_5 Income + \beta_6 Renove + \beta_7 Price + \varepsilon, \quad (6)$$

$$P(y = 1 \mid X) = \beta_1 + \beta_2 Height + \beta_3 VolumeoftheFreezer + \beta_4 Income + \beta_5 Renove + \beta_6 Price + \varepsilon, \quad (7)$$

$$P(y = 1 \mid X) = \beta_1 + \beta_2 Width + \beta_3 NumberofServices + \beta_4 WaterConsumption + \beta_5 Income + \beta_6 Renove + \beta_7 Price + \varepsilon, \quad (8)$$

$$\mathrm{P(y = 1 \mid X)} = \beta_1 + \beta_2 \mathrm{Capacity} + \beta_3 \mathrm{Revolutions} + \beta_4 \mathrm{Income} + \beta_5 \mathrm{Renove} + \beta_6 \mathrm{Price} + \varepsilon, \quad (9)$$

The results of the marginal effects of (6), (7), (8), and (9) are shown in Table 7. As can be seen, the presence of an earlier RENOVE does indeed positively affect the purchase of high- efficiency washing-machines, fridges and dishwashers, so we find evidence of the so-called memory effect. However, we find no evidence of a cross-memory effect in the case of tumble-driers as they were not included in the 2018 RENOVE programme. We also analysed this memory effect month by month but found no clear effects.

It is worth stressing again here that the RENOVE programme ended long before the experiment started. This clearly shows that the programme may still have an effect on the purchase of the most highly-efficient appliances. Several potential explanations for the memory effect found in this study could be suggested. One is that stores know that a rebate programme is due to start on a certain date, so they increase stocks of the most energy-efficient appliances in expectation of a significant increase in the sales of such appliances due to the programme. When the programme ends they may still have a substantial stock of the most energy-efficient appliances, so they continue selling them (maybe even at lower prices) to clear the stock out. A second explanation may be that rebate

8 Where a RENOVE programme was run prior to the experiment, there could have been a cross-appliance memory effect. Such an effect is similar to the cross-subsidisation effect and takes place when a consumer wants to buy two specific appliances only one of which is covered by the RENOVE programme. The subsidy received for the first appliance may enable the consumer to buy a second appliance with a higher efficiency level. However, in the field experiment we are unable to control who is buying each appliance, so we cannot analyse whether such a cross-appliance memory effect exists.

programmes usually have an intense advertising campaign, so consumers may continue to visit the stores attracted by the RENOVE programme long after the programme itself has ended. Yet another potential explanation is that the stores may continue to offer special prices to keep attracting consumers.

Most papers that analyse the impact of rebate programmes tend to focus on the period when the programme is running. It is unclear from such studies whether rebate programmes are effective and efficient in promoting the purchase of highly energy-efficient products. Mixed results are obtained depending on the country and the product.

For instance, Datta and Filippini (2016) analyse the effectiveness of the Energy Star rebate policy programme in the USA for washing-machines, dishwashers, refrigerators and air conditioners. They find an increase of between 3.3 % and 6.6 % in sales of highly efficient appliances as a consequence of the programme. Some studies find that rebate programmes are effective: Chuang et al. (2018) find that rebate programmes in Southern California can be effective depending on the product category. In fact, they find that thanks to this programme there is a reduction in energy consumption from pool pumps (12 %) and refrigerators (6 %), lighting and HVAC based on the EE label. However, for dishwashers and washing-machines their results show an increase in average energy consumption. Olsthoorn et al. (2017) show that the effectiveness of rebates across 8 EU Member States is affected by the income, risk and time preferences of the recipients. Li et al. (2016) find that a rebate programme for refrigerators at the USA affected willingness to pay for them: the programme increased uncertainty among consumers regarding the quality of highly energy-efficient refrigerators. Houde and Aldy (2017) show that in the presence of a rebate programme consumers tend to buy appliances which are of higher quality but not necessarily more energy-efficient. Finally, Galarraga et al. (2013) show that the RENOVE rebate programme for dishwashers in Spain generated welfare losses and a rebound effect and had a significant cost.

