
# DELIVERABLE No 3.4
# Report on energy literacy and consumers' purchase of energy-efficient appliances

Due date of deliverable: August 2018

Actual submission date: May 2019

Start date of project: 01/09/2016 Duration: 36 month

Organisation name of lead contractor for this deliverable: ETH Zürich

| Project co-funded by the European Commission within the Seventh Framework Programme | | |
|---|---|---|
| Dissemination level | | |
| PU | Public | x |
| PP | Restricted to other programme participants (including the Commission Services) | |
| RE | Restricted to a group specified by the consortium (including the Commission Services) | |
| CO | Confidential, only for members of the consortium (including the Commission Services) | |

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 723791.

# Report on energy literacy and consumers' purchase of energy-efficient appliances

Nina Boogen[a]
Giovanna d'Adda[b,c]
Claudio Daminato[a]
Massimo Filippini[a,d]
Yu Gao[e]
Lorenz Goette[f]
Adrian Obrist[a]
Massimo Tavoni[c,g]

[a] ETH Zürich
[b] Università degli Studi di Milano
[c] EIEE-CMCC
[d] Università della Svizzera italiana
[e] Peking University
[f] University of Bonn
[g] Politecnico di Milano

## Table of Contents

# Executive summary


- We conduct two randomized field experiments to investigate the role of limited knowledge about the energy costs of using durables on consumers' actual purchase decisions.
- In a first experiment conducted in Switzerland, we collected data on the efficiency of existing appliances and light bulbs at home of some households, and then sent them a letter with personalized information about the potential of monetary savings they could achieve by using energy efficient appliances and light bulbs, compared to the existing ones.
- Using data on actual purchase decisions of 661 households, we find a relevant impact of the informational intervention. Our results show that the intervention induces households to purchase new home appliances that consume on average 18 percent less electricity consumption compared to the households in the control group. Moreover, households receiving the informational treatment significantly increase the purchase of energy efficient light bulbs.
- In a second experiment carried out in collaboration with an Italian online retailer, we test the impact of making the energy usage cost of household appliances more salient. Treatments vary whether information on the yearly or lifetime energy cost of appliances is provided alongside the standard energy class and consumption in kWh information.
- Using data on 20,371 visitors to the website refrigerators' pages and 6,441 orders, we find that making appliances' energy costs salient leads to a shift in purchases from more to less efficient products.
- These findings suggest that the effectiveness of policies that aim at increasing the adoption of energy efficient technologies by correcting the potential limited knowledge of consumers about the energy costs of using these durables strongly reliers on how the information is provided.
- Together, these studies support the design and implementation of decision support tools that allow consumers to easily obtain an estimate of the monetary savings they could achieve by investing in energy efficient technologies, compared to the existing energy consuming durables they have at home.

# Summary for Policymakers

Although some investments in energy efficient electrical appliances, heating systems or energy efficient home renovations may ensure net monetary savings over their lifetime, households often fail to make these investments. As a possible explanation for this phenomenon, the economic literature has suggested that consumers may have limited information about the energy costs of the energy-consuming durables when taking the decision of purchase. However, the existing empirical studies provide inconclusive evidence about the role of imperfect information about energy costs on the households energy-consuming durable purchases. In this report, we present results from two randomized field experiments that aim at testing the impact of providing information about the energy costs of using durables on consumers' actual purchase decisions.

In the first experiment, the authors conduct a randomized field experiment with 661 households in Switzerland to investigate the effect of providing tailored information about the potential of monetary savings (reduction of energy costs) from adopting efficient energy-consuming durables on households' actual decisions of purchase. In a first phase, we organized some visits at the participants' home to collect information on the electricity consumption of the existing home appliances and lighting. After the in-home visits, we sent a report to the participants with individualized information about the potential monetary savings from the adoption of new comparable efficient appliances and light bulbs. One year later, we asked the treated households whether they purchased any new home appliances or light bulbs and, in this case, the characteristics of the newly purchased durables. Comparing the actual choices of purchase of treated households with those of a control group after the information treatment, we find a relevant impact of our intervention. Our results show that the intervention induces households to purchase new home appliances that consume on average 18 percent less electricity consumption compared to the households in the control group. Moreover, providing information about the energy cost of light bulbs increases the probability that households purchase (at least) one energy efficient light bulb by around 9 percentage points.

In the second experiment, the authors conduct a large scale field experiment, in collaboration with a large Italian online retailer, measuring the impact of making more salient the energy usage cost of household appliances, namely refrigerators. Customers viewing the website refrigerator pages during the study period were randomly assigned to one of the three conditions. Treatments vary whether information on the yearly or lifetime energy cost of appliances is provided alongside the standard energy class and consumption in kWh information. The control group presents the default product visualization of the retailer, with no information on energy usage costs, but only the standard energy class label. We observe the impact of the treatments on purchases and search behavior. Using data on 20,371 visitors to the website refrigerators' pages and 6,441 orders, we find that making appliances' energy costs salient leads to a shift in purchases from more to less efficient products. This effect is concentrated among clients shown appliances' lifetime energy cost. Treatments also increase the number of product pages viewed and the time spent on them by customers, a result driven by products in lower energy classes.

The results of these two experiments inform policy makers that providing information about the energy costs of energy-consuming durables does have an impact on households' choices of purchase. The provision of tailored information, through a letter sent at home, about the monetary savings from using energy efficient appliances, compared to the existing ones, increased the adoption of energy efficient durable goods. On the contrary, information on energy usage cost of appliances provided directly at the point of sale (online retailer) decreased the adoption of energy efficient durable goods. This highlights that, in the case of information policies, what matters is not only the informational content but also the way in which the information is presented.

On the one hand, this study suggests that providing households with information on the potential of monetary savings (versus energy costs) is more effective in driving households' investments in energy efficiency. On the other hand, individualized information provision that builds on the current stock of durables and that is made available to the households at home seems to be more effective than information treatments at the point of sale. Together, these studies support the design and implementation of decision support tools that allow consumers to easily obtain an estimate of the monetary savings they could achieve by investing in energy efficient technologies, compared to the existing energy consuming durables they have at home. Moreover, the results of this study suggest that, while providing information about the energy costs of using durables may result in a higher ability of consumers to take optimal decisions from a private perspective, it might also induce consumers to make suboptimal choices from a social perspective, depending on the consumers' characteristics and the features of the institutional contexts in which these decisions are taken.

Generally, we should be cautious in interpreting the results of experiments conducted with a specific sample of Italian and Swiss households, to the overall Europe. Consumers' preferences, households' socio-economic characteristics and institutational features can be substantially heterogeneous across European countries and are likely to influence the way in which consumers respond to the informational interventions considered in this study. Future research should then try to complement the findings of this work by testing the impact of the information treatments in different countries and targeting a larger sample of individuals. Moreover, future research should try to understand which households (e.g., high vs lower income earners) are more or less likely to respond to the informational intervention. A limitation of this study is that the sample size in the first experiment is not large enough to carry out a sound investigation of the heterogeneity of the effects of the intervention. Another limitation of this study is that the short period considered after the informational intervention does not allow to study the medium-to-long term effects on consumers behavior. Future research should then investigate whether such informational interventions permanently modify households behavior of purchase of new durables or only induce short term responses.

# Chapter 1 – The role of monetary information on Energy Efficiency: Experimental evidence from consumers durable choices

Nina Boogen[a], Claudio Daminato [a], Massimo Filippini [a,b] and Adrian Obrist[a]

[a] ETH Zürich, Centre for Energy Policy and Economics

[b] Università della Svizzera Italiana

## 1. Introduction

Several studies have documented a large potential for energy efficiency improvements in the residential sector (among others McKinsey & Company 2009; Filippini and Hunt 2011; Alberini and Filippini 2018). However, even though some investments in energy efficient electrical appliances, heating systems or energy efficient home renovations ensure net monetary savings over their lifetime, households often fail to make these investments (Allcott and Taubinsky, 2015). This phenomenon is referred to as the energy efficiency gap (Jaffe and Stavins, 1994). As potential determinants of the energy efficiency gap, the literature has discussed various market and behavioural anomalies (Broberg and Kazukauskas, 2015; Gillingham and Palmer, 2014). Recent studies have highlighted the importance of lack of cognitive skills and knowledge about the costs of energy use as barriers to energy-efficient investments (Blasch et al., 2018; Brent and Ward, 2018).

We explore the role of limited knowledge about the monetary costs of energy use in the consumers' valuation of energy efficiency. On the one hand, limited knowledge might induce households to keep using existent energy-consuming durables even when their replacement with more energy efficient durables would decrease the total costs of producing energy services over the households' life cycle. On the other hand, conditional on the decision of purchase of a new energy-consuming durable, consumers that under-(over-)estimate the monetary costs of energy use might tend to under-(over-) invest in energy efficient technologies. Whether lack-of knowledge about energy cost affects the consumers' valuation of energy efficiency is still debated in the literature. While some previous empirical studies confirm that a lack of information leads to underinvestment in energy efficiency (Ward et al., 2011; Newell and Siikamäki, 2014; Davis and Metcalf, 2016; Houde, 2018), few recent studies do not find that providing more information affects investment decisions (Allcott and Sweeney, 2016; Allcott and Greenstone, 2017; Allcott and Knittel, 2019).

Our goal in this work is to investigate whether information provision about the monetary savings (reduction of energy costs) from the adoption of efficient energy-consuming durables affects either the decisions of purchase of home appliances and lighting, or the level of energy efficiency of the newly purchased durables, or both. To answer this question, we conducted a randomized field experiment with 661 households to investigate the effect of tailored information provision about the potential of monetary savings from adopting efficient technologies. Using in-home visits, we collected information on the electricity consumption of

the participants' existing home appliances and lighting. We then sent them a report with individualized information about the potential monetary savings from the adoption of new comparable efficient appliances and light bulbs. The experimental setting allows us to compare the actual choices of purchase of households in the treatment and control groups to draw conclusions about the impact of the intervention.

Using detailed information about existing home appliances and light bulbs at home, as well as the energy-consuming durable choices of the participanting households, we find a relevant impact of our intervention. In fact, while the information treatment does not affect the probability for households to purchase a new home appliance, we find a substantial response of households in terms of the electricity consumption of the newly purchased home appliances. In particular, the intervention induces households to purchase home appliances that consume on average 18 percent less electricity consumption compared to the households in the control group. We also find evidence of an increase in the probability for households to purchase a new light bulb following the information treatment.[1] Moreover, conditional on the decision of purchasing a new light bulb, the intervention increases the probability that households purchase (at least) one energy efficient light bulb by around 9 percentage points.

This paper is closely related to a growing body of literature that studies the determinants of consumers' undervaluation of energy efficiency (among others Davis and Metcalf 2016; Houde 2018; Allcott and Knittel 2019). We contribute to this literature by providing experimental evidence about the impact of tailored monetary information on the adoption of energy efficient technologies. To the best of our knowledge, this is the first work that analyses the impact of providing tailored information about the monetary savings from the adoption of efficient technologies on actual purchase decisions.

The remainder of this chapter in the report is organized as follows. Section 2 describes the experimental design and the information treatment. In Section 3 we present descriptive statistics from the experimental data. Section 4 presents the empirical results. Section 5 concludes.

[1] Clearly, this might reflect either an increase in the replacement of old light bulbs as well as an increase in the total stock of light bulbs at home.

## 2. Experimental design

The aim of this Section is to provide an overview of the experimental design that we use to investigate the role of limited knowledge about the energy costs on households energy-consuming durable choices. We administered a randomized control trial in collaboration with two local utilities in Switzerland (Aziende Industriali di Lugano and Stadtwerk Winterthur). The goal was to provide a group of households with infomation about the potential of monetary savings that they could achieve by purchasing energy-efficient durable goods. Table 1 reports a sketch of the experimental design.

A subgroup of customers of these two utilities has been randomly allocated to treatment and control groups. In 2017, we sent a letter with an invitation to take a baseline survey to the customers allocated to the treatment group. The survey collected detailed information about demographic characteristics as well as energy-related knowledge of the participants. At the end of the survey, the participants were offered to receive a free basic energy audit about the energy efficiency of the major home appliances and lighting. This was implemented in two steps: (i) an in-home visit during which a research assistant collected information on the energy efficiency of the existing major appliances (fridge, separate freezer, dishwasher, washing machine and clothes dryer) and lighting;[2] (ii) delivery of a report with information about the potential of monetary savings on the electricity bill coming from the adoption of energy efficient appliances and light bulbs.

