CER-ETH – Center of Economic Research at ETH Zurich

Can Information about Energy Costs Affect Consumers Choices? Evidence from a Field Experiment

N. Boogen, C. Daminato, M. Filippini, A. Obrist

Working Paper 20/334
May 2020

Economics Working Paper Series

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Can Information about Energy Costs Affect Consumers Choices? Evidence from a Field Experiment*

Nina Boogen[†1], Claudio Daminato[‡1], Massimo Filippini[§1,2], and Adrian Obrist[¶1]

[1] *ETH Zürich*
[2] *Università della Svizzera italiana*

This version: Saturday 2nd May, 2020

Abstract

There is an ongoing debate in the literature about whether consumers are fully informed when investing in energy efficiency. We experimentally evaluate the role of imperfect information or limited attention about energy costs of home appliances and light bulbs on households' choices. Using in-home visits, we collect information on the energy efficiency of home appliances and light bulbs that households own. Exploiting these unique data, the intervention provided treated households with customized information about the potential of monetary savings from the adoption of new comparable efficient durables. We find a substantial impact of our information treatment on both the energy efficiency of the newly purchased durables and the intensity of utilization of existing home appliances. Our findings suggest that individuals are not fully informed about or pay attention to energy costs when purchasing and utilizing home appliances.

Keywords: Imperfect information; Limited attention; Consumers durable choices; Energy efficiency; Field experiment.
JEL Classification Codes: C93, D12, D83, Q40.

*This paper is based on data collected within the EU H2020 Project "PENNY". We acknowledge financial support from the European Union's Horizon 2020 research and innovation program under grant agreement No 723791 - project PENNY "Psychological, social and financial barriers to energy efficiency", and financial support from the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 16.0087. Furthermore, we would like to thank the utilities that cooperated during the data collection process. This research is also part of the activities of SCCER CREST, which is financially supported by the Swiss Commission for Technology and Innovation (CTI) / Innosuisse. The authors would also like to thank participants at the Empirical Methods for Energy Economics Workshop in Quebec and the Annual Conference of the International Association of Energy Economics in Ljubljana for helpful suggestions. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Swiss Government nor the European Commission. All omissions and remaining errors are the authors' responsibility.

†Center of Economic Research (CER-ETH), ETH Zürich, Zürichbergstrasse 18, 8032 Zürich, Switzerland. Phone: +41 44 632 88 45. <nboogen@ethz.ch>

‡Center of Economic Research (CER-ETH), ETH Zürich, Zürichbergstrasse 18, 8032 Zürich, Switzerland. <dclaudio@ethz.ch>

§Ex Laboratorio, Office 205 (Level 2), Via Buffi 13, 6904 Lugano, Switzerland. Phone: +41 58 666 4640. <massimo.filippini@usi.ch>

¶Center of Economic Research (CER-ETH), ETH Zürich, Zürichbergstrasse 18, 8032 Zürich, Switzerland. <aobrist@ethz.ch>

1. Introduction

A body of recent research has suggested that individuals are not fully informed about some product characteristics when taking decisions of purchase, such as out-of-pocket costs of health plans (Abaluck and Gruber, 2011), sales taxes (Chetty et al., 2009) or shipping and handling charges (Brown et al., 2010). Specifically, imperfect information or limited attention about energy costs have been brought forward in the literature as a prominent explananation for the observation that, even though it appears that some investments in energy-consuming durables ensure net monetary savings over their lifetime (McKinsey & Company, 2009), households often fail to make these investments (Allcott and Taubinsky, 2015).

There is an ongoing debate in the literature on the explanations for this phenomena, known as the "energy efficiency gap", ranging from the idea that the private net benefits that consumers obtain from investments in energy efficiency, as estimated by engineering models, are overstated (Fowlie et al., 2018), to the role of various market and behavioral anomalies (Broberg and Kazukauskas, 2015; Gillingham and Palmer, 2014). In particular, while some previous empirical studies find that imperfect information leads to underinvestment in energy efficiency (Newell and Siikamäki, 2014; Davis and Metcalf, 2016; Houde, 2018), some recent studies do not find this factor affecting investment decisions (Allcott and Sweeney, 2016; Allcott and Greenstone, 2017; Allcott and Knittel, 2019).

In this paper, we experimentally evaluate the role of imperfect information or limited attention about the monetary costs of using home appliances and light bulbs in consumers' investment efficiency and durables intensity of utilization.[1] This is an interesting context to study the role of imperfect information in consumers' choices because of the private and social gains from the adoption of the more efficient durables predicted by engineering models, and the empirical evidence of substantial lack of individuals' knowledge of electricity prices and costs of running household appliances (Blasch et al., 2018). Were they imperfectly informed, consumers would underestimate the future monetary savings associated with higher energy efficiency, making them systematically biased against more energy efficient products. 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 using them 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.