In spite of these results from the literature, our findings suggest that the impact of RENOVE extends beyond the period when the programme is actually running. Findings in regard to the effectiveness of rebate programmes may thus therefore change if their analysis focuses on a period that extends beyond the end of the programme.

In any case, this memory effect is a very interesting finding that is worth exploring in further research. We believe that further research in greater depth is needed to consider the impacts of rebate programmes in the long run.

Table 7: Evidence for the memory effect of the RENOVE programme in Spain

Washing-machines			**Fridges**			**Dishwashers**			**Tumble-driers**		
	Marginal effects	Z		Marginal effects	Z		Marginal effects	z		Marginal effects	z
Capacity (kg)	0.0015584*** (0.0003676)	4.24	**Height (mm)**	0.0008188*** (0. 0000912)	8.98	**Width (=1 if the size is 600 mm)**	0.0001685 (0.0001854)	0.91	**Capacity (kg)**	0.0037924*** (0.0010805)	3.51
Type of embedding (=1 free installation)	0.0076803*** (0.0017512)	4.39	**Freezer Volume (L)**	-0.0060498*** (0.0006533)	-9.26	**Number of services**	0.085433*** (0.0047746)	17.89	**Spin speed (rpm)**	0.0004226*** (0.0000885)	4.78
Water consumption (L)	-1.95e-06*** (4.08e-07)	-4.78				**Water consumption (L)**	-0.0003379*** (0.0000175)	-19.34			
Income (in the area where the store is located)	-1.10e-08 (1.42e-08)	-0.78	**Income (in the area where the store is located)**	-1.61e-06* (8.57e-07)	-1.88	**Income (in the area where the store is located)**	-1.07e-07 (5.42e-07)	-0.20	**Income (in the area where the store is located)**	-7.28e-08* (4.30e-08)	-1.69
RENOVE (=1 if the sale took place at a store where a RENOVE had been run before the experiment)	0.0014371*** (0.0004836)	2.97	**RENOVE (=1 if the sale took place at a store where a RENOVE had been run before the experiment)**	0.0537222*** (0.0185774)	2.89	**RENOVE (=1 if the sale took place at a store where a RENOVE had been run before the experiment)**	0.0513082*** (0.0115189)	4.45	**RENOVE (=1 if the sale took place at a store where a RENOVE had been run before the experiment)**	-0.0013552 (0.0011)	-1.23
Price (€)	0.0031537*** (0.0008616)	3.66	**Price (€)**	0.9088423*** (0.0329011)	27.62	**Price (€)**	0.5144678*** (0.0239864)	21.45	**Price (€)**	0.0001339*** (0.0000285)	4.70
Number of obs = 15,789 LR chi2(6) = 991.47 Prob > chi2 = 0.0000 Log likelihood = -568.02177 Pseudo R2 = 0.4660			Number of obs = 6,977 LR chi2(5) = 1957.13 Prob > chi2 = 0.0000 Log likelihood = -3667.4834 Pseudo R2 = 0.2106			Number of obs = 5,823 LR chi2(6) = 2610.14 Prob > chi2 = 0.0000 Log likelihood = -1990.3871 Pseudo R2 = 0.3960			Number of obs = 4,379 LR chi2(5) = 2988.92 Prob > chi2 = 0.0000 Log likelihood = -852.22941 Pseudo R2 = 0.6368		
Standard errors are shown in parentheses											
***, ** and * indicate significance at the 1%, 5% and 10% levels.											