During the in-home visit, the research assistants briefly explained the purpose of the visit (collecting data on the existing home appliances and light bulbs), without providing specific information to the participants about the existing appliances or suggestions about how to improve the energy efficiency of the home appliances or lighting. We used the information collected during the in-home visits to recover data on the energy efficiency of the existing appliances of the participants. For each appliance, we then collected information about a comparable new appliance available on the market at the time of the audit which satisfies high energy efficiency standards (energy label A++ and A+++). We used this information to compute the appliance-specific potential of monetary saving coming from the adoption of a new energy efficient appliance.

Following the in-home visits, the households allocated to the treatment group received information about the potential of savings they could achieve by replacing their existing home appliances with energy efficient ones and from the purchase of energy efficient light bulbs. The information provision to the participants has been implemented in two ways: (i) we sent them a letter via regular mail with a brief report of the energy audit; (ii) we sent an email inviting them to access a website with similar information to that included in the report sent via regular mail. All participants in the treatment group received both the letter and the invitation to access the website. The information provided through the website was similar to that included in the letter sent via regular mail, with the difference that the information about the potential of saving coming from the adoption of a new energy efficient appliance was based on the intensity of usage of each appliance selected by the participants.

No customer of the utilities allocated to the control group was contacted with reference to the research project in 2017. In the fall of 2018 (between October 2018 and January 2019), the same selection process was implemented for the customers in the control group: they received an invitation letter to take the same baseline survey followed by an invitation to receive the in-home visit. During the in-home visit, participants in the control group was also asked about the decisions of purchase of

[2] The research assistants were instructed to take pictures of the nameplates of the major home appliances and count the number of the light bulbs at home, distinguishing between halogen, energy-saving and LED bulbs.

Table 1: Experimental design

| | *T = 0* | *T = 1* |
|---|---|---|
| *Treated* | Baseline survey<br>In-home visit<br>Information treatment | Follow-up survey |
| *Control* | | Baseline survey<br>In-home visit<br>Survey on past purchases |

energy-consuming durables taken in the previous year.

In February 2019, we carried out a follow-up survey to the participants in the treatment group asking about their decisions of purchase following the information treatment. This research design allows us to collect detailed information about the energy consumption of the major home appliances and the energy efficiency of lighting at home, as well as the efficiency of the newly purchased durables, for both control and treatment groups.

We exploit the experimental design to simply compare the decisions of purchase of treated and control group in the post-treatment period. Thanks to the random assignment, we can conclude that any differences in the choices between the two groups that we might observed in the post-treatment period come from the information treatment.

## *2.1 Timing and attrition patterns*

Table 2 presents a summary of the different steps of the experiment and the attrition patterns. The analysis of these patterns can help rule out the potential bias that would arise in the presence of differential attrition between households in the treatment and control groups for which we observe the purchase decisions in the post-treatment period.

The two utilities agreed to provide the contacts of 40000 households, randomly selected among their customers, to take part to the experiment (20000 from AIL and 20000 from SW). These customers were randomly allocated between the treatment (29000 households) and the control group (11000 households).[3] Between April and September 2017, the households allocated to the treatment received an invitation to take a baseline survey on aspects related to energy behavior which was completed by around 5.43% of the households that we contacted (1575 households). At the end of the survey, the participants have been offered to receive a free basic energy audit about the energy efficiency of the major home appliances and lighting. Among those who completed the survey, around 70% of the households (1106) informed us that they were interested in receiving the basic energy audit and provided us with their contact details.

We contacted these households to schedule an appointment for the in-home visit between October 2017 and January 2018. Around 46% of the households that provided us with their contact details booked and received the in-home visit (510 households). Around 87% of the households that received the information treatment completed the follow-up survey one year later.

The attrition rates observed for the control group are similar to those observed for the treatment group, at each step of the

[3] The treatment group included 14000 customers of AIL and 15000 customers of SW.

Table 2: Participation and attrition patterns

| Timeline | | |
|---|---|---|
| March 2017 | Allocation to treatment and control groups | |
| | **Control** *(N=11,000)* | **Treated** *(N=29,000)* |
| April - September 2017 | | Baseline survey *(N=1,575) completed survey* *(N=1,106) want to take the audit* |
| October 2017 - January 2018 | | In-home visits *(N=510) booked and received in-home visit* |
| February 2018 | | Letters sent *(N=510)* |
| June 2018 | | Invitation to Website access *(N=510)* |
| September 2018 | Baseline survey *(N=638) completed survey* *(N=424) want to take the audit* | |
| October 2018 - January 2019 | In-home visits and survey on past purchases *(N=219) booked and received in-home visit* | |
| February 2019 | | Follow-up survey *(N=443)* |

experiment. In fact, the share of households that completed the baseline survey among those contacted in the control group is 5.8% (which compares to the 5.43% observed for the treatment group). Moreover, around 66% of the households in the control group informed us that they were interested in receiving the basic energy audit and provided us with contact details, among those that completed the baseline survey (which compares to the corresponding figure of 70% observed for the treatment group). Finally, the share of households in the control group that actually booked and received the in-home visit among those that provided us with their contact details is 51%, similar to the 46% observed for the treatment group.

Our final experimental sample includes information on 442 households in the treatment group and 219 households in the control group.

## *2.2 Implementation*

In this Section we describe how we organized the implementation of the in-home visits, and how we used the information collected during the visits to build a dataset with data on the energy efficiency of the existing energy-consuming durables of the participants.

**The in-home visits** Several steps have been taken towards the implementation of the in-home visits. Before starting the visits, we discussed with experts from the utilities and the Swiss association of appliances producers (Fachverband Elektroap-

parate für Haushalt und Gewerbe Schweiz - FEA) to identify an effective and feasible way to obtain information related to the energy efficiency of the appliances during the in-home visits. We concluded that a reliable measurement of the electricity consumption of the existing appliances could be obtained, during a short in-home visit, by collecting data on the appliances' brand, model number, serial number (nameplate), energy label and dimensions or capacity. We restricted the data collection to the major home appliances (fridge, freezer, dishwasher, washing machine, tumble dryer), representing the most energy-intensive consuming durables in the residential sector. Also, we limited the collection of information about lighting at home to the number of halogen, energy saving and LED light bulbs.

The project participants have been divided in several groups based on their living area in the city of Winterthur and district of Lugano. Every two weeks, a group of participants was contacted to schedule an appointment at their residence with one of our research assistants. The reservation of each participant's slot for the in-home visit was managed using Setmore (1 hour slots within auditors stated availability). A reservation notification was sent to the research assistant directly following the participant's reservation.

The in-home visits were carried out by research assistants that we hired among bachelor and master students with a background in economics or engineering in Lugano and Zurich. The research assistants were trained about the project goals, the expected behavior with the participants during the in-home visits (e.g., no advice related to purchase decisions to improve the energy efficiency has been given to the participants by the research assistants), and the process of data collection. They received a training manual with detailed information on the project background, definition of auditing standards, process of scheduling of audits, energy audit process, explanation of characteristics to be collected the large home appliances and lighting. The training of the research assistants included an instruction meeting and pilot audits organized in collaboration with the partner utilities.

During the in-home visit, our research assistants were instructed to briefly explain that the purpose of the visit was to collect information on the existing home appliances and light bulbs. The data collection was carried out by the research assistants using an online survey that we designed with questions about brand, model, serial number, energy label of each major appliance, as well as the number of halogen, energy saving and LED light bulbs, using a tablet and the platform Epicollect. We also allowed for the possibility to include pictures of the appliances' nameplates directly on the survey taken with this paltform. The information collected during the visit was initially stored locally on the tablets we provided to the research assistants, and then uploaded daily on the servers of the research institute. Each in-home visit lasted between 15 and 30 minutes, depending on the characteristics of the participants' residence.

**Recovery of the information on the electricity consumption of the existing home appliances** We used the information collected during the in-home audits to recover data on the electricity consumption of the existing appliances of the participants. The following procedure has been adopted to determine the electricity consumption of the appliances: (i) use the nameplate number to identify the energy consumption indicated by the producer; (ii) in case the nameplate number was not available, or it was not possible to recover the electricity consumption declared by the producer from the nameplate number (relevant for old appliances), an estimation of the consumption of the appliances was obtained through the database Compareco

(https://www.compareco.ch), using information about the year of purchase and other appliances characteristics.[4]

For each appliance, we then collected information about the electricity consumption of comparable new appliances available on the market at the time of the in-home visit with high energy efficiency standards (energy label A++ and A+++). The matching between the existing appliances at home and the alternatives on the market was performed based on the physical characteristics (height, width, capacity, volume) of the appliances. The information collected this way were used to compute the appliance specific potential of saving coming from the adoption of a new energy efficient appliance.

## *2.3 Information provision*

Following the in-home visit, the participants in the treatment group received an informational intervention, which consisted of two parts: (i) in February 2018, we sent them a letter via regular mail with a brief report about the electricity consumption of their existing appliances and lighting, and the potential monetary savings from the adoption of comparable energy efficient durables available in the market; (ii) in June 2018, we sent an email offering them to access a website with similar information to that included in the report sent via regular mail. All participants in the treatment group received both the letter and the invitation to access the website. No customer of the utilities allocated to the control group was contacted with reference to the research project at this time.

In both the letter and the website, we provided participants with a brief report about the energy efficiency of each of their existing major electrical appliances, and the potential of monetary savings coming from the adoption of new efficient appliances available on the market. To facilitate the participants' understanding of its content, the report also included a brief description of the information included.

An example of the information content for a washing machine, as presented in the letter, is included in Figure 1. The tables for home appliances contained information about the electricity consumption (in kWh) of each existing appliance, the corresponding monetary costs (in CHF), and the annualized operative costs. The appliance-specific information varied depending on the type of appliance. While we provided information on the annual electricity consumption and corresponding operating costs for fridges and freezers, an estimate of the electricity consumption per cycle and corresponding monetary costs was provided for dish washers, washing machines and tumble dryers. The annualized operating costs of dish washers, washing machines and tumble dryers have been computed using the number of cycles hypothesized in the calculation of the European energy labels (280, 220 and 160 cycles per year for dishwashers, washing machines and clothes dryers, respectively). Second, for each appliance, we reported information about the electricity consumption (in kWh), corresponding monetary cost (in CHF) and annualized operative costs of two comparable alternative appliances available on the market with two levels of efficiency standard (A++ and A+++), as well as a range of prices at which it was possible to purchase such appliances. Finally, we provided information about the potential monetary savings on the operating costs associated to the purchase of an appliance with energy label A++ and A+++, compared to the existing appliance.

[4] Information about the appliances' energy label was available for only a small fraction of the appliances. To avoid issues related to the lack of comparability between the consumption reported by the producers' manuals and the energy label, we did not use the information from the energy label even when available.

Figure 1: Information provision, appliances

## Washing machine

Characteristics of your appliance: Producer: Miele, Width: 60 cm, Height: 85 cm, Year of purchase: unknown

| | Your appliance | Alternative appliance on the market (load capacity of 8 kg) | |
|---|---|---|---|
| | | A++ | A+++ |
| Consumption per cycle | 1.020 kWh | 1.170 kWh | 0.470 kWh |
| Cost of one cycle | 0.204 CHF | 0.234 CHF | 0.094 CHF |
| Annual operating costs[ii] | 45 CHF | 51 CHF | 21 CHF |
| Approximate price range of new appliances | | 725-2309 CHF | 440-4099 CHF |
| Estimate of potential annual savings on operating costs (compared to current appliance) | | No savings | 24 CHF |

[ii] The annual operating costs for the washing machine are estimated assuming 220 cycles.

- You can save an estimated CHF 24.- per year in electricity costs by replacing your washing machine with a new A+++ appliance.