We conduct a randomized field experiment with around 600 households in Switzerland to investigate the effect of providing personalized information about the potential of monetary

[1] As discussed in Caplin and Dean (2015) and Davis and Metcalf (2016), limited knowledge about energy costs may reflect either a rational trade-off between the costs of information acquisition and the expected benefits of learning or forms of irrationality in the individuals' decision making process.

savings from using more energy efficient technologies. During in-home visits, we collected information on the electricity consumption of the participants' existing home appliances and lighting.[2] We then sent a letter to treated households with customized information about the potential of monetary savings from adopting new comparable efficient appliances and light bulbs. Finally, we carried out a follow-up survey to collect data on post-treatment choices. The standard tests of balance on observables show that the treatment assignment was unconfounded. We lend further credibility to the validity of the assumption of unconfounded treatment assignment by showing that, before the informational intervention, households in treatment and control groups made purchase choices with similar investment efficiency. Estimation of the treatment effects is thus obtained by simply comparing the actual choices of purchase of households in treatment and control groups in the post-treatment period. We investigate whether the informational treatment affects the decisions of purchase of new home appliances and lighting, the level of energy efficiency of the newly purchased durables, and the intensity with which households use existing home appliances such as dishwashers, washing machines and tumble dryers.

Using detailed data about existing home appliances and light bulbs at home, the energy-consuming durable choices of the participating households, as well as information on the intensity of appliances' utilization, 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 energy efficiency of the newly purchased home appliances. In particular, the intervention induces households to purchase home appliances that consume on average 14 percent less electricity compared to the households in the control group, for a given level of utilization. Moreover, conditional on the decision of purchasing a new light bulb in a given year, the intervention increases the probability that households purchase (at least) one energy efficient light bulb by around 8 percentage points. Further, we show that the customized informational intervention induces a reduction in the intensity of utilization of the appliances, also when households do not replace any existing appliances at home. This result is consistent with households underestimating, in the pre-treatment period, the energy costs of running the existing appliances. We also find that our informational intervention affected mostly the behavior of purchase of those households that, ex-ante, had the larger potential of savings from the adoption of new efficient energy-consuming durables (i.e., higher treatment intensity), consistently with our informational intervention affecting households' choices through enhanced knowledge about energy costs or attention to savings. Finally, we find that the personalized informational intervention induced households to purchase home appliances with lower total lifetime costs, also when we consider individual-specific levels of utilization. Together, the findings from

[2] We consider households' choices related to fridge, separate freezer, dishwasher, washing machine, tumble dryer and light bulbs. Together, they accounted for around 50 percent of households' electricity consumption in Switzerland in 2017 (data recovered in 2020 from https://www.bulletin.ch/de/news-detail/haushalt-stromverbrauch-gesunken.html).

the field study point to a significant role of imperfect information or limited attention about energy costs in households' investment efficiency in home appliances and light bulbs.

This paper is related to a broad literature that uses information treatments to study the role of limited knowledge in individuals' decision making in a variety of contexts, from social security to the take-up of social benefits (Duflo and Saez, 2003; Chetty and Saez, 2013; Bhargava and Manoli, 2015; Liebman and Luttmer, 2015). We show that providing personalized information about the energy costs of durables can induce a substantial investment efficiency response, adding to previous studies demonstrating that customized information can improve consumer choices in different settings (Hastings and Weinstein, 2008; Bertrand and Morse, 2011; Kling et al., 2012).

We also contribute to a growing body of economic research that studies the role of information, certification, labels and inaccurate information on investment in energy efficiency (among others Allcott and Taubinsky 2015; Davis and Metcalf 2016; Houde 2018). This is one of the first papers that provides evidence on the role of imperfect information in consumers' choices of purchase of household durables exploiting a field experiment and data on actual decisions of purchase. The most prominent studies investigating the role of imperfect information in consumers' misperception of energy efficiency in a similar setting consider only light bulbs (Allcott and Taubinsky, 2015), whose purchase require a small initial investment.[3]

While some recent works (e.g., Fowlie et al. 2018) point more towards the presence of an overstatement of the private benefits from energy efficiency investments as an explanation for people's underinvestment in energy efficiency, we show that investment in some energy efficient durables has positive private returns and that imperfect information about energy costs does represent a barrier to investment efficiency in the context of home appliances and light bulbs. Our work is especially complementary to the paper by Allcott and Knittel (2019) that, in an experimental setting, provide consumers with information about vehicles fuel economy at the point of sale, finding no evidence that American drivers are not informed about fuel costs when taking their purchase decision. Providing customized information at home about the potential of monetary savings from using more efficient durables compared to the existing durables, we show that (some) consumers are not fully informed about the energy costs of home appliances and light bulbs. The paper also relates to the recent contribution by d'Adda et al. (2020), who randomize the presence of information about the energy costs of refrigerators in an online setting with the aim of investigating the role of salience of energy costs in consumers' choices of purchase of new refrigerators.

While previous studies have typically provided individuals with standardized information on energy costs as they are active in the marketplace or in a stated choice setting, we exploit an experimental design that uses in-home visits and a customized informational intervention

[3] While Allcott and Taubinsky (2015) show that providing information about energy costs increases the willingness to pay for energy efficient light bulbs in a stated preferences setting, they do not find significant effects on the actual consumers' behavior of purchase.

that is implemented before consumers access the marketplace. These features of our field study are important. First, using in-home visits allows us to compute individual potential of monetary savings from investment in energy efficient products (i.e., treatment intensity). Exploiting the heterogeneity in treatment intensity, we can show that the personalized informational intervention induced households' responses mainly through increased knowledge and no other mechanisms, such as warm glow or advertisement for new energy efficient products. Further, providing the information at home, before consumers entered the market, on the one hand allows to exclude that the intervention acted through enhanced salience of energy costs and, on the other, allows consumers to accumulate the necessary knowledge about the features of the alternatives in their choice set, and their individual returns from investing in energy efficiency. Finally, while most of the existing studies focused on the role of imperfect information in the consumers' choices of purchase of new durables we are, to the best of our knowledge, the first to show that an informational intervention about the energy costs of durable goods also has implications in terms of the level of utilization of the existing durables.