5.3 Caveats and future research

One of the main advantages of conducting a field experiment is that we can test in real-life conditions whether providing monetary information through sales staff and/or a supplementary label is effective in promoting the purchase of high-efficiency appliances. However, there are also some well-known drawbacks inherent in experiments, as it is not always possible to control all factors that affecting them. For instance, the large number of sales and consumers at El Corte Inglés made it really difficult to fully control what information consumers received and how they interpreted it. Not could we control whether consumers who received the information during Treatment 1 actually purchased the appliance at that time or postponed the purchase until Treatment 2 was in place or even until after the Treatments had ended. Other relevant information that we were unable to access included consumer characteristics such as gender, household composition, current disposable income, whether this was a first purchase or a replacement, what final price was paid and/or what other services they obtained together with the appliances such as extra after-sales technical assistance, etc. We are aware that all this information could have been collected via a survey of consumers who bought appliances, but it must be realised that the design of the field experiment had to be adapted to what was reasonable for and doable by the retailer that was collaborating with the research.

Another limitation is that we obtained sales data from the stores only while the experiment was running, i.e. we had no access to sales before and after the experiment. We cannot test the long run effects of our experiment or the memory effect. For instance, we have no clue whether sales staff continue to provide information on LEC.

6. Conclusions and policy implications

Encouraging the adoption of energy-efficient appliances is one of the principal challenges that must be tackled if EE targets at EU level are to be achieved. We propose providing consumers with additional information on energy cost in monetary terms and test that proposal in terms of increases in the purchase of high-efficiency appliances. However, the evidence as to the effectiveness of monetary information is not yet fully clear.

This paper provides new, clear evidence on the effectiveness of providing consumers with monetary information to promote the purchase of high-efficiency appliances in Spain. To that end, a field experiment was conducted at 29 El Corte Inglés stores for washing-machines, fridges, dishwashers and tumble-driers. Lifetime energy cost information was given in addition to the existing EE label. Two different treatments were implemented and tested during the field experiment. In the first, monetary information was provided visa sales staff. In the second it was provided via a supplementary label and via sales staff.

The results show that consumer decision-making differs from one product category to another and that different variables play different roles depending on the specific appliances.

We find that providing monetary information is statistically significant and effective in promoting the purchase of A++ washing-machines and dishwashers when information is provided by sales staff only or in combination with an additional label. However, neither treatment helps to promote the purchase of A+++ washing-machines and dishwashers, and Treatment 1 decreases the probability of selling A+++ fridges. The opposite effect is found for tumble-driers: treatment 2 increased the probability of selling A+++-labelled tumble-driers but decreased that of purchasing those with A++ labels. In the case of washing-machines, the main reason for these results is that the scope for

improvement is very small as more than 98 % of sales in the control stores already involve A+++ appliances.

We also find that technical attributes such as product size, height and number of services are significant and increase the probability of buying an energy-efficient appliance. Heterogeneous effects are found for other attributes such as freezer volume for fridges and water consumption for washing-machines and dishwashers. This indicates that providing LEC information combined with technical attributes may be effective in impacting and influencing consumer decision-making depending on the product category.

Heterogeneous impacts are also found for income in the area of purchase. Indeed, in higher-income areas we find a higher probability of buying a A++ fridges and C-labelled tumble-driers. In the case of washing-machines and dishwashers no link is found between income and the probability of buying energy-efficient appliances. Finally, prices are significant and relevant in the decision-making processes of consumers.

There is an interesting finding related to the RENOVE rebate programme that was in place prior to our experiment. We find a memory effect, in that the RENOVE programme has a positive impact on sales of high-efficiency appliances even after the programme is over. This is a surprising result. As far as we know, most studies of the effectiveness of rebate programmes examine their effectiveness during their implementation periods. This evidence of a memory effect adds a new dimension to the study of the impact of several economic instruments such as rebates, taxes and/or feebates and whether their positive or negative effects may continue well after the time when they cease to be applied. Looking for evidence for other goods such as housing or vehicles would be a very interesting extension of this research.