The information content related to lighting was organized in two parts, as shown in Figure 2. First, we provided information about the number of light bulbs at the participant's home, distinguishing between halogen, energy saving and LED bulbs. For each type of light bulbs, we provided an estimate of both the annual electricity consumption for each light bulb and the total electricity consumption for lighting considering the number and efficiency of the existing light bulbs. Second, we provided an estimate of the monetary savings potential from the replacement of the existing halogen bulbs with either energy saving bulbs or LED bulbs. The saving potential was reported both in terms of the annual electricity expenditure for lighting as well as in total costs of electricity in 10 years.[5]

The information provided through the website was similar to that included in the letter sent via regular mail, with the difference that the information about the potential of saving coming from the adoption of a new energy efficient appliance was based on the intensity of usage selected by the participants for dishwasher, washing machine and tumble dryer. The members of the treatment group have been contacted via email and invited to access the Website where they could obtain more personalized information about the potential of savings coming from the adoption of a new appliance. To access their personal information on the Website, participants were required to follow a simple registration procedure using their customer number.

[5] Total costs of electricity included the cost of purchase of the light bulbs and was normalized over 10 years to take into account the different lifetimes of each light bulb type (assumed to be 2, 10 and 15 years for halogen, energy saving and LED bulbs, respectively).

Figure 2: Information provision, lighting

| Lighting | | | |
|---|---|---|---|
| | **Halogen** | **Energy Saving** | **LED** |
| Total number of light bulbs | 29 | 13 | 5 |
| Annual cost per light bulb [iv] | 8.51 CHF | 2.22 CHF | 1.11 CHF |
| Total annual costs | 247 CHF | 29 CHF | 6 CHF |
| Price of the light bulb | 4 CHF | 6 CHF | 5 CHF |
| Lifetime | 2 years | 10 years | 15 years |
| Total cost of one bulb for 10 years | 105 CHF | 28 CHF | 14 CHF |
| Estimated annual saving in Francs for each Halogen light bulb replaced | - | 6.29 CHF | 7.40 CHF |

[iv] The estimation of the annual electricity consumption for each light bulb has been performed assuming the usage of light bulbs that exhibit similar luminosity (700 lm) and light color (2500 K). This corresponds to a capacity of 46 W for halogen, 12 W for energy saving and 6 W for LED light bulbs. Additionally, it was assumed that every light bulb was used for 1000 hours per year.

- We estimate that you can save approximately CHF 215.- in annual electricity costs by replacing your 29 Halogen light bulbs with LED bulbs!
- If you replace your 29 Halogen bulbs with LED bulbs, you can save approximately CHF 2639.- in total electricity costs for lighting in 10 years!

# 3. Data

We combine data coming from the energy audit with the data collected from the baseline survey to build a dataset with information on households in the treatment and control group. The dataset is unique, in that it contains joint information on households socio-demographic characteristics, energy-related financial literacy, environmental values and electricity consumption as well as detailed information on the energy efficiency of the stock of home appliances and light bulbs.

## *3.1 Sample characteristics*

In this Section we present a comparison between some key facts in the experimental data and in the data coming from the baseline survey, as well as the Swiss National Statistics, to identify possible attrition patterns resulting from the different steps of the data collection. Moreover, we present a comparison of some key demographic characteristics of the treatment and control groups to explore whether, and to what extent, the attrition process was not random.

In Table 3, we present a comparison of selected household characteristics between households in the treatment and control groups, the entire sample of households that took the baseline survey and the Swiss national statistics.[6] Although we targeted the population of customers of two local utilities in Switzerland we still compare the statistics at the national level to inform about the extent to which the characteristics of the households in our sample are similar to those of the overall Swiss population. We report the statistics at the national level as computed by Eurostat (residence characteristics, household type and education) and by OECD (household income).

The ownership rate is higher in the treatment (78%) and control groups (82.41%), compared to the same figure in the survey sample (58.59%) and the Swiss national statistics (44.50%). The share of couples with or without children is larger among the households in the treatment, control and surveyed samples (74.27%, 79.17% and 71.36% respectively) compared to the Swiss national statistics (where the corresponding figure is 56.32%). The Swiss statistics also show that the 40.87% of the population is single with or without children, while this figure is smaller among households in the treatment, control and surveyed samples. The distribution of household size in the treatment, control, and survey samples is similar to that observed for the Swiss population, even though households with two members are overrepresented, consistently with the evidence presented for the household type. Moreover, while the Swiss Statistics show that 15.0% of households have 5 or more members, the share of households with 5 or more people is only between 8% and 9% in the treatment, control and survey samples. Households in our sample are on average more educated than those in the Swiss population. The share of households with a tertiary degree is also slightly higher among households in the treatment group, compared to those in the control group. Finally, a larger share of respondents in the treatment group were employed (63%) at the time of the survey compared to the control group (47%). The share of employed respondents in the treatment group is similar to those in survey sample and the Swiss national statistics.

[6] No official statistics are available on the important socio-economic characteristics reported in Table 3 for the service areas of the two utilities.

Table 3: Selected Household Characteristics

| | Treatment Sample % | Control Sample % | Survey Sample % | Switzerland % |
|---|---|---|---|---|
| **Ownership Status** | | | | |
| Owner | 77.91 | 82.41 | 58.59 | 44.50 |
| **Household Type** | | | | |
| Couple with/without Children | 74.27 | 79.17 | 71.36 | 56.32 |
| Single with/without Children | 21.12 | 17.59 | 24.13 | 40.87 |
| Non-Family Household | 4.61 | 3.24 | 4.51 | 2.05 |
| **Household Size** | | | | |
| 1 | 15.48 | 14.76 | 19.20 | 16.00 |
| 2 | 42.75 | 48.57 | 39.89 | 29.00 |
| 3 | 15.23 | 15.24 | 16.22 | 18.00 |
| 4 | 17.94 | 12.38 | 16.59 | 23.00 |
| 5 or more | 8.60 | 9.05 | 8.11 | 15.00 |
| **Gross Monthly Income [CHF]** | | | | |
| below 1'500 | 0.00 | 1.75 | 1.01 | |
| 1'501 to 3'000 | 4.37 | 2.92 | 3.91 | |
| 3'001 to 4'500 | 4.37 | 10.53 | 6.37 | |
| 4'501 to 6'000 | 13.12 | 14.62 | 11.96 | |
| 6'001 to 9'000 | 28.86 | 29.82 | 28.04 | |
| 9'001 to 12'000 | 19.83 | 17.54 | 22.46 | |
| more than 12'000 | 29.45 | 22.81 | 26.26 | |
| Average monthly household disposable income | | | | 7490 |
| **Education** | | | | |
| Lower Secondary Education and Less | 1.46 | 1.85 | 2.11 | 18.20 |
| Upper Secondary/Vocational | 41.02 | 50.46 | 40.42 | 46.30 |
| Tertiary | 57.52 | 47.69 | 57.46 | 35.40 |
| **Employment** | | | | |
| Working | 63.11 | 46.76 | 68.79 | 58.95 |

The decisions of purchase of energy-related consuming durables likely depend on the participants' residence characteristics. We then wish to verify that these characteristics are also mostly balanced between treatment and control groups. The characteristics of the participant's residence are shown in Table 4. We compare these characteristics across households in the treatment and control group. The households in the treatment sample live in 64.48% of the cases in single-family households (SFH). In contrast, the control sample lives in 72.69% of the cases in SFHs. Thus there is a significant difference between the treatment and control group. The size of the SFH residences are not much different than MFH residences, where the majority of the households live in a residence of 100-150 $m^2$. Further, there is no significant difference in the residence size between the treatment and control group. Also the age structure of the MFH and SFH residences are similar, except for very new SFH residences (built 2001 or later), the treatment group shows a higher share (13.5%) than the control group (7.6%). This difference is significant at the 10% level, but not on the 5% level.

Table 4: Residence Characteristics

| | Treatment Sample % | Control Sample % | t-statistic |
|---|---|---|---|
| Share of single-family house | 64.48 | 72.69 | 2.046 |
| **Single-family house (SFH)** | | | |
| *SFH Size [m2]* | | | |
| below 100 | 6.01 | 5.13 | -0.368 |
| 100 - 150 | 39.48 | 40.38 | 0.177 |
| 151 - 200 | 29.18 | 32.05 | 0.602 |
| above 200 | 25.32 | 22.44 | -0.650 |
| *Residence Age of SFH* | | | |
| Before 1940 | 26.27 | 22.29 | -0.895 |
| 1940 to 1970 | 16.53 | 17.20 | 0.174 |
| 1971 to 2000 | 43.64 | 52.23 | 1.672 |
| 2001 or later | 13.56 | 7.64 | -1.825 |
| **Apartment in multi-family house (MFH)** | | | |
| *MFH Size [m2]* | | | |
| below 100 | 33.59 | 38.98 | 0.714 |
| 100 - 150 | 56.25 | 50.85 | -0.687 |
| above 150 | 10.16 | 10.17 | 0.003 |
| *Residence Age of MFH* | | | |
| Before 1940 | 12.31 | 15.25 | 0.552 |
| 1940 to 1970 | 13.08 | 20.34 | 1.282 |
| 1971 to 2000 | 37.69 | 33.90 | -0.500 |
| 2001 or later | 33.08 | 27.12 | -0.816 |

The value orientations of the households might influence both their choices of purchase of new energy-consuming durables as well as the selection into receiving an energy audit. For this reason, we are interested in testing that the attrition process did not result into treatment and control groups being unbalanced with respect to their value orientations.

In the baseline survey, we measure the extent to which biospheric, altruistic, egoistic and hedonic values are important to the respondents (Steg et al., 2014). Biospheric values reflect a concern with the quality of nature and the environment for its own sake. Altruistic values reflect a concern with the welfare of other human beings. People with strong egoistic values focus on costs and benefits of choices that influence the resources people have, such as wealth, power, and achievement. Hedonic values reflect a concern with improving one's feelings and reducing effort. Participants were asked to indicate, on a scale from -1 (Opposed to my values) until 7 (Of supreme importance), to what extent the value is a guiding principle in their life. Biospheric values were measured by four categories (Respecting the earth; Unity with nature; Protecting the environment; Preventing

pollution). Altruistic values were also measured by four categories (Equality; A world at peace; Social justice; Helpful). Egoistic values are measured with five categories (Social power; Wealth; Authority; Influential; Ambitious). Finally, hedonic values are measured with three categories (Pleasure; Enjoying life; Gratification for oneself). Table 5 shows that the biospheric and altruistic values seem to play an important role, as the average value in the treatment and control group are between 5 and 6. The egoistic values are least important to the respondents in the sample, as the average in the two groups are below 2.5. Lastly, the importance of the hedonic value is around 4.3. Importantly, the value of the t-statistics leads us to conclude that there are no significant differences in the treatment and control group concerning their value orientation.

Table 5: Value Orientations

| Value Orientation | Treatment Sample | Control Sample | t-statistic |
|---|---|---|---|
| Egoistic | 2.273 | 2.402 | 1.1563 |
| Altruistic | 5.304 | 5.372 | 0.7492 |
| Biospheric | 5.571 | 5.663 | 1.0583 |
| Hedonic | 4.254 | 4.363 | 0.9004 |

Finally, we also compare the level of energy-related financial literacy of respondents in the treatment and control sample. Table 6 presents the statistics of this comparison. It seems that the treatment group has a higher level of energy-related financial literacy with an average score of 5, while households in the control group reach an average score of only 4.7. This is mainly driven by a small difference in the level of two financial literacy questions, while for example we do not see a significant difference between the treatment and control sample on their knowledge of the electricity price nor their ability to perform a lifetime cost calculation.

Table 6: Energy-related financial literacy

| | Treatment Sample | Control Sample | t-statistic |
|---|---|---|---|
| Knowledge electricity price [%] | 30.84 | 31.94 | 0.283 |
| Cost of a washing cycle [%] | 50.99 | 43.06 | -1.865 |
| Cost of running a PC [%] | 39.46 | 36.97 | -0.603 |
| Knowledge LED savings [%] | 57.18 | 50.00 | -1.717 |
| Compound interest rate [%] | 97.09 | 92.59 | -2.602 |
| Understanding of inflation [%] | 91.99 | 90.28 | -0.726 |
| Risk diversification [%] | 90.05 | 83.33 | -2.445 |
| Lifetime cost claculation [%] | 41.50 | 43.52 | 0.485 |
| Energy-related financial literacy [0-8] | 5.01 | 4.72 | -2.029 |

Overall, we find that the characteristics of the treatment and control groups are balanced. Importantly, households in the two groups have similar home-ownership status rates, household size and income distributions, as well as value orientations.