The remainder of this paper is organized as follows. In Section 2 we sketch a simple conceptual framework to think about the effects of the informational intervention. Section 3 describes the customized information treatment and the experimental design. In Section 4 we present the sample characteristics, while Section 5 presents the estimates of the treatment effects on households' choices of purchase and durables utilization. Section 7 concludes.

2. Conceptual framework

To describe the potential role of imperfect information or limited attention about the energy costs in consumers' choices, we sketch a simple model in which a consumer chooses between two energy-consuming durables with different energy intensities, in a framework similar to Allcott and Greenstone (2012).

The problem of the consumer can be thought of as a problem of optimal investment in the presence of limited knowledge on the stream of future costs of operating the durable good.[4] Moreover, we can also think of the least efficient durable in the consumer's choice set as the durable that the consumer is currently using. In this case, this becomes a problem of optimal durables replacement.

In each period, the consumer decides how much capital to invest in a durable good that will provide her with a flow of utility from a level of utilization (i.e., energy services from the durable) m in the following periods. The cost of producing these energy services depends on the technology of the good that has been chosen e and the electricity price c^e. Assume

[4] We consider individuals' limited knowledge as the result of a combination of imperfect information and limited attention. Clearly, this can reflect either irrationality in individuals' decision making or rationally inattentive behavior as in Caplin and Dean (2015).

that there exist only two goods in the consumer's choice set, differing only for their level of energy intensity e_A and e_B, with $e_A < e_B$, that require different initial investments P_A and P_B.[5]

In a standard investment model with no market failures or behavioral anomalies in the individuals' decision making process, a consumer would choose to purchase the energy-consuming durable A over B only if:

$$\underbrace{\left(\sum_t \frac{c^e(m_B e_t^B - m_A e_t^A)}{(1+r)^t}\right)}_{\text{actual energy savings}} > \underbrace{P^A - P^B}_{\text{investment}} \tag{1}$$

where r is a constant discount factor. Other factors might influence the *experienced* utility from the purchase of the more energy efficient durable good. On the one hand, the consumer might obtain additional utility θ related, for instance, to the emotional reward from helping the environment or the possibility that the more efficient product is also associated with more advanced features. On the other hand, the purchase of the more energy efficient durable may be associated with non-monetary costs γ, depending on the presence of search costs (which may vary depending on the individuals' opportunity cost of time) or market failures such as credit constraints.

Moreover, several market failures and behavioral anomalies such as imperfect information or limited attention about energy costs, present bias or low computational skills can influence the individuals' valuation of the savings from energy efficiency, and then the *perceived* utility from the purchase of the more energy efficient durable good. In the presence of imperfect information or limited attention about energy costs, the consumer will choose the more efficient durable A only if:

$$\underbrace{\Gamma(\xi)\left(\sum_t \frac{c^e(m_B e_t^B - m_A e_t^A)}{(1+r)^t}\right)}_{\text{perceived energy savings}} + \underbrace{\theta}_{\text{non-monetary benefits}} > \underbrace{P^A - P^B}_{\text{investment}} + \underbrace{\gamma}_{\text{non-monetary costs}} \tag{2}$$

where, as in Allcott et al. (2014), $\Gamma(\xi)$ is the valuation weight in the presence of behavioral and psychological anomalies and $\xi = (c^e, e^B, e^A, r)$ is the set of parameters that determines the gross utility gains from energy efficiency.

Clearly, imperfect information or limited attention about energy costs, might or might not explain under-adoption of energy efficient durables. The latter might indeed simply reflect individuals' preference heterogeneity, present bias (see, e.g., Allcott et al. 2014), or the fact that the investment in the more energy efficient durables do not deliver (Fowlie et al., 2018). To isolate the role of imperfect information or limited attention, in this work we exploit an experimental design to provide individuals with customized information on

[5] P_B may reflect scrappage costs when the good B represents the existent durable good.

energy costs. We then test the hypothesis that consumers are perfectly informed and pay attention about the energy costs of home appliances and light bulbs, so that providing some consumers with information will not make them change behavior of purchase compared to the individuals in the control group, i.e., $\frac{\Delta\Gamma(\xi)}{\Delta\xi} = 0$.

Further, in case households misperceive energy costs, one might expect that an informational intervention would influence also the level of utilization of the durable m, given the same durable's energy intensity.[6] If individuals underestimated (overestimated) energy costs, the informational intervention would indeed correspond to an increase (decrease) in the *perceived* marginal electricity price. Hence, indicating with m_i^T and m_i^C the level of utilization of households in treated and control groups, respectively, and assuming that the demand for energy services is downward sloping, we can test the hypothesis that individuals are overall informed about energy costs $\left(\frac{E[m_i^T - m_i^C]}{\Delta\xi} = 0\right)$, overall overvalue $\left(\frac{E[m_i^T - m_i^C]}{\Delta\xi} > 0\right)$ or undervalue $\left(\frac{E[m_i^T - m_i^C]}{\Delta\xi} < 0\right)$ energy costs, for the subset of households that maintain the existing stock of appliances between pre- and post-treatment periods.