Household preferences regarding different types of appliance seem to be determinant in consumer decision-making for the purchase of washing-machines, fridges, dishwashers and tumble-driers. However, more research is needed to analyse the impact of several factors, such as the current income of consumers. In this experiment, we were unable to control for this factor, as the volume of sales at El Corte Inglés was very high. Moreover, future experimental studies should be conducted to compare the effectiveness of providing monetary information on different scales (lifetime energy savings vs. lifetime energy costs). A new EE label came in force in March 2021 with a new EE scale, so it would also be interesting to test the effectiveness of monetary information with the new label with the A-G scale.

Acknowledgments

This study was conducted with the collaboration of El Corte Inglés as part of the CONSumer Energy Efficiency Decision making (CONSEED) project, an EU-funded H2020 research project under grant agreement number 723741. This research is also supported by the Spanish State Research Agency through María de Maeztu Excellence Unit accreditation 2018-2022 (Ref. MDM-2017-0714) and by the Basque Government (Spain) through the BERC 2018-2021 programme. Marta Escapa is grateful for financial support from the University of the Basque Country (Grant GIU18/136) and from the Spanish Ministry of Science, Innovation and Universities (Grant RTI2018-093352-B-I00).

References

Allcott, H., Sweeney, R.L., 2016. The Role of Sales Agents in Information Disclosure: Evidence from a Field Experiment. Manag. Sci. 63, 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. Am. Econ. Rev. 105, 2501–2538. https://doi.org/10.1257/aer.20131564

Anderson, S.T., Newell, R.G., 2004. Information programs for technology adoption: the case of energy-efficiency audits. Resour. Energy Econ. 26, 27–50. https://doi.org/10.1016/j.reseneeco.2003.07.001

Busse, M.R., Knittel, C.R., Zettelmeyer, F., 2013. Are Consumers Myopic? Evidence from New and Used Car Purchases. Am. Econ. Rev. 103, 220–256. https://doi.org/10.1257/aer.103.1.220

Cameron, A.C., Trivedi, P.K., Trivedi, P.K., 2005. Microeconometrics: Methods and Applications. Cambridge University Press.

Carroll, J., Denny, E., Lyons, S., 2016. The Effects of Energy Cost Labelling on Appliance Purchasing Decisions: Trial Results from Ireland. J. Consum. Policy 39, 23–40. https://doi.org/10.1007/s10603-015-9306-4

Carroll, J., Lyons, S., Denny, E., 2014. Reducing household electricity demand through smart metering: The role of improved information about energy saving. Energy Econ. 45, 234–243.

Chuang, Y., Delmas, M.A., Pincetl, S., 2018. Are Residential Energy Efficiency Programs Effective? An Empirical Analysis in Southern California [WWW Document]. URL /paper/Are-Residential-Energy-Efficiency-Programs-An-in-AGALI-D./127446073ed37fa0b47122644bdb4f9ad2c35d7d (accessed 12.16.20).

Cohen, F., Glachant, M., Söderberg, M., 2017. Consumer myopia, imperfect competition and the energy efficiency gap: Evidence from the UK refrigerator market. Eur. Econ. Rev. 93, 1–23. https://doi.org/10.1016/j.euroecorev.2017.01.004

Datta, S., Filippini, M., 2016. Analysing the impact of ENERGY STAR rebate policies in the US. Energy Effic. 9, 677–698. https://doi.org/10.1007/s12053-015-9386-7

Davis, L.W., Metcalf, G.E., 2016. Does Better Information Lead to Better Choices? Evidence from Energy-Efficiency Labels. J. Assoc. Environ. Resour. Econ. 3, 589–625. https://doi.org/10.1086/686252

de Ayala, A., Foudi, S., Solà, M. del 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 Effic. 14, 3. https://doi.org/10.1007/s12053-020-09921-0

Deutsch, M., 2010. Life Cycle Cost Disclosure, Consumer Behavior, and Business Implications. J. Ind. Ecol. 14, 103–120. https://doi.org/10.1111/j.1530-9290.2009.00201.x

Galarraga, González-Eguino, Markandya, 2011a. 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