However, some differences emerge with respect to the share of employed respondents (higher in the treatment group), the share of households living in single-family houses (higher in the control group) and the level of energy-related financial literacy (slightly higher among households in the treatment group). To address possible concerns coming from these compositional differences, we also present results of the treatment effects conditional on a large set of controls. We show that our results change little once we control for these respondents' and households' characteristics.

## *3.2 Potential of monetary savings*

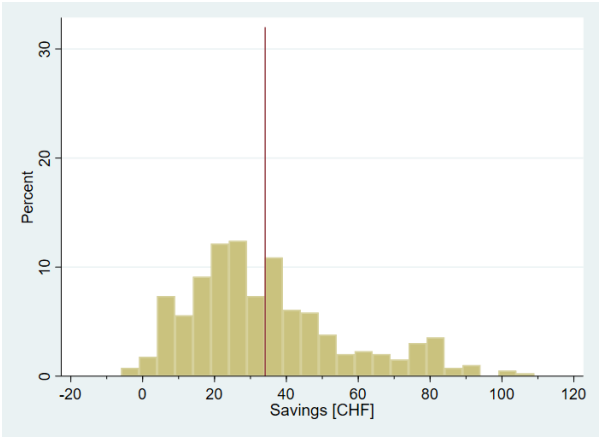
As described in section 2.3, we provided households allocated to the treatment group with information on their existing large electrical appliances and lighting through a letter and a website. In particular, we informed participants about the potential electricity cost reductions associated with the replacement of the existing devices, with new energy efficient ones. The following subsection aims at visualizing the range of these potential monetary savings.

Regarding the appliances, participants received information on the potential yearly reduction in monetary energy costs compared to the most efficient A+++ alternatives on the market.[7] The saving potentials (by appliance) are presented in Figure 3 for the sample of treated households that completed the follow-up survey. Depending on the appliance, the saving potential that we estimated amounts to 20-45 CHF of their annual electricity costs on average if they switched to the most efficient alternative on the market at that time. Additionally, all distributions of potential monetary savings reported in the five panels exhibit substantial variation implying that significant reductions in electricity expenses may be achieved by replacing very inefficient appliances. For example, replacing refrigerators, freezers and tumble dryers at the very right end of the sample distribution is estimated to lead to a decrease in annual energy costs of more than 100 CHF.

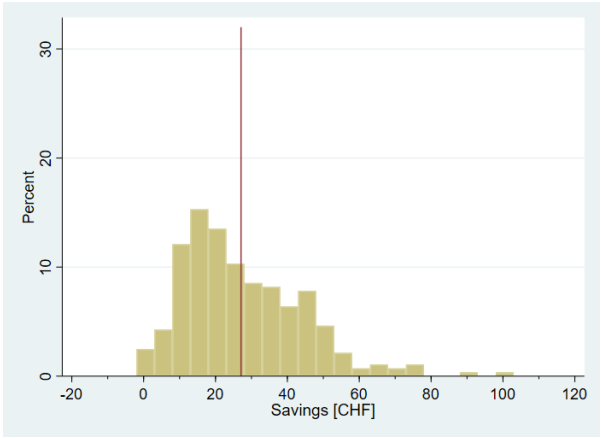
As indicated in Figure 4, potential monetary savings are even higher in the case of lighting. Under the assumptions taken to compute the yearly electricity consumption of each type of light bulb, replacing one halogen with one LED light bulb is estimated to lower electricty consumption by 40 kWh.[8]. Based on regional electricity prices and the number of halogen bulbs installed, households were estimated to be able to reduce annual energy cost for lighting by almost 190 CHF on average, if all energy-inefficient light bulbs were replaced by LED ones.

[7] Due to systematic price differences between the two utilities considered we based our calculations on 18.5 Rp./kWh for AIL and 20 Rp./kWh for SW.

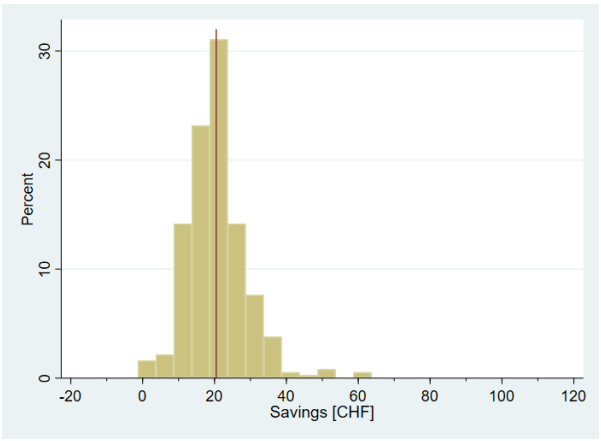
[8] In order to calculate this potential, we relied on data for halogen and LED light bulbs that exhibit similar luminosity (700 lm) and light color (2500 K) values. This corresponds to a capacity of 46 W for halogen and 6 W for LED light bulbs. Additionally, it was assumed that every light bulb was used for 1000 hours per year.



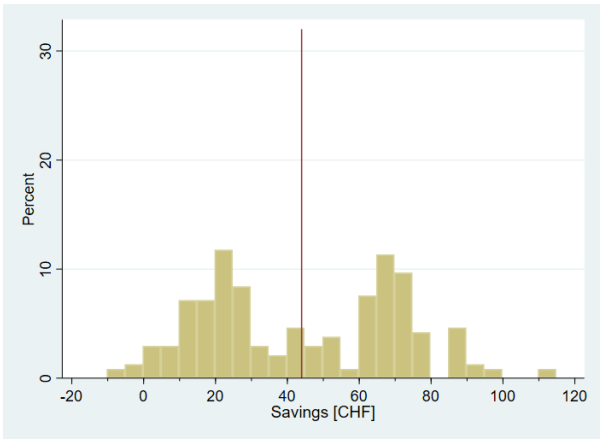

(a) Refrigerator



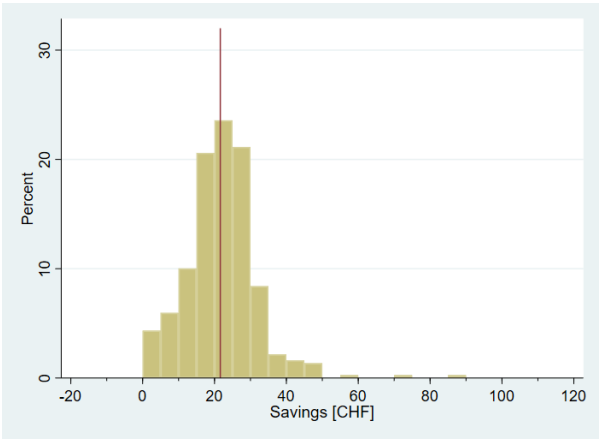

(b) Freezer




(c) Washing Machine




(d) Tumble Dryer




(e) Dishwasher

Figure 3: Potential monetary savings by appliance for treatment group

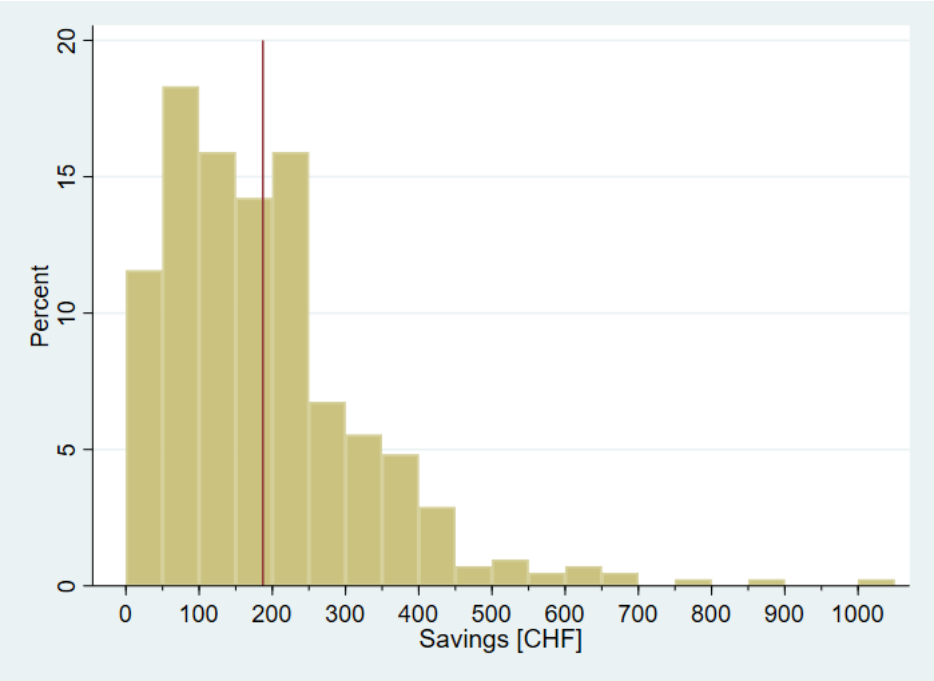



Figure 4: Potential yearly savings of electricity cost by replacing all halogen with LED light bulbs for treatment group

## 4. Empirical strategy

The information treatment provides exogenous variation in the knowledge about the potential of monetary savings that participants could achieve in their electricity bill by purchasing new energy efficient consuming durables. We aim at estimating the impact of this monetary information on households actual decisions of purchase. The experimental design allows us to estimate the impact of the information treatment by simply regressing the outcome of interest on a treatment indicator, using data from the post-treatment period. The regression models also control for a set of observable characteristics. In this context, the identifying assumption is that there are no unobservable differences between participants in the treatment and control groups, conditional on the set of covariates. We then estimate the following equation:

$$Y_i = \beta D_i + \delta X_i + \epsilon_i \tag{1}$$

where $Y_i$ is an indicator of energy-consuming durable choices which can be both dichotomous or continous, $D_i$ is a treatment indicator and $X_i$ is a set of respondents' and households' characteristics. The controls include the respondents' age, gender, education level (tertiary education or lower), energy-related financial literacy (high or low) and employment status, household income, household size, an indicator for whether the household owns their home, the dwelling type, dwelling size, age of the dwelling and utility service area. The coefficient of main interest $\beta$ indicates the reduced form impact of the information treatment on households choices. In particular, we wish to estimate the impact of the information treatment on: (i) the probability of purchase of new energy-consuming durables; (ii) the efficiency of the newly purchased durables, conditional on the purchase decision. Equation (1) is estimated using a Probit model when the outcome variable is binary and using OLS when the outcome

variable is continuous.

## 4.1 Impact of the intervention on the probability of purchase of new energy-consuming durables

To address the question of whether the information treatment had an impact on the probability of purchase of new energy-consuming durables, we exploit two survey questions asking households if they purchased a new appliance or a new light bulb, respectively, between November 2017 and December 2018.[9] Table 7 reports the marginal effects of the intervention on the probability to purchase at least one new home appliance (Columns 1 and 2) and light bulbs (Columns 3 and 4). Columns (2) and (4) report results obtained including the set of controls.

In the control group, around 19% of the households reported to have purchased at least one new home appliance in the year before the in-home visit. We find that our information treatment did not affect the probability to purchase a new home appliance. In contrast, we find that the information treatment increased the probability to purchase at least a new light bulb by 7.7 percentage points ($p$-value of 0.051). This effect is relevant, provided that the share of participants purchasing a new light bulb in the control group is around 68%.