In this setting, any behavioral change induced by an informational intervention that increases the valuation of energy efficiency $\Gamma(\xi)$, through enhanced knowledge, and then the *perceived* utility from purchasing a more energy efficient durable, is clearly welfare increasing.

3. Informational intervention

We administered the randomized control trial in collaboration with two local utilities in Switzerland: Aziende Industriali di Lugano (AIL) and Stadtwerk Winterthur (SW). SW serves almost 50'000 households in the city of Winterthur, while AIL serves around 97'000 households in the city of Lugano and some surrounding municipality.[7] The goal was to provide a group of households with information about the potential of monetary savings that they could achieve by purchasing energy-efficient durable goods. In this section we first describe the informational content of the intervention and then the design of the experiment and its implementation.

3.1 Information treatment

Households 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 major household appliances (fridge,

[6]Clearly, a change in households' behavior with respect to the level of utilization may follow the purchase of a new, more efficient, energy-consuming durables, because of the increased marginal costs of using the durable due to the higher capital costs, the different energy efficiency and technology (see, e.g, Gillingham et al. 2016), or because of individuals' status quo bias (Blasch and Daminato 2020).

[7]In Switzerland, the electricity market is not yet open to competition for residential customers. Thus, the two utilities serve the whole population in the respective service area.

freezer, dishwasher, washing machine, tumble dryer) 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.

In both the letter and the website, we provided participants with a brief report about the energy efficiency of each of their existing electrical appliances, and the potential of monetary savings they could achieve from the adoption of new, comparable, more 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.

Washing machine

Characteristics of your aplliance: Producer: Bosch, Width: 60cm, Height: 90cm, Year of Purchase: 2007

	Your appliance	**Alternative appliance on the market** (load capacity: 8kg)	
		A++	A+++
Consumption per cycle	1.050 kWh	1.170 kWh	0.470 kWh
Cost of one cycle	0.210 CHF	0.234 CHF	0.094 CHF
Annual operating cost[ii]	46 CHF	51 CHF	21 CHF
Approximate price range of new appliance		725-2309 CHF	440-4099 CHF
Estimate of potential annual savings on operating costs (compared to current appliance)		No savings	25 CHF

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

- You can save an estimated CHF 25.- per year in electricity costs by replacing your washing machine with a new A+++ appliance.

Figure 1: Information provision, appliances

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!

Figure 2: Information provision, lighting

An example of the information content for a washing machine, as presented in the letter sent to the participants, is included in Figure 1. The table includes 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 dishwashers, washing machines and tumble dryers. The annualized operating costs of dishwashers, 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).[8]

In addition, for each existing appliance, we reported the same information for 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.

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.[9]

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.

3.2 Experimental design

The experimental design is sketched in Figure 3, which presents a summary of the different steps of the experiment. The two utilities agreed to provide the contacts of 40,000 households, randomly selected among their customers, to take part to the experiment (20,000 from AIL

[8]Information on the standard number of cycles can be found here: https://www.bfe.admin.ch/bfe/de/home/effizienz/die-energieetikette/die-energieetikette-fuer-haushaltsgeraete.html

[9]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).

and 20,000 from SW). These customers were randomly allocated between the treatment (29,000 households) and the control group (11,000 households).[10]