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

Galarraga, I., Abadie, L.M., Ansuategi, A., 2013. Efficiency, effectiveness and implementation feasibility of energy efficiency rebates: The "Renove" plan in Spain. Energy Econ., Supplement Issue: Fifth Atlantic Workshop in Energy and Environmental Economics 40, Supplement 1, S98–S107. https://doi.org/10.1016/j.eneco.2013.09.012

Gerarden, T.D., Newell, R.G., Stavins, R.N., 2017. Assessing the Energy-Efficiency Gap. J. Econ. Lit. 55, 1486–1525. https://doi.org/10.1257/jel.20161360

Greene, D.L., 2011. Uncertainty, loss aversion, and markets for energy efficiency. Energy Econ., Special Issue on The Economics of Technologies to Combat Global Warming 33, 608–616. https://doi.org/10.1016/j.eneco.2010.08.009

Hoffmann, C., Thommes, K., 2020. Can digital feedback increase employee performance and energy efficiency in firms? Evidence from a field experiment. J. Econ. Behav. Organ. 180, 49–65. https://doi.org/10.1016/j.jebo.2020.09.034

Houde, S., Aldy, J.E., 2017. Consumers' Response to State Energy Efficient Appliance Rebate Programs. Am. Econ. J. - Econ. Policy 9, 227–255.

Jaffe, A., Stavins, R., 1994. The energy paradox and the diffusion of conservation technology. Resour. Energy Econ. 16, 91–122.

Kallbekken, S., Sælen, H., Hermansen, E.A.T., 2013. Bridging the Energy Efficiency Gap: A Field Experiment on Lifetime Energy Costs and Household Appliances. J. Consum. Policy 36, 1–16. https://doi.org/10.1007/s10603-012-9211-z

Krutwig, M.C., Tanțău, A., 2018. Obligatory versus voluntary energy audits: are there differences in quality? Proc. Int. Conf. Bus. Excell. 12, 522–532. https://doi.org/10.2478/picbe-2018-0047

Labandeira, X., Labeaga, J.M., Linares, P., López-Otero, X., 2020. The impacts of energy efficiency policies: Meta-analysis. Energy Policy 147, 111790. https://doi.org/10.1016/j.enpol.2020.111790

Li, X., Clark, C.D., Jensen, K.L., Yen, S.T., 2016. The Effect of Mail-in Utility Rebates on Willingness-to-Pay for ENERGY STAR Refrigerators. Environ. Resour. Econ. 63, 1–23. https://doi.org/10.1007/s10640-014-9833-5

Linares, P., Labandeira, X., 2010. Energy Efficiency: Economics and Policy. J. Econ. Surv. 24, 573–592. https://doi.org/10.1111/j.1467-6419.2009.00609.x

Olsthoorn, M., Schleich, J., Gassmann, X., Faure, C., 2017. Free riding and rebates for residential energy efficiency upgrades: A multi-country contingent valuation experiment. Energy Econ., Seventh Atlantic Workshop in Energy and Environmental Economics 68, 33–44. https://doi.org/10.1016/j.eneco.2018.01.007

Organización de Consumidores y Usuarios, 2020. Electrodomésticos: las marcas más duraderas y fiables. OCU.

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

Skourtos, M., Damigos, D., Tourkolias, C., Kontogianni, A., 2021. Efficient energy labelling: the impact of information content and style on product choice. Energy Effic. 14, 58. https://doi.org/10.1007/s12053-021-09950-3

Solà, M. del M., de Ayala, A., Galarraga, I., 2021. The Effect of Providing Monetary Information on Energy Savings for Household Appliances: A Field Trial in Spain. J. Consum. Policy. https://doi.org/10.1007/s10603-021-09483-3

Solà, M. del M., de Ayala, A., Galarraga, I., Escapa, M., 2020. Promoting energy efficiency at household level: a literature review. Energy Effic. 14, 6. https://doi.org/10.1007/s12053-020-09918-9

Sorrell, S., Scott, S., Schleich, J., 2004. The Economics Of Energy Efficiency: Barriers to Cost-Effective Investment. Edward Elgar Pub, Cheltenham ; Northampton, Mass.