Table 7: Impact on the probability of purchase of new durables, marginal effects

| | Indicator of purchase | | | |
|---|---|---|---|---|
| | Appliances | | Light bulbs | |
| | (1) | (2) | (3) | (4) |
| Treatment | -0.014 | 0.003 | 0.049 | 0.077* |
| | (0.032) | (0.036) | (0.038) | (0.040) |
| Controls | No | Yes | No | Yes |
| Observations | 631 | 543 | 631 | 543 |

Notes: Estimated marginal effect of the treatment indicator from the Probit model are reported. Dependent variable in Columns (1) and (2) is a binary indicator for households that have purchased at least one new home appliance between November 2017 and December 2018. Dependent variable in Columns (3) and (4) is a binary indicator for households that have purchased at least one light bulb between November 2017 and December 2018. Regression models in Columns (2) and (4) control for the respondents' age, gender, education level (tertiary education or lower), energy-related financial literacy (high or low) and employment status, household income, household size, an indicator for whether the household owns their home, the dweling type, dwelling size, age of the dwelling and utility service area.
Standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

[9] The exact phrasing of the question asking about the purchase of the new appliances was the following: *"Since November 2017, have you, or any other persons living with you, purchased one or more new home appliances (fridge, separate freezer, dishwasher, washing machine, clothes dryer)?"*. Similarly, we also asked: *"Between November 2017 and December 2018, have you, or any other persons living with you, purchased any light bulbs?"*. Because the follow-up survey has been carried out in February 2019, we also ask respondents to report the month of purchase and then use this information to exclude purchases made in January and February 2019.

## 4.2 *Impact of the intervention on the efficiency of the newly purchased energy-consuming durables*

We are now interested in testing whether the information treatment had an impact on the efficiency of the newly purchased energy-consuming durables. We analyse the treatment effects on the purchases of new home appliances and light bulbs separately. First, we consider the average annual electricity consumption of the purchased appliances, assuming a constant level of utilization.[10] Among the 631 households in the final experimental sample, 114 households purchased at least one new home appliance between November 2017 and December 2018. Table 8 reports the treatment effects on the average electricity consumption of the appliances purchased by these households. In particular, Columns (1) and (2) present results for the log of average electricity consumption of the newly purchased appliances. Column (2) reports results obtained including the set of controls. The main result on Column (1) shows that the information treatment decreased the average electricity consumption of the home appliances consumers purchase by around 18%, significant at the 1 percent level. Adding the set of covariates changes the point estimates little, with the effect that remains significant at the 5 percent significance level. Columns (3) to (7) present results for each home appliance separately. We find a negative and statistically significant impact of the information treatment on the electricity consumption of the newly purchased freezers, dishwashers, and clothes dryers. While the point estimates for the effect on the electricity consumption of purchased fridges and washing machines are negative, these effects are not statistically significant.

Table 8: Effect on the log electricity consumption of newly purchased appliances, conditional on puchase

| | Log electricity consumption | | | | | | |
|---|---|---|---|---|---|---|---|
| | Average all new appliances | | Fridge | Freezer | Dishwasher | Washing machine | Clothes dryer |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Treatment | -0.184*** | -0.182** | -0.252 | -0.250* | -0.0757** | -0.105 | -0.143** |
| | (0.0507) | (0.0840) | (0.151) | (0.131) | (0.0350) | (0.0845) | (0.0590) |
| Controls | No | Yes | No | No | No | No | No |
| Observations | 114 | 102 | 33 | 21 | 45 | 27 | 20 |
| Adjusted $R^2$ | 0.075 | 0.094 | 0.044 | 0.109 | 0.085 | 0.010 | 0.184 |

Notes: OLS estimates of the treatment effects are reported. Dependent variable in Columns (1) and (2) is the log of average annual electricity consumption of the newly purchased home appliances. Dependent variable in Columns (3), (4), (5), (6) and (7) is the log of the annualized electricity consumption of the newly purchased fridges, freezers, dishwashers, washing machines and clothes dryers, respectively. Regression model in Columns (2) controls for the respondents' age, gender, education level (tertiary education or lower), energy-related financial literacy (high or low) and employment status, household income, household size, an indicator for whether the household owns their home, the dweling type, dwelling size, age of the dwelling and utility service area.
Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

Second, we also investigate the impact of the information treatment on households decisions regarding the efficiency of the newly purchased light bulbs, conditional on the decision of purchase. We use three indicators for the efficiency of the newly purchased light bulbs: (i) an indicator for whether the household has purchased at least one energy efficient (LED) bulb between November 2017 and December 2018; (ii) an indicator for whether all the light bulbs purchased by the household in the period considered are energy efficient (LED bulbs); (iii) an indicator for whether all the light bulbs purchased by the household in the

[10] For fridges and freezers, we simply take the yearly electricity consumption as reported by the producers. For dishwashers, washing machines and clothes dryers, we take the electricity consumption per (typical) cycle of use as reported by the producers and multiply it by the number of cycles hypothesized in the calculation of the European energy labels (280, 220 and 160 cycles per year for dishwashers, washing machines and clothes dryers, respectively).

period considered are energy inefficient (halogen bulbs).

The estimates of the treatment effects on the lighting efficiency are presented in Table 9. We find a relevant impact of the information treatment on the probability to purchase efficient light (LED) bulbs (Columns 1 and 2). Receiving information about the monetary savings associated with the purchase of energy efficient light bulbs increases the probability to purchase an energy efficient light bulb by around 7 percent points, significant at the 1 percent level. The point estimate for the marginal effect increases little when adding covariates to the regression (8.9 percentage points increase). In the control group, when taking the decision to purchase a new light bulb, around 85 percent of participants have purchased at least one energy efficient (LED) bulb.

Table 9: Impact on the purchase of new light bulbs, conditional on puchase, marginal effects

| | At least one EE bulb | | All EE bulbs | | All HG bulbs | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Treatment | 0.072*** | 0.089*** | -0.029 | -0.036 | -0.054** | -0.065** |
| | (0.025) | (0.029) | (0.046) | (0.049) | (0.024) | (0.027) |
| Controls | No | Yes | No | Yes | No | Yes |
| Observations | 447 | 389 | 447 | 389 | 447 | 389 |

Notes: Estimated marginal effect of the treatment indicator from the Probit models are reported. Dependent variable in Columns (1) and (2) is an indicator for whether the household has purchased at least one energy efficient (LED) bulb between November 2017 and December 2018. Dependent variable in Columns (3) and (4) is an indicator for whether all the light bulbs purchased by the household in the period considered are energy efficient (LED bulbs). Dependent variable in Columns (5) and (6) is an indicator for whether all the light bulbs purchased by the household in the period considered are energy inefficient (halogen bulbs). Regression models in Columns (2), (4) and (6) control for the respondents' age, gender, education level (tertiary education or lower), energy-related financial literacy (high or low) and employment status, household income, household size, an indicator for whether the household owns their home, the dweling type, dwelling size, age of the dwelling and utility service area.
Standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

As shown in Columns (3) and (4) of Table 9, the information treatment does not affect the probability for households to purchase only energy efficient light bulbs, when purchasing a new light bulb. The intervention has instead a sizable impact on the probability for the households to purchase only halogen bulbs (as shown in Columns 5 and 6). The information treatment reduces the probability that consumers purchase only halogen bulbs by around 6 percentage points (5.4 and 6.5 percentage points when excluding and adding the controls, respectively), significant at the 5 percent level. Around 6 percent of the households in the control group purchased only light bulbs with low energy efficiency (halogen bulbs). These results suggest that the information treatment mostly affects the decisions of households that, prior to the treatment, lacked sophistication in their decision making process with respect to investment in energy efficiency (households that were purchasing halogen bulbs), while the behavior of more ”sophisticated” households remains unaltered following the information treatment.

### *4.3 Placebo intervention*

The results presented in Table (8) are informative of an important impact of the information treatment on the electricity consumption of the energy-consuming durables that consumers buy. As discussed in Section 4, the validity of our empirical strategy

Table 10: Effect of placebo treatment on electricity consumption of the appliances

| | All appliances purchased pre-treatment period | |
|---|---|---|
| | Log electricity consumption | |
| | (1) | (2) |
| Treatment | -0.006 | 0.002 |
| | (0.029) | (0.031) |
| Controls | No | Yes |
| Observations | 248 | 213 |
| Adjusted $R^2$ | -0.004 | 0.072 |

Notes: OLS estimates of the placebo treatment effects are reported. Dependent variable in Columns (1) and (2) is the log of average annual electricity consumption of the home appliances purchased in the pre-treatment period. Regression model in Columns (2) controls for the respondents' age, gender, education level (tertiary education or lower), energy-related financial literacy (high or low) and employment status, household income, household size, an indicator for whether the household owns their home, the dweling type, dwelling size, age of the dwelling and utility service area. Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

crucially relies on the absence of unboservable differences between treatment and control groups, i.e., the treatment assignment was random and the attrition process was not determined by factors that influence households decisions with respect to their investment in energy efficiency. A necessary condition for the validity of our empirical strategy is that, in the pre-treatment period, there were no differences in the energy-consuming durable choices of the two groups of households.

We exploit the information collected during the in-home visits about the year of purchase and electricity consumption of the existing appliances to test this hypothesis. We then regress the log average electricity consumption of the home appliances purchased in the years 2015, 2015 and 2017 on the treatment indicator, controlling for covariates.[11] The results presented in Table 10 show that, before the intervention, households allocated to control and treatment groups purchased home appliances with the same average electricity consumption.

## *4.4 Illustrative evidence*

To gain further insights into how the intervention affected households purchase decisions of energy-consuming durables, we plot the distributions of the average electricity consumption of the home appliances consumers bought before and after the information treatment, separately by treatment status.

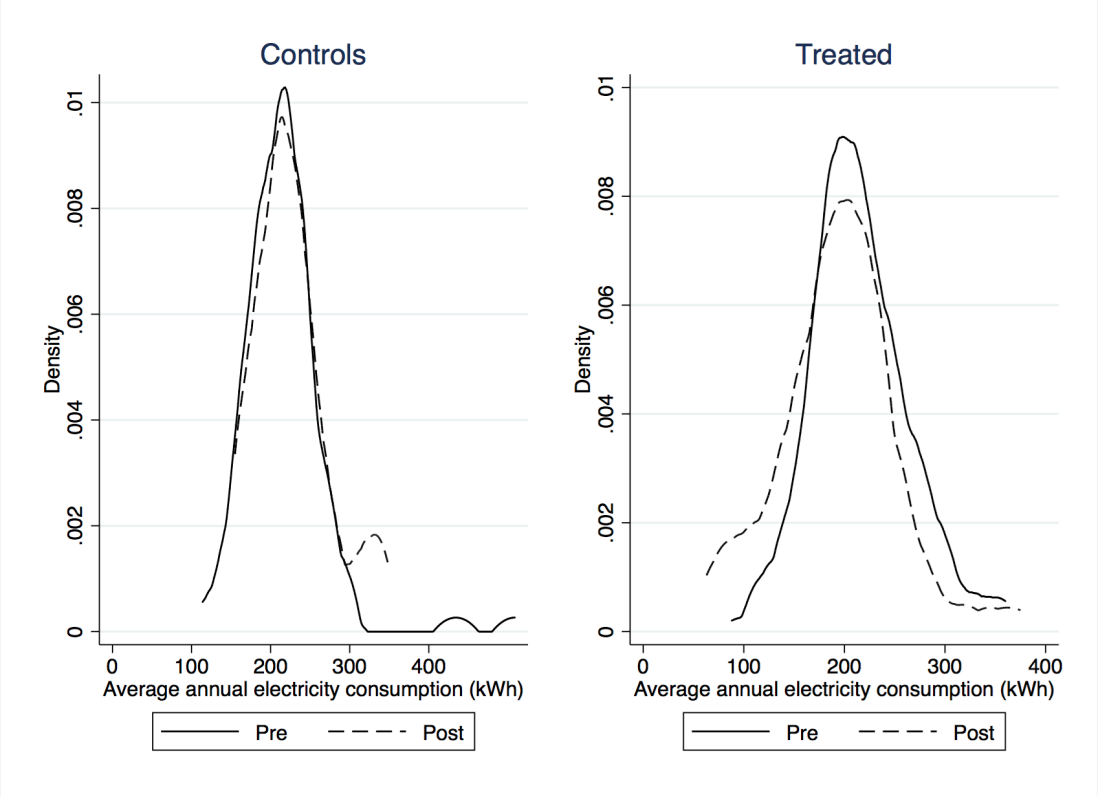
The graph on the left panel of Figure 5 shows that the distributions of the average electricity consumption of the home appliances purchased by the households in the control group before (solid line) and after the treatment (dash line) almost perfectly overlap. This evidence is informative that the home appliance choices of the control group did not change between pre- and post-treatment periods.