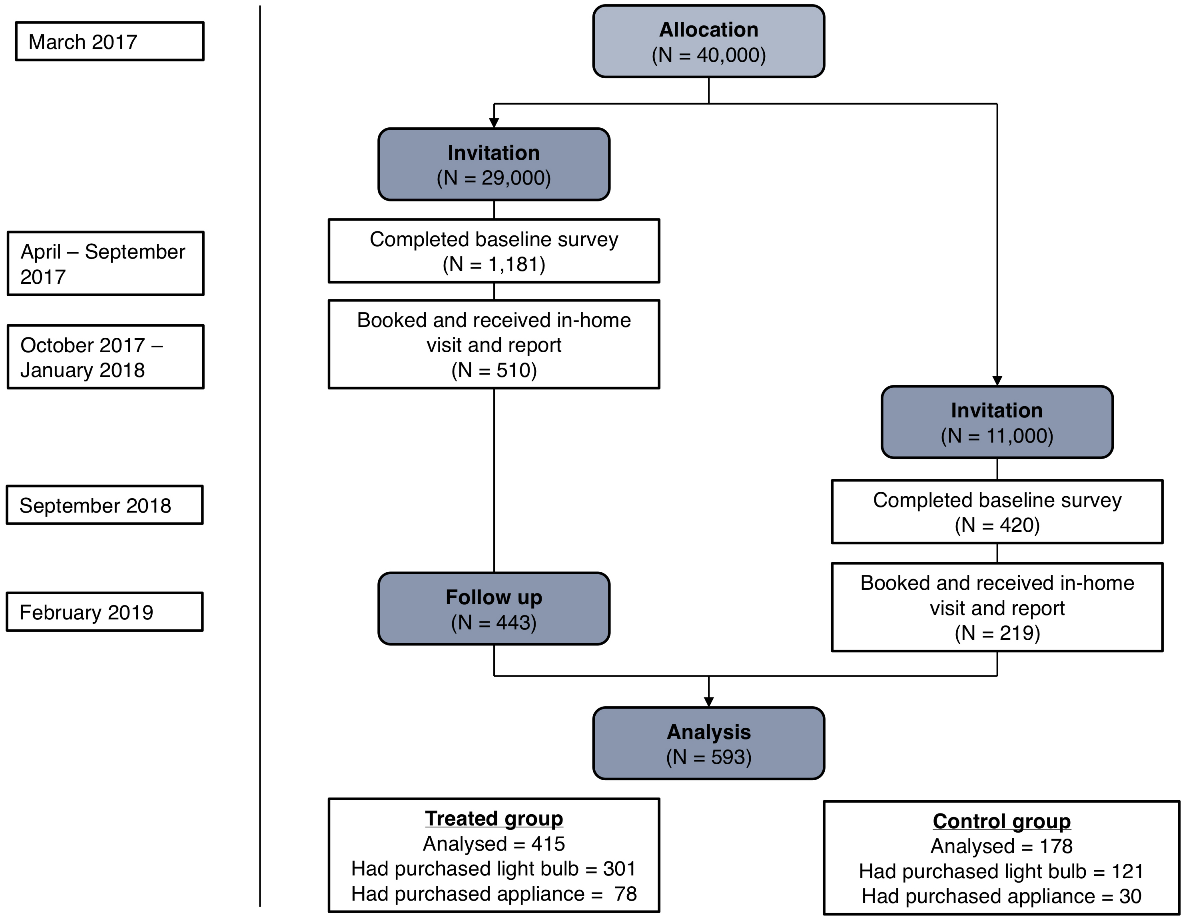


Figure 3: Experimental design

Between April and September 2017, the households allocated to the treatment received an invitation to take a baseline survey. At the end of the survey, the participants have been offered to receive a free in-home visit to then obtain information about the energy efficiency of their major home appliances and lighting. 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 completed the survey booked and received the in-home visit (510 households). 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

[10]The treatment group included 14,000 customers of AIL and 15,000 customers of SW.

efficiency of the existing appliances of the participants.

After the in-home visits, for each existing home appliance, we collected information about a comparable new appliance available on the market at the time of the in-home visit which satisfies high energy efficiency standards (energy label A++ and A+++). The information was gathered from the online shops of two leading national retailers and one neutral online database for appliances.[11] We used this information to compute the appliance-specific potential of monetary saving coming from the usage of a new energy efficient appliance. This information was then used to compile a customized report, which was subsequently sent to each household in the treated group by regular mail. In February 2019, we carried out a follow-up survey asking participants in the treatment group about their purchase decisions in the previous year.

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, the same recruitment 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 were also asked about the decisions of purchase of energy-consuming durables taken in the previous year.

The final experimental sample in the analysis includes information on 415 households in the treatment group and 178 households in the control group. In the next sections we describe more in detail the different steps of the randomized field experiment and then discuss the validity of the assumptions we need to take in this context to conclude that any differences in the choices between the two groups observed in the post-treatment period come from the information treatment.

Baseline survey

The baseline survey collected detailed information about socio-economic characteristics of the respondent and her household, dwelling characteristics, some of the basic human values (such as altruistic values) as well as energy-related knowledge of the participants. The baseline survey was completed by around 4.1% of the households that we contacted for the treatment group (1,181 households) and 3.8% in the control group (420 households).

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 Elektroapparate für Haushalt und Gewerbe Schweiz - FEA) to identify an effective and feasible way to obtain information related to the energy

[11] https://www.topten.ch/

efficiency of the appliances. 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 the online scheduling tool Setmore (1 hour slots within the research assistants' 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 at the Universities of 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 data collection standards, process of scheduling of in-home visits, procedures to be implemented during the in-home visit, explanation of characteristics to be collected the large home appliances and lighting. The training of the research assistants included an instruction meeting and pilot in-home visits 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 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. 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 durables electricity consumption

We used the information collected during the in-home visits 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[12], using information about the year of purchase and other appliances characteristics.[13]

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.

Follow-up survey

We went back to the participants in the treatment group one year after we provided them with the information. In this follow-up survey we asked about their decisions of purchase following the information treatment. Around 87% of the households that received the information treatment completed the follow-up survey one year later.

3.3 Possible threats to the validity of the experimental setting

The validity of our experimental strategy for the impact of the information treatment relies on some assumptions. Specifically, we need: (i) no differential selection into the baseline survey between treatment and control groups; (ii) no differential selection in taking the in-home visits (conditional on taking the survey); (iii) no selection among the households in the treated group into the follow-up survey.

To lend support to the credibility of this experimental setting, we show that these necessary conditions for the validity of these assumptions are satisfied. First, we observe similar response rates to the baseline survey between treatment group (4.1%, in 2017) and control

[12] https://www.compareco.ch

[13] 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.

group (3.8%, in 2018). Attrition rates are relatively high between baseline survey and taking the in-home visit. However, as shown in Column 1 of Table 11 in the Appendix, we find no evidence of differential attrition between treatment and control groups in taking the in-home visits (conditional on having taken the survey). Finally, we provide evidence that no selection on observables occured into the follow-up among the treated.[14] In section 4.1, we examine the balance of observables between treatment and control groups. Further, in Section 5.4, we test for pre-intervention differences in consumers' choices between treatment and control group using data about purchase decisions in the years 2016 and 2017. Overall, these results support the internal validity of our experiment.

4. Sample characteristics

In this section, we present a comparison of some key individuals characteristics in treatment and control groups. Furthermore, we provide figures on the scope of the saving potential of large household appliances and light bulbs as well as evidence that the level of energy-related knowledge in our sample is low.