Stadelmann, M., Schubert, R., 2018. How Do Different Designs of Energy Labels Influence Purchases of Household Appliances? A Field Study in Switzerland. Ecol. Econ. 144, 112–123. https://doi.org/10.1016/j.ecolecon.2017.07.031

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

Waechter, S., Sütterlin, B., Siegrist, M., 2015. The misleading effect of energy efficiency information on perceived energy friendliness of electric goods. J. Clean. Prod. 93, 193–202. https://doi.org/10.1016/j.jclepro.2015.01.011

Yeomans, M., Herberich, D., 2014. An experimental test of the effect of negative social norms on energy-efficient investments. J. Econ. Behav. Organ. 108, 187–197. https://doi.org/10.1016/j.jebo.2014.09.010

Annex A

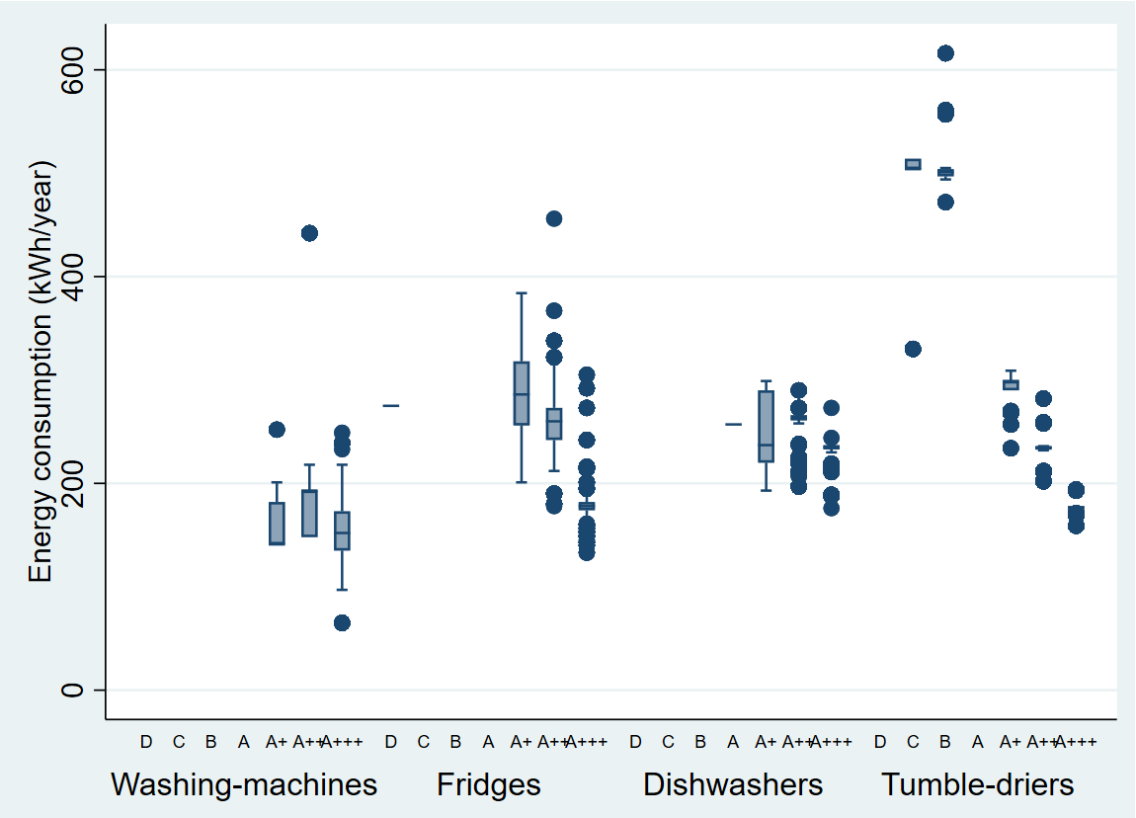

Figure A1: Distribution of the household appliances sold during the field experiment.