In contrast, the graph on the right panel of Figure 5 shows that the information treatment induces a shift of the distribution of the average electricity consumption of appliances bought by households in the treatment group after the treatment. In particular,

[11] We exclude home appliances purchased after October 2017, when the implementation of the in-home visits started.

the information treatment seems to both increase the probability that households purchase new home appliances with very low average electricity consumption, as well as induce a reduction in the probability that consumers buy home appliances with high electricity consumption on average. This illustrative evidence complements the results presented in Table 8 about the impact of the intervention on the average electricity consumption of new home appliances purchased by the participant households.

Figure 5: Information treatment and electricity consumption distribution, pre vs post



## 5. Conclusions and outlook

In this work we provide novel experimental evidence about the role of (lack-of) information about the energy cost of durable goods on the consumers' valuation of energy efficiency. We analyse the impact of providing households with tailored information about the potential of monetary savings from the adoption of energy efficient appliances and light bulbs, compared to the existing durables. We find that the information treatment decreases the average electricity consumption of the home appliances purchased by the households by around 19 percent. The intervention also increases the probability that households choose to purchase new energy efficient light bulbs by around 9 percentage points.

These results suggest the importance of providing tailored information about the potential of monetary savings coming from the adoption of energy efficient appliances. This could be achieved by providing monetary information about the yearly operating costs of the energy consuming durables that households use, including such information in the energy label available to consumers at the time of purchase of new durables, or designing tailored decision support tools that help consumers in the choice of new efficient technologies that take into account the monetary costs of usage of the existing energy consuming durables.

# Chapter 2 – The salience of the energy-efficiency trade-off and the purchase of energy efficient appliances

Giovanna d'Adda[a,b], Yu Gao[c], Lorenz Goette[d] and Massimo Tavoni[b,e]

[a] Università degli Studi di Milano
[b] EIEE-CMCC
[c] Peking University
[d] University of Bonn
[e] Politecnico di Milano

## 1. Introduction

When buying energy-using durables and comparing products with different levels of energy efficiency (henceforth EE), consumers may rationally choose to purchase low-EE items when their total cost, inclusive of the sale price and the net present value of all future energy bills, is lower than that of more energy efficient appliances. However, it has long been suggested that consumers may be imperfectly informed about, or inattentive to, energy costs when they buy energy-using durables, a suggestion supported by recent empirical evidence (Allcott and Taubinsky, 2015; Larrick and Soll, 2008).

These results are explained by theoretical models of salience (Kőszegi and Szeidl, 2012; Bordalo et al., 2013) that predict a bias towards costs and benefits that are concentrated in time, and a neglect of costs and benefits that are dispersed over time. According to these models, present bias and time inconsistency can arise when the future benefits of a decision are distributed over a long period of time. Investments in EE display this feature: higher price for a more efficient device is typically concentrated at the time of purchase, while the benefits accrue slowly over time. Therefore, present-biased behavior may be a particularly severe problem for EE investment.

Existing evidence on the impact of providing information on the energy cost of appliances primarily relies on data from choice experiments, or from analysis of naturally occurring data on purchases of energy using products (Allcott and Taubinsky, 2015; Larrick and Soll, 2008; Sallee et al., 2016; Cohen et al., 2017; Busse et al., 2013; Allcott and Wozny, 2014; Allcott, 2011). These studies provide mixed evidence on the impact of making energy cost information more transparent and salient (for a review, see Cattaneo (2019)).

Our study, to the best of our knowledge, is the first large scale field experiment testing the impact of providing information about the energy cost of appliances on real appliance purchase decisions. We conducted the field experiment in collaboration with a large Italian online retailer over a period of five months. We focused on refrigerators, as they are responsible for a large

share of total household energy use, about 14 per cent (Enea), and their energy consumption does not vary greatly with usage. Treatments varied whether information on the yearly or lifetime energy cost of appliances was provided alongside the standard energy class and consumption in kWh information. We observe the impact of the treatments on purchases and search behavior. Using data on 20,371 visitors to the website refrigerators' pages and 6,441 orders, we find that making appliances' energy costs salient leads to a shift in purchases from more to less efficient products. This effect is concentrated among clients shown appliances' lifetime energy cost. Treatments also increase the number of product pages viewed and the time spent on them by customers, a result driven by products in lower energy classes. The remainder of the paper proceeds as follows: Section 2 describes the field experiment and data; Section 3 presents the empirical results; and Section 4 concludes.

Note. Due to its complexity, long timing (the project started in 2014, but was delayed several times due to change of management at the partner company) and huge amount of data produced (in terms of navigation process in addition to the purchasing decision), this field experiment is the joint out of the PENNY and COBHAM projects. COBHAM -a European Research Council grant- has carried out many additional field experiments in different parts of the world (see http://www.cobham-erc.eu/). In terms of division of labour between the two project, the design and implementation of the experiment was mostly done in COBHAM, while the analysis of the data and writing of the paper and report was mostly done in PENNY. The ensuing scientific article will acknowledge both projects.

## 2. Experimental setting and design

### *2.1 Description of the sample*

The RCT was conducted between June 1st and October 16th, 2018 on the website of a major Italian online retailer. Our sample is made of customers who viewed and/or purchased a refrigerator during the duration of the study. To be eligible for the RCT, customers must browse the desktop version of the website: this rules out customers who viewed the website only from their mobile phones or tablets. Customers need to be registered and logged-on to the website to make a purchase, but not to navigate its pages. Given that customers can be identified through a user ID only once the log-on to the website, we restrict the analysis to the pages viewed by registered and logged-on customers.

### *2.2 Experimental design*

The RCT aims to measure the impact of making more salient the energy usage cost of household appliances, namely refrigerators. Customers viewing the website refrigerator pages during the study period were randomly assigned to one of the three conditions:

- 1-year condition: provides information on the yearly energy usage cost of each product.
- 15-years condition: provides information on the lifetime energy usage cost of each product.

- Control: presents the default product visualization of the retailer, with no information on energy usage costs.

When the energy cost information was provided, it was through a sentence placed next to an icon mimicking the energy class symbol contained in the energy label. This icon was present also in the control condition and was aimed at helping customers understand that the information provided referred to energy costs. The sentence reported the energy usage cost in Euro as "You spend €X in 1 year/15 years", depending on the treatment.

The energy cost was calculated, for each product, by multiplying the yearly energy consumption, expressed in kWh, as reported on the energy label, by the average unit cost of a kWh, reported on the website of the Italian Authority for Energy, Gas and Water (ARERA).[1] We selected the latest available figure of the price of a kWh, equal to €0.1998 in the second quarter of 2018, and computed all energy usage costs applying this same unit cost, undiscounted, to all future periods. The average lifetime of a refrigerator was set at 15 years, based on estimates available from the website of the National Agency for new technologies, energy and sustainable development (Enea).[2] Interested customers could verify the data, on which the energy cost calculation as based, as described below. We provided the energy cost information in two places on the website:

- On product listing pages, where products are displayed in a list: here, the information on a specific product appeared when the customer hovered the mouse over it (Figure 1).
- On product pages, where a single product is displayed in detail: here, the information was placed just below the product image (Figure 2).

In addition, each time the customer clicked on the cost information sentence, a pop-up window would open, explaining the nature of the information and the sources of data for the kWh unit cost and refrigerator lifetime (Figure 3).

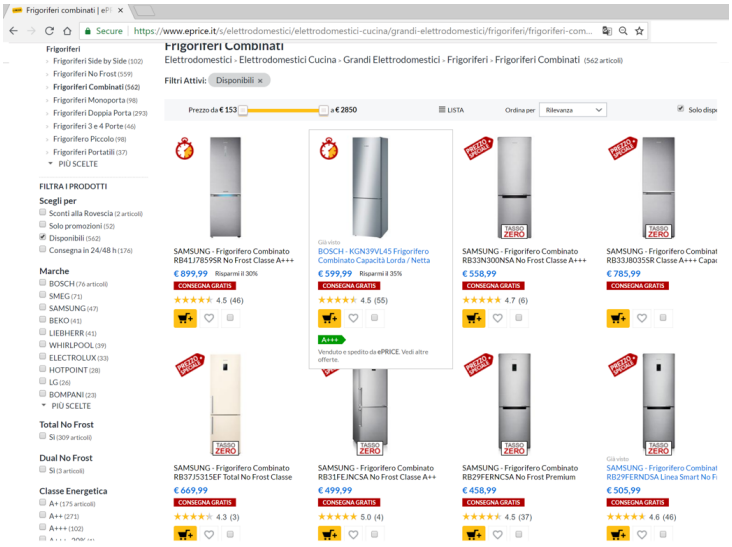
Assignment to treatment was performed by a cookie-based software routinely used by the online retailer for AB tests. Each customer, visiting the retailer's website for the first time during the study period, was randomly assigned to one of the three treatments. Therefore, as long as a customer did not erase the cookies, she would be exposed to the same treatment on all her subsequent visits. Moreover, if a customer registered or logged on to the website from the desktop, the treatment was from that moment onward associated to her customer ID and would be displayed also on other devices or web browsers, as long as the customer was logged on when starting to browse refrigerator pages. This, however, implies that the same customer could be exposed to multiple treatments, if she viewed refrigerators from different computers or laptops without being registered or logged on. This should attenuate any treatment effect we detect, but otherwise should not represent a threat to the identification, since the occurrence of such cases should be orthogonal to treatment. We, however, minimize this threat by focusing on registered and logged-on users and by making sure that no user in our sample is exposed to multiple treatments. The product categories that are part of the study are free-standing refrigerators (excluding minibars) available for delivery during the time of the study, so built-in or out-of-stock refrigerators were excluded from the RCT. About 2000 products on the online retailer's catalog satisfied these criteria and were thus included in the study.

[1] The information was taken from the following page, which was also available as a link for interested customers to click on: <https://www.arera.it/it/dati/eep35.htm>.

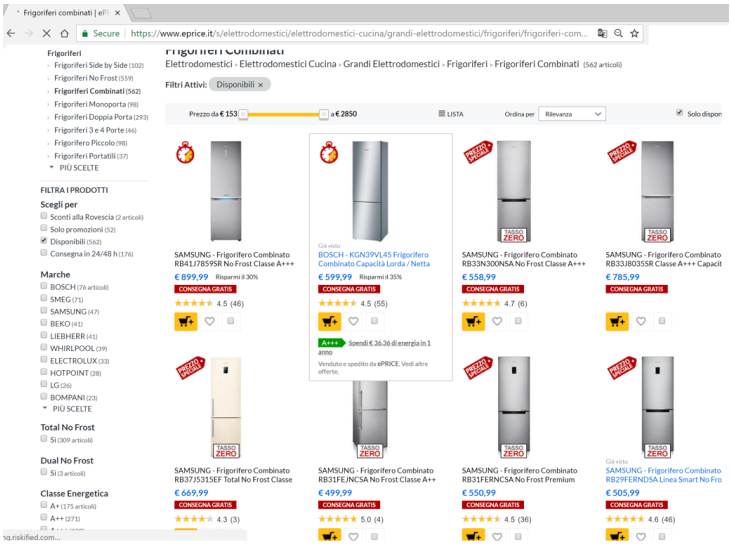
[2] The website reports results from a series of engineering studies evaluating the average lifetime of a refrigerator: <http://kilowattene.enea.it/KiloWattene-refrigeration-info.html>.