We combined data from the baseline household survey, the in-home visits and the follow-up questionnaire. By means of the large household survey we collected pre-treatment data on household characteristics, residents' socio-demographics, respondents' energy-related knowledge as well as their environmental values.[15] The in-home visits allowed us to obtain data on the energy efficiency and year of purchase of the existing appliances and efficiency of light bulbs in the participants' home.[16] We collected data on the treated households' decisions of purchase of new energy-using durables in the post-treatment period using a follow-up survey. Specifically, we collected detailed information on the newly purchased durables: the electricity consumption (kWh/year) and the energy efficiency class (A+++, A++, ...) of home appliances purchased in 2018, the reason for replacing an existing appliance, as well as the type of light bulbs purchased in year 2018. Further, during the in-home visit we could also collect information on the home appliances purchased by households in the years prior to 2018.[17]

[14] Results for the test of selection into the follow-up survey based on observables are reported in Column 2 of Table 11 in the Appendix.

[15] We follow Allcott and Knittel (2019) and impute missing covariates with sample means. Table 10 in Appendix reports the (low) share of missing values for each covariate in the sample used for the analysis.

[16] The information collected during the in-home visits carried out in October 2017-January 2018 represent the pre-treatment data for the treatment group, while information collected during the in-home visits completed in the fall of 2018 serve as post-treatment data for the control group.

[17] We asked households in which year the existing appliances were purchased, and collected consumption data using the information on the appliances' nameplates collected during the in-home visits. We only collected information on the type of existing light bulbs (but did not ask about the year of purchase).

4.1 Balance

Our final sample consists of 593 households (415 treated and 178 control).[18] As described in Section 3.2, the target population of customers of the two utilities was originally randomly allocated between treatment and control groups. However, because the (same) recruitment process occurred in two different time periods (2017 for the treatment group vs 2018 for the control group), and an additional selection (into the follow-up) occurred among individuals in the treatment group, we wish to compare the balance of selected covariates among groups to complement the evidence supporting the validity of the experimental setting provided in Section 3.3. In Table 1, we present a comparison of selected respondents' and households' characteristics between households in treatment and control groups.[19] These data were collected by means of the baseline survey (in two different periods for treatment and control groups) before the in-home visits. The time-varying information refer to the same time period, that is the year before the baseline survey was carried out among the individuals assigned to the treatment group (2016).[20]

Most of the observables considered differ only marginally across treatment and control group. The distribution of household size is similar in treatment and control samples and averages at around 2.6 residents per dwelling. Households in treatment and control groups are also balanced with respect to their income level. The share of households that earn less than 6000 CHF per month is around 18%, while around 23 and 19% of the households stated to have a monthly gross income between 6000 and 9000 CHF, and between 9000 and 12000 CHF, respectively.[21] Participants in our experiment seem to have relatively high levels of education on average. The share of households with a tertiary degree is above 50% and statistically equal between treatment and control groups. While the majority of the respondents to the survey were men in both groups, We find a significantly higher share of female participants in the treatment group. Additionally, it appears that the respondents in the treatment group were around three years younger on average than the ones in the control group. Respondents in treatment and control groups are balanced with respect to the level of advanced financial literacy, status-quo bias and environmental values. Tenants represent a minority in our sample, with equal ownership rate in both treatment and control groups of around 80%. As tenants often live in multi-family houses, it is not surprising that the share of single-family houses is relatively high (around 70%), though not statistically different between the two groups. Further, we find no difference in the age of the buildings

[18] 631 households (415 treated and 216 control) actually took part in the experiment. However, one utility sent an erroneous reminder to the baseline survey followed by a corrected version that acted like another reminder a few days later, which threatened equal participation across treatment and control group. Hence, we decided to exclude people that answered after receiving the corrected version.

[19] A detailed description of the definition of the variables included in Table 1 is included in Appendix.

[20] The survey asks about household income and number of household members for the five previous years. We adjust the age of the respondents in the control group to consider time of interview effects.

[21] We observe household income in ranges for gross monthly total income.

Table 1: Balance on observables

	Control	Treatment	t-test
female	0.275	0.383	** (-2.49)
age	58.161	55.152	*** (2.68)
household size	2.679	2.619	(0.55)
university	0.534	0.595	(-1.36)
income: 6000 or less	0.175	0.179	(-0.12)
income: 6001-9000	0.226	0.242	(-0.41)
income: 9001-12000	0.198	0.179	(0.52)
advanced financial literacy	3.129	3.231	(-1.35)
status-quo index	2.617	2.543	(0.52)
biospheric index	5.591	5.570	(0.23)
tenant	0.197	0.226	(-0.77)
multi-family house	0.292	0.353	(-1.42)
living area (sq. m)	156.348	151.005	(0.86)
building period: 1970-2000	0.339	0.283	(1.36)
building period: after 2000	0.148	0.206	(-1.64)
moved in before 2012	0.180	0.236	(-1.50)
Lugano	0.511	0.378	*** (2.98)
p-value of F-test of joint significance		0.136	
Observations	178	368	546