Table A1: Descriptive statistics.

Washing-machines	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Capacity (kg)	25,554	8.044435	0.9457208	4	17
Water consumption (L)	25,554	10025.57	817.7853	6400	17000
Income (in the area where the store is located)	25,554	31127.77	7579.388	18332	45159
Price (€)	24,311	579.0299	207.0885	229	2349
Fridge	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Height (mm)	17,911	1936.627	95.51165	734	2040
Capacity- Volume of the freezer (L)	17,911	92.68226	11.38256	21	289
Income (in the area where the store is located)	17,911	31368.67	7493.066	18332	45159
Price (€)	11,097	929.2723	296.8308	379	6229
Dishwashers	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Width (=1 if the size is 600 mm)	16,093	582.9988	47.55289	450	600
Number of services	16,093	13.07078	1.518393	9	16
Water consumption (L)	16,093	2846.01	331.8684	1820	3920
Income (in the area where the store is located)	16,093	31518.98	7705.54	18332	45159
Price (€)	9,418	584.7331	175.7439	269	1545
Tumble drier	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Type of tumble-drier	6,976	0.2822534	0.5496487	0	2
Income (of the zone where the centre is located)	6,976	30641.4	8052.981	18332	45159
Price (€)	5,881	787.6103	234.8268	249	1649

Table A2: Average prices per EE level and period. The highest catalogue prices per product category and EE level are marked in bold (NB: not all products are priced here. We searched for prices on the official website of the store, and several models did not appear there).

Washing-machine	**A+++**	**A++**	**A+**	**A**	**Overall**
Trat 1	572.73€ N=4731	459.63€ N=87	506.77€ N=18	.	570.45€ N=4836
Trat 2	585.54€ N=3634	644.46€ N=50	464€ N=2	.	586.37€ N=3686
Control	581.09€ N=15591	499.88€ N=177	419€ N=21	.	579.96€ N=15789
Overall	590.11€ N=23956	511.75€ N=314	459.73€ N=41	.	579.02€ N=24311
Fridge	**A+++**	**A++**	**A+**	**A**	**Overall**
Trat 1	1107.84€ N=955	857.72€ N=1576	577.27€ N=133	.	933.38€ N=2664
Trat 2	1095.70€ N=649	831.01€ N=774	531.12€ N=33	.	942.20€ N=1456
Control	1069.90€ N=2678	846.89€ N=4073	615.68€ N=226	.	925.00€ N=6977
Overall	1082.27€ N=4282	847.63€ N=6423	595.53€ N=392	.	929.27€ N=11097
Dishwasher	**A+++**	**A++**	**A+**	**A**	**Overall**
Trat 1	703.07€ N=472	540.91€ N=1234	448.82€ N=275	.	566.76€ N=1981
Trat 2	735.02€ N=372	550.27€ N=958	441.16€ N=284	.	573.65€ N=1614
Control	761.96€ N=1475	557.71€ N=3428	459.37€ N=920	.	593.91€ N=5823
Overall	745.65€ N=2319	552.75€ N=5620	453.91€ N=1479	.	384.73€ N=9418

Tumble-drier	**A+++**	**A++**	**A+**	**A**	**B**	**C**	**Overall**
Trat 1	1111.20€ N=183	802.24€ N=433	703.54€ N=11	.	512.39€ N=76	281.7€ N=10	841.82€ N=713
Trat 2	1834.61€ N=253	761.14€ N=467	684.62€ N=16	.	460.91€ N=45	265.37€ N=8	825.13€ N=789
Control	1025.34€ N=995	771.44€ N=2608	657.47€ N=59	.	456.55€ N=624	266.02€ N=93	772.02€ N=4379
Overall	1038.03€ N=1431	773.87€ N=3508	668.41€ N=86	.	462.51€ N=745	267.38€ N=111	787.61€ N=5881