Figure 1: Listing page

(a) Control




(b) 1-year condition




(c) 15-year condition

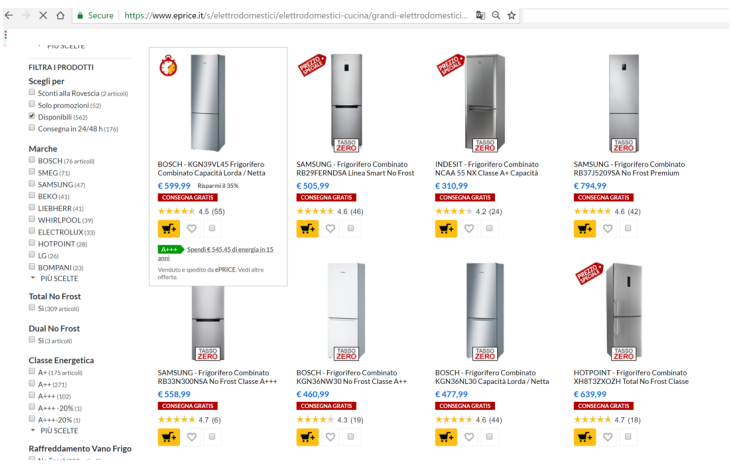
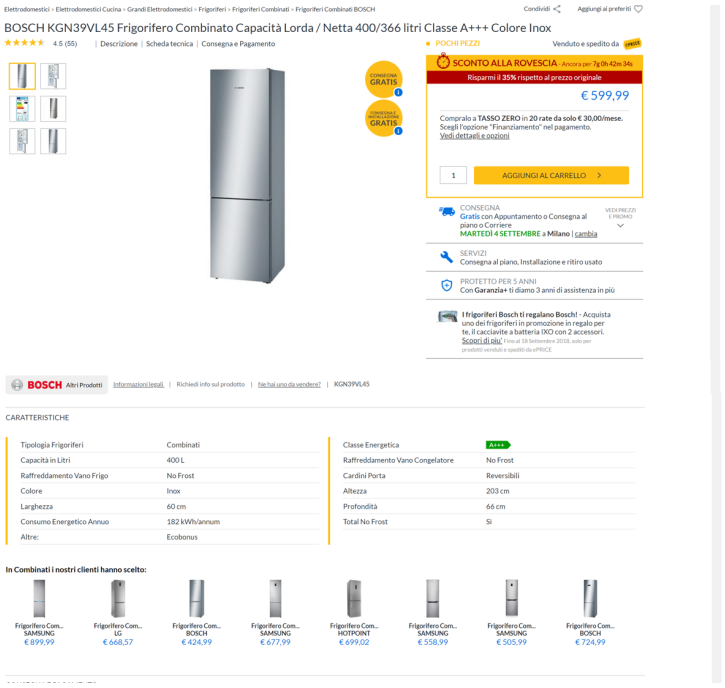


Figure 2: Product page

(a) Control




(b) 1-year condition

| | |
|---|---|
| Classe Energetica | A+++ Spendi € 36,36 di energia in 1 anno |
| Raffreddamento Vano Congelatore | No Frost |
| Cardini Porta | Reversibili |
| Altezza | 203 cm |
| Profondità | 66 cm |
| Total No Frost | Si |

(c) 15-year condition

| | |
|---|---|
| Classe Energetica | A+++ Spendi € 545,45 di energia in 15 anni |
| Raffreddamento Vano Congelatore | No Frost |
| Cardini Porta | Reversibili |
| Altezza | 203 cm |
| Profondità | 66 cm |
| Total No Frost | Si |

Figure 3: Pop-up

(a) Control

*By design, the control condition does not provide such a page*

(b) 1-year condition


(c) 15-year condition

### *2.3 Data*

The analysis relies on the combination of different datasets. The main source of data consists of navigation data, extracted daily from the online retailer. The data contains one observation per page visited by users, for all users who visited any page of the retailers' website between June 1st and October 16th, 2018. The raw data contains information on the municipality of the user's IP address, details on the page visited, whether the user used the internal search engine and the search query, the time of the page visit and the number of seconds spent viewing the page. If the page viewed by the customer is a product page (Figure 2), then the data also report the product code, whether the product was added to the cart or to the favorites, or whether it was ordered. The second set of data comes from the product catalog, and contains information on the products that were part of the study, i.e. on refrigerators. For each product, identified by the product code, the data reports a description of the product, the product brand, category (e.g. one door, fridge-freezer, three doors, side-by-side, etc.), energy class, yearly consumption in kWh, and the corresponding yearly and lifetime energy costs in Euro. Finally, we have daily price information for each refrigerator that was viewed on the website during the time of the study. That is, for each product viewed, we have the price applied to the product each day from June 1st to October 16th, plus its shipping price and information on whether a promotion was active on the product on that date.

## 3. Results

### *3.1 Treatment effect on purchase decisions*

We first evaluate the direct impact of making energy usage costs more salient and transparent, and the differential direct impact of changing the level of aggregation of the energy cost information, on the overall number of refrigerators' purchases. While we expect the treatment to lead to the replacement of less efficient purchases with more efficient ones, we have no prior expectation on the treatments' net effect on the overall level of sales. It is possible that the energy cost information is valued per se by customers, who would then be more likely to purchase a product from the online retailer than from its competitors when treated. This would result in a positive treatment effect on overall sales. However, it is also possible that the energy cost information may make more salient the total cost of a refrigerator, thus discouraging purchases. We cannot a priori predict which effect will prevail, and thus the overall sign of treatment effects on sales. We address this question using an individual level dataset that includes the full sample of registered customers who browsed refrigerator pages, regardless of whether they bought a refrigerator or not. We estimate the following linear regression model:

$$y_{it} = \beta_1 + \beta_2 Treat_i + \gamma_t + \varepsilon_{it} \quad (1)$$

Where $y_{it}$ is a dummy equal to 1 if customer $i$, who visited the website refrigerator pages for the first time at time $t$, purchased a refrigerator; and $\gamma_t$ are time fixed-effects related to the date of the first visit. $Treat_i$ is treatment status: we first compare treated and control customers, and then distinguish between the 1-year and the 15-years energy cost treatments. Standard errors are clustered at the municipality level.

Table 1 reports regression results. Columns 1 and 3 show regressions without date fixed-effects, while Columns 2 and 4 include them. Being treated had no effect on the overall likelihood that a customer buys a refrigerator. This result holds even when we distinguish the two treatments. This is reassuring, as it implies that the treatments did not introduce systematic selection in the sample of customers who made purchases.

Table 1: Treatment effects on overall purchases

| **Dependent variable** | **Buy a refrigerator** | | | |
|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** |
| Treat | 0.005 | | 0.004 | |
| | (0.007) | | (0.007) | |
| Treat 1 year | | 0.011 | | 0.011 |
| | | (0.008) | | (0.009) |
| Treat 15 years | | -0.000 | | -0.002 |
| | | (0.007) | | (0.008) |
| Day f.e. | No | No | Yes | Yes |
| Constant | 0.313*** | 0.313*** | 0.313*** | 0.313*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Number of Obs | 20371 | 20371 | 20371 | 20371 |
| R-Squared | 0.000 | 0.000 | 0.018 | 0.018 |

Notes: OLS, s.e. clustered at municipality level. * significant at 10%; ** significant at 5%; *** significant at 1%

Next, we examine the impact of being treated, and of individual treatments, on the energy class of purchased products. Out of 6441 refrigerators purchased over the five months of the study, 168 were minibars, so we exclude them from the analysis. Of the remaining 6191 refrigerators, 1053 were of energy class A+++ or more,[3] 2588 of class A++, 2533 of class A+ and 17 of class A. Given the low number of A-class products purchased, in the analysis we pool them with A+ refrigerators.[4] Figure 4 shows the share of customers, computed over the total sample - thus including customers who made no purchase - who bought a refrigerator of energy class A+++ or above (Panel (a)), A++ (Panel (b)) and A+ or below (Panel (c)), by treatment. Sales of most efficient refrigerators are highest in the Control treatment, and lowest in the 15-years treatment, while the opposite pattern is observed for the least efficient products. As for A++ class refrigerators, the 1-year treatment is associated with the highest share of purchases of products in this class, followed by the Control and 15-years treatments.

We test the statistical significance of these results through regression analysis, in two ways: first, we consider the full sample of customers, and test whether being exposed to the energy cost information, and its different levels of aggregation, influenced the decision to buy refrigerators of different energy classes. We label this the unconditional analysis, which mirrors the approach

[3] At the time of the study, 2 additional energy classes were available: A+++ minus 10% and A+++ minus 20%, respectively 20 and 30 per cent more efficient than the average A+++ refrigerator. We observe 4 purchases in each of these energy classes, so we pool them with A+++ products.

[4] By law, refrigerators below the energy class A+ could not be sold.

displayed in Figure 4. Because of the correlation in the outcome variables – given a certain level of purchases, increasing the share of purchased products belonging to an energy class decreases the share of purchases products in other energy classes – the unconditional analysis uses SUR regressions to estimate treatment effects.

Figure 4: Share of refrigerator purchases, by energy class and treatment

(a) A+++ or above (b) A++ (c) A+ or less

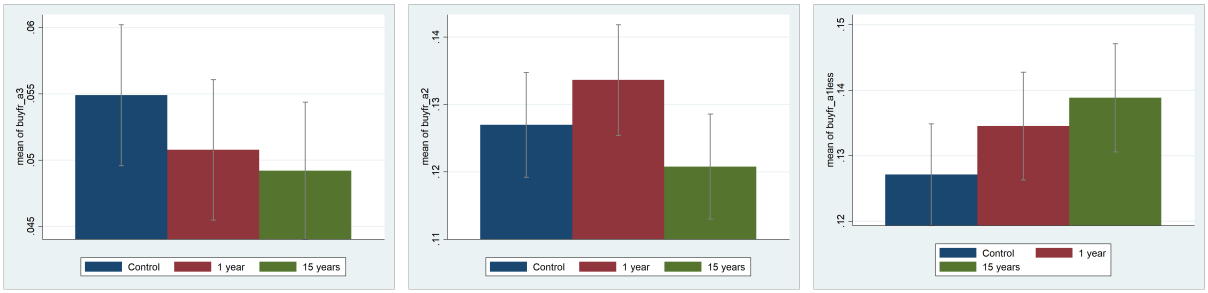



Table 2 shows regression results. Treated customers are less likely to purchase refrigerators of energy class A+++ or more, and are more likely to purchase those of energy class A+ or less. Only the latter result is statistically significant at the 10 per cent level, and it is driven by the 15-years treatment, which increases the share of least efficient purchases by 1.2 per cent ($p < 0.05$).

Second, we focus on customers who bought a refrigerator during the experiment, and test whether the treatments affected the energy class of the products purchased. We call this the conditional analysis, since we study treatment effects conditional on a purchase being made. We thus estimate equation (1), where $y_{it}$ now is the energy class of the product purchased by customer $i$, who visited the website refrigerator pages for the first time at time $t$. We use an ordered probit model, given the nature of the dependent variable, which we code by assigning higher values to less efficient energy classes.

Table 3 displays the regression results, which confirm the ones from the unconditional analysis. Treated customers purchase on average products of lower energy classes, an effect driven by the 15-years treatment. Both results are statistically significant at the 5 per cent level.

More efficient products tend to have other desirable characteristics, and thus be more expensive on average. Table 4 replicates the conditional analysis, only replacing energy class with sale price as the dependent variable. Consistent with the observed effects of the treatments on energy class, and with the presence of a positive correlation between efficiency and price, treated customers do buy cheaper refrigerators, but the result is not statistically significant.

It is possible that the reduced energy costs of these products does not outweigh their higher price, resulting in a higher total cost, computed as the sum of sale price and lifetime energy cost. Figure 5 shows that, indeed, higher energy efficiency is not associated with lower total cost: the total cost of products of class A+++ or more is the same as that of A+ or less products, and lower than that of A++ products.

Did the treatments lead clients to purchase products with a lower total cost? Table 5 reports the results of the conditional

analysis, which are similar to those on price: treated customers buy products with lower total cost, but the effect is not statistically significant.