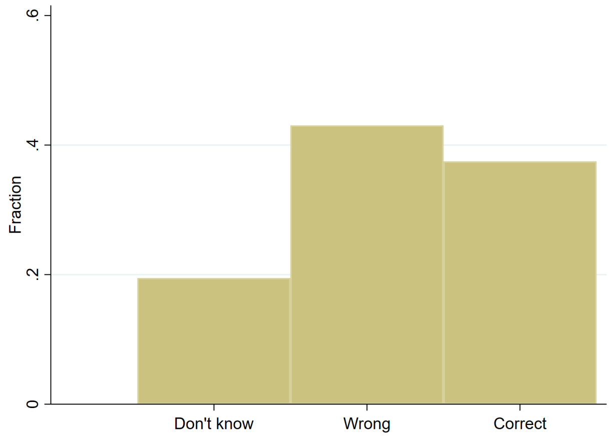
Notes: The Table repors a comparison of selected respondents' and households' characteristics between households in treatment and control groups. Mean values by group and the value of the t-test for mean comparison are reported. By chance, few variables are statistically different at conventional significance levels between treatment and control group, but the F-test fails to reject the joint significance of all observable characteristics included. Hence, we conclude that characteristics of treatment and control groups are similar and the two groups are balanced on observables.

in which treated and control households live.

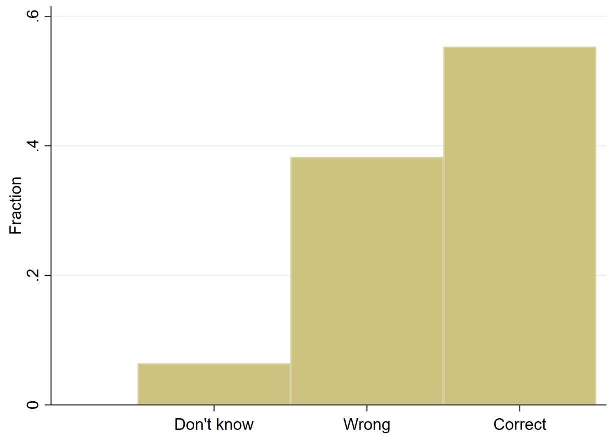
Even though we observe that by chance few variables are statistically different at conventional significance levels between treatment and control group, the F-test fails to reject the joint significance of all observable characteristics included. Hence, we conclude that characteristics of treatment and control groups are similar and the two groups are balanced on observables. On the basis of this, we proceed with the assumption that treatment assignment is unconfounded. Nevertheless, we also present results of the treatment effects conditional on a large set of controls in order to address possible concern coming from potential compositional differences and to increase the precision of treatment effects estimates. We show that our results only change little once we control for these respondents' and households' characteristics.

4.2 Energy-related knowledge in the baseline

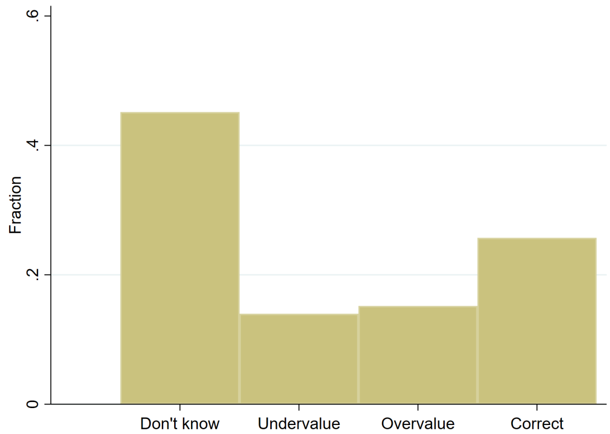
The baseline household survey included a set of specific questions designed to assess the level of energy-related knowledge of the respondents. The first question aims at eliciting the level of knowledge about the operating cost of large household appliances. More specifically,



(a) Cost washing cycle



(b) Saving LED



(c) Electricity price

Figure 4: Energy-related knowledge in the pretreatment data

we asked about the approximate cost of running a washing machine with a load of 5 kg at 60°C. The second question asked how much a LED bulb allows to save approximately in electricity costs compared to a halogen bulb. The third question asked to indicate the marginal electricity price (the cost in CHF of 1 kWh).

Figure 4 presents a summary of the answers to three questions related to this type of energy-related literacy and indicates that it was generally low before the treatment. Only around 38% of the respondents in our pooled sample are aware of the monetary costs of this washing cycle. The remaining respondents either stated that they cannot quantify the cost or assessed it incorrectly. Only about half of the sample knows, approximately, the energy savings potential associated with using a LED light bulb compared to a conventional halogen bulb. Additionally, the majority of the respondents do not know what is roughly the electricity price they face or indicate a wrong value. Only around one forth assessed their electricity price correctly.