Annex B

The training of sales staff consisted of various points. The idea was to cover all possible levels of knowledge of EE issues and household appliances. The structure was the following:

1. Main concepts of the field experiment (e.g. treatments)
2. Calendar of the field experiment
3. Training session:
    a. Introduction. Basic knowledge of EE. What is EE? Different EE levels.
    b. How are the EE levels of the appliances under study (washing-machines, fridges and dishwashers) calculated?
    c. Why are there appliances which have the same EE level but different energy consumptions?
    d. What are the main assumptions made in estimating average energy consumption under the EU EE label?
    e. How are monetary lifetime energy savings estimated for each appliance (washing-machine, fridge, dishwasher)?
    f. What energy price is used for these estimations?
    g. What lifetime is used in estimating monetary lifetime energy savings?
4. Supplementary information. Tables with estimated monetary information. This part is mainly devoted to showing how the tables with the LEC could be used.

BC3 WORKING PAPER SERIES

Basque Centre for Climate Change (BC3), Bilbao, Spain

The BC3 Working Paper Series is available on the internet at the following addresses:

http://www.bc3research.org/lits_publications.html

http://ideas.repec.org/s/bcc/wpaper.html

BC3 Working Papers recently available:

2016-03 Anil Markandya, Kishore Dhavala and Allesandro Palma: *The role of flexible biofuel policies in meeting biofuel mandates.*

2016-04 Stefano Balbi and Ferdinando Villa: *Beyond ecosystem services: a food security perspective*.

2016-05 María Victoria Román, Iñaki Arto and Alberto Ansuategi: *The geographic distribution of the economic impact of climate finance.*

2017-01 Marta Olazabal, Ibon Galarraga, James Ford, Alexandra Lesnikowsky and Elisa Sainz de Murieta: *Towards successful adaptation: a check list for the development of climate change adaptation plans.*

2017-02 Itxaso Ruiz, Sérgio H. Faria and Marc B. Neumann: *Drivers of climate change opinion*.

2017-03 Stefano Balbi: *Traveling for happiness, moving to adapt: An agent-based perspective on population mobility.*

2017-04 Xaquin Garcia-Muros, Christoph Böhringer and Mikel Gonzalez-Eguino: *Cost-effectiveness and incidence of alternative mechanisms for financing renewables.*

2018-01 Ibon Galarraga, Josu Lucas and Steffen Kallbekken: *Consumer purchases of energy-efficient cars: behavioural implications for policy.*

2018-02 Federica Cappelli, Caterina Conigliani, Valeria Costantini, Keti Lelo, Anil Markandya, Elena Paglialunga and Giorgia Sforna: *Climate Change and Armed Conflicts African Observatory (CACAO): a georeferenced map of Africa.*

2019-01 Elena Galán del Castillo: *Revisión sistemática de los efectos del paso a un ordeño al día en pequeños rumiantes.*

2020-01 María del Mar Solà, Amaia de Ayala and Ibon Galarraga: *The effect of providing monetary information on energy savings for household appliances: a field trial in Spain*.

2020-02 Ambika Markanday, Steffen Kallbekken and Ibon Galarraga: *Impact framing and experience for determining acceptable levels of climate change risk: A lab experiment.*

2021-01 João Pompeu, Itxaso Ruiz, Antonio Ruano, Hugo Bendini and María José Sanz*: Land use and land cover databases for Mediterranean landscape analysis at the watershed scale*.

2021-02 Gonzalo Morcillo and Sérgio Henrique Faria*: Procesos visibles de la transición del hielo superficial con burbujas a hielo profundo con clatratos en el testigo EDML de Antártida*.

2021-03 María del Mar Solà, Marta Escapa and Ibon Galarraga: *Effectiveness of monetary information in promoting the purchase of energy-efficient appliances: evidence from a field experiment at a major retailer in Spain.*