Table 2: Treatment effect on the energy class of purchases: unconditional analysis

| **Dependent variable** | **Buy a refrigerator** | |
|---|---|---|
| | **(1)** | **(2)** |
| *A+++ or more* | | |
| Treat | -0.005 | |
| | (0.003) | |
| Treat 1 year | | -0.004 |
| | | (0.004) |
| Treat 15 years | | -0.006 |
| | | (0.004) |
| Constant | 0.055*** | 0.055*** |
| | (0.003) | (0.003) |
| *A++* | | |
| Treat | 0.000 | |
| | (0.005) | |
| Treat 1 year | | 0.007 |
| | | (0.006) |
| Treat 15 years | | -0.006 |
| | | (0.006) |
| Constant | 0.127*** | 0.127*** |
| | (0.004) | (0.004) |
| *A+ or less* | | |
| Treat | 0.010* | |
| | (0.005) | |
| Treat 1 year | | 0.007 |
| | | (0.006) |
| Treat 15 years | | 0.012** |
| | | (0.006) |
| Constant | 0.127*** | 0.127*** |
| | (0.004) | (0.004) |
| Date f.e. | No | No |
| Number of Obs | 20371 | 20371 |
| R-Squared | 0.000 | 0.000 |

Notes: SUR regressions. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Treatment effect on the energy class of purchases: conditional analysis

| **Dependent variable** | **Refrigerator's energy class** | | | |
|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** |
| Treat | 0.064** | 0.065** | | |
| | (0.030) | (0.030) | | |
| Treat 1 year | | | 0.051 | 0.054 |
| | | | (0.039) | (0.037) |
| Treat 15 years | | | 0.077** | 0.076** |
| | | | (0.031) | (0.032) |
| Day f.e. | No | Yes | No | Yes |
| Constant | 2.819*** | 2.304*** | 2.819*** | 2.303*** |
| | (0.076) | (0.198) | (0.076) | (0.198) |
| Number of Obs | 6191 | 6191 | 6191 | 6191 |

Notes: Ordered probit, s.e. clustered at the municipality level. Excluding minibars (untreated). * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Treatment effect on the price of purchases: conditional analysis

| **Dependent variable** | **Refrigerator's price** | | | |
|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** |
| Treat | -14.691 | -12.150 | | |
| | (9.580) | (9.633) | | |
| Treat 1 year | | | -18.433 | -16.768 |
| | | | (11.416) | (11.523) |
| Treat 15 years | | | -10.822 | -7.373 |
| | | | (10.320) | (10.418) |
| Day f.e. | No | Yes | No | Yes |
| Constant | 580.421*** | 578.751*** | 580.421*** | 578.750*** |
| | (7.302) | (7.394) | (7.302) | (7.395) |
| Number of Obs | 6187 | 6187 | 6187 | 6187 |
| R-Squared | 0.000 | 0.028 | 0.000 | 0.028 |

Notes: OLS, s.e. clustered at the municipality level. Excluding minibars (untreated). * significant at 10%; ** significant at 5%; *** significant at 1%

Figure 5: Total cost of products, by energy class

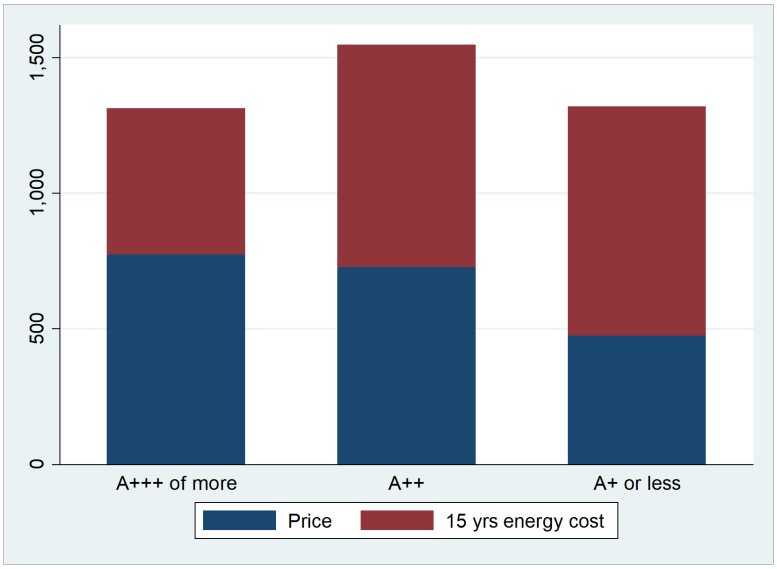



Table 5: Treatment effect on the total cost of purchases: conditional analysis

| Dependent variable | Refrigerator's total cost (price+15 yrs energy cost) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Treat | -7.996 | -3.886 | | |
| | (14.313) | (14.463) | | |
| Treat 1 year | | | -16.102 | -13.285 |
| | | | (17.693) | (18.101) |
| Treat 15 years | | | 0.386 | 5.837 |
| | | | (14.651) | (15.044) |
| Constant | 1315.487*** | 1312.786*** | 1315.487*** | 1312.784*** |
| | (10.983) | (11.263) | (10.984) | (11.263) |
| Number of Obs | 6187 | 6187 | 6187 | 6187 |
| R-Squared | 0.000 | 0.029 | 0.000 | 0.029 |

Notes: OLS, s.e. clustered at the municipality level. Excluding minibars (untreated). * significant at 10%; ** significant at 5%; *** significant at 1%

## 3.2 *Treatment effect on search patterns*

The results on purchases indicate that the treatment affected customers' choice of products. We exploit the data we have on the pages viewed by customers to study whether the different choices are the result of different search patterns induced by the

treatments. The outcome variable in this analysis is the likelihood to view a refrigerator's product pages, and we exploit the panel nature of the navigation dataset by running individual fixed-effects linear regressions.

We begin by examining overall page viewing in Columns 1 and 2 of Table 6. Treated customers are more likely to view product pages, a result statistically significant at the 1 per cent level. When distinguishing between treatments, the 15-year treatment appears to more consistently and significantly affect overall page viewing. When we disentangle these effects by energy class, we see that the treatments increase the attention given to products of energy class A++ and A+ or less. This is not the result of a shift in customers' attention from refrigerators of class A+++ or more, since the decrease in attention given to high efficiency products is small and not statistically significant. Rather, the increased page viewing, that we observe as an overall treatment effect, is directed to low efficiency products. As in the analysis on purchase decisions, the result appears driven by the 15-years treatment.

Table 6: Treatment effect on pages viewed, overall and by energy class

| **Dependent variable** | **Refrigerator's product page viewed** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **All** | | **A++ or more** | | **A++** | | **A+ or less** | |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| Treat | 0.128*** | | -0.009 | | 0.061* | | 0.079** | |
| | (0.033) | | (0.021) | | (0.032) | | (0.031) | |
| Treat 1 year | | 0.070 | | -0.073 | | 0.086 | | 0.060 |
| | | (0.110) | | (0.069) | | (0.108) | | (0.103) |
| Treat 15 years | | 0.131*** | | -0.006 | | 0.060* | | 0.080** |
| | | (0.034) | | (0.021) | | (0.033) | | (0.031) |
| Date f.e. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 1.235*** | 1.254*** | 0.260*** | 0.280*** | 0.439*** | 0.431*** | 0.528*** | 0.534*** |
| | (0.029) | (0.044) | (0.018) | (0.028) | (0.028) | (0.043) | (0.027) | (0.041) |
| Number of Obs | 359493 | 359493 | 359493 | 359493 | 359493 | 359493 | 359493 | 359493 |
| R-Squared | 0.093 | 0.093 | 0.010 | 0.010 | 0.017 | 0.017 | 0.028 | 0.028 |

Notes: OLS individual fixed-effects panel regression, s.e. clustered at municipality level. Additional controls: date f.e. * significant at 10%; ** significant at 5%; *** significant at 1%

## 4. Conclusions

We report results from a field experiment, conducted with a large online retailer of household appliances in Italy, where we increase the salience and transparency of energy cost information. Experimental treatments add to the information on the energy class and consumption in kWh of refrigerators the translation of such energy consumption into yearly or lifetime energy cost in Euro. We observe purchase and search behavior of customers on the online retailer's website. Our results show that the treatments increase the share of less efficient refrigerators (energy class A++ and less) purchased, and the attention given to these products by customers in their search. This effect is driven by the lifetime energy cost treatment.

## References

Alberini, A. and Filippini, M. (2018). Transient and persistent energy efficiency in the us residential sector: evidence from household-level data. *Energy Efficiency*, 11(3):589–601.

Allcott, H. (2011). Consumers' perceptions and misperceptions of energy costs. *American Economic Review*, 101(3):98–104.

Allcott, H. and Greenstone, M. (2017). Measuring the welfare effects of residential energy efficiency programs. Technical report, National Bureau of Economic Research.

Allcott, H. and Knittel, C. (2019). Are consumers poorly informed about fuel economy? evidence from two experiments. *American Economic Journal: Economic Policy*, 11(1):1–37.

Allcott, H. and Sweeney, R. L. (2016). The role of sales agents in information disclosure: evidence from a field experiment. *Management Science*, 63(1):21–39.

Allcott, H. and Taubinsky, D. (2015). Evaluating Behaviorally Motivated Policy: Experimental Evidence from the Lightbulb Market. *American Economic Review*, 105(8):2501–2538.

Allcott, H. and Wozny, N. (2014). Gasoline Prices, Fuel Economy, and the Energy Paradox. *The Review of Economics and Statistics*, 96(5):779–795.

Blasch, J., Boogen, N., Daminato, C., and Filippini, M. (2018). Empower the consumer! Energy-related financial literacy and its socioeconomic determinants. CER-ETH Economics working paper series 18/289, CER-ETH - Center of Economic Research (CER-ETH) at ETH Zurich.

Bordalo, P., Gennaioli, N., and Shleifer, A. (2013). Salience and consumer choice. *Journal of Political Economy*, 121(5):803–843.

Brent, D. A. and Ward, M. (2018). Energy efficiency and financial literacy. *Journal of Environmental Economics and Management*, 90:181–216.

Broberg, T. and Kazukauskas, A. (2015). Inefficiencies in Residential Use of Energy – A Critical Overview of Literature and Energy Efficiency Policies in the EU. *International Review of Environmental and Resource Economics*, 8(2):225–279.

Busse, M. R., Knittel, C. R., and Zettelmeyer, F. (2013). Are consumers myopic? evidence from new and used car purchases. *American Economic Review*, 103(1):220–56.

Cattaneo, C. (2019). Internal and external barriers to energy efficiency: which role for policy interventions? *Energy Efficiency*, pages 1–19.

Cohen, F., Glachant, M., and Söderberg, M. (2017). Consumer myopia, imperfect competition and the energy efficiency gap: Evidence from the uk refrigerator market. *European Economic Review*, 93:1–23.

Davis, L. W. and 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.

Filippini, M. and Hunt, L. C. (2011). Energy Demand and Energy Efficiency in the OECD Countries: A Stochastic Demand Frontier Approach. *Energy Journal*, 32(2).

Gillingham, K. and Palmer, K. (2014). Bridging the energy efficiency gap: Policy insights from economic theory and empirical evidence. *Review of Environmental Economics and Policy*, 8(1):18–38.

Houde, S. (2018). How consumers respond to product certification and the value of energy information. *The RAND Journal of Economics*, 49(2):453–477.

Jaffe, A. B. and Stavins, R. N. (1994). The energy-efficiency gap: What does it mean? *Energy Policy*, 22(10):804–810.

Kőszegi, B. and Szeidl, A. (2012). A model of focusing in economic choice. *The Quarterly journal of economics*, 128(1):53–104.

Larrick, R. P. and Soll, J. B. (2008). The MPG illusion. *Science*, 320(5883):1593–94.

McKinsey & Company (2009). *Unlocking energy efficiency in the US economy*. McKinsey & Company.

Newell, R. G. and Siikamäki, J. (2014). Nudging energy efficiency behavior: The role of information labels. *Journal of the Association of Environmental and Resource Economists*, 1(4):555–598.

Sallee, J. M., West, S. E., and Fan, W. (2016). Do consumers recognize the value of fuel economy? evidence from used car prices and gasoline price fluctuations. *Journal of Public Economics*, 135:61–73.

Steg, L., Perlaviciute, G., van der Werff, E., and Lurvink, J. (2014). The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions. *Environment and Behavior*, 46(2):163–192.

Ward, D. O., Clark, C. D., Jensen, K. L., Yen, S. T., and Russell, C. S. (2011). Factors influencing willingness-to-pay for the ENERGY STAR® label. *Energy Policy*, 39(3):1450–1458.