4.3 Potential of monetary savings

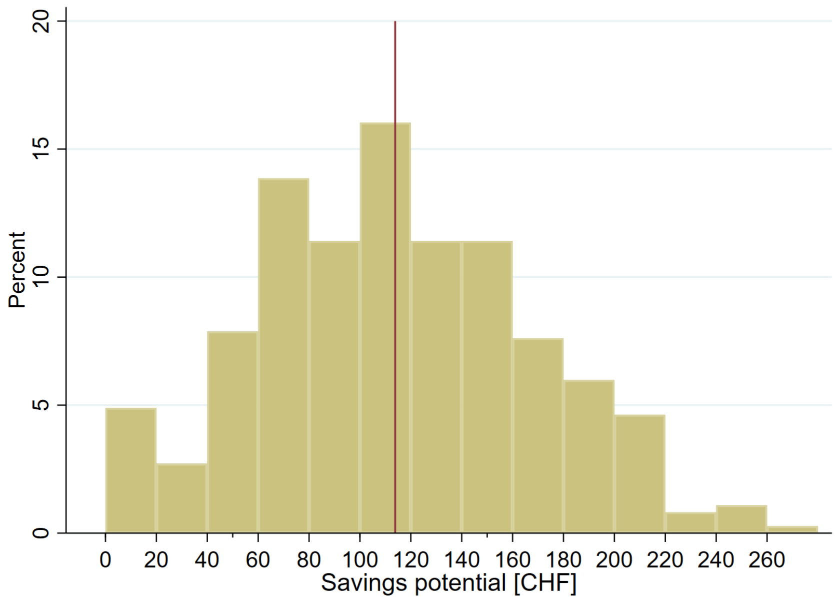
As described in Section 3.2, we provided households allocated to the treatment group with information on their existing large electrical appliances and lighting through a letter and a website. In particular, we informed participants about the potential electricity cost reductions associated with the 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 also received information on the potential yearly reduction in monetary costs from using the most efficient A+++ alternatives on the market, compared to their existing appliances.[22] The total saving potential of all appliances owned in the pre-treatment period is presented in Figure 5.a for the sample of treated households that completed the follow-up survey. The total saving potential that we estimated amounts to over 110 CHF of annual electricity costs on average if all existing appliances were replaced by the most efficient alternative on the market at that time. Additionally, the distribution of potential monetary savings exhibits substantial variation implying that significant reductions in electricity expenses may be achieved by replacing very inefficient appliances. For example, replacing the most inefficient refrigerators, freezers and tumble dryers is estimated to lead to a decrease in annual energy costs of more than 100 CHF.

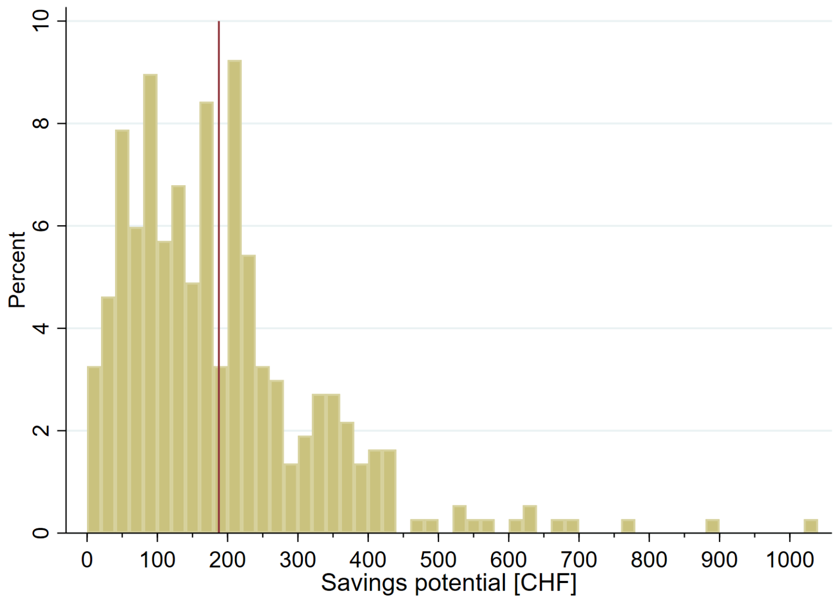
As indicated in Figure 5.b, potential monetary savings are even higher in the case of lighting. Under the assumptions taken to compute the yearly electricity consumption of each type of light bulb, replacing one halogen with one LED light bulb is estimated to lower electricity consumption by 40 kWh.[23] Based on regional electricity prices and the number of

[22] 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.

[23] In order to calculate this potential, we relied on data for halogen and LED light bulbs that exhibit similar



(a) Home appliances



(b) Lighting

Figure 5: Potential of yearly monetary savings for the treated

halogen bulbs installed, households were estimated to have the possibility of reducing annual energy cost for lighting by almost 190 CHF on average, if all energy inefficient light bulbs were replaced by LED ones.

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.

5. Empirical results

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 informational intervention on households' actual decisions of investment in energy-using durables and utilization.

Since the balance analysis in Section 4 indicated that there are no systematic differences between treatment and control groups, 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. However, since we do find that some individual characteristics are unbalanced between treatment and control groups, we identify the impact of the information provision under the conditional independence assumption, that is there are no unobservable differences between participants in the treatment and control groups, conditional on a set of covariates. We have shown the common support condition to be amply satisfied in our setting.

We then estimate the following equation:

$$Y_i = \beta D_i + \delta X_i + \epsilon_i \tag{3}$$

where Y_i is an indicator of energy-consuming durable choices which can be both dichotomous or continuous, D_i is a treatment indicator and X_i is a set of respondents' and households' characteristics. The controls include the respondents' gender, age, income, education, financial literacy, status-quo bias, environmental values as well as for a set of households and building characteristics (ownership status, household and dwelling size, building period, moving-in year, utility service area).[24] The inclusion of the set of observable characteristics also aims to improve the precision of the estimated treatment effects. The coefficient of main interest β indicates the reduced form impact of the informational intervention on households' choices. In particular, in our main empirical analysis we wish to estimate the information treatment effect on: (i) the probability of purchase of new energy-consuming durables; (ii) the level of energy efficiency of the newly purchased durables, conditional on the purchase decision, and (iii) the intensity of utilization.[25] Equation (1) is estimated using a Probit model when the outcome variable is binary and using OLS with robust standard errors when the outcome variable is continuous.

[24] Details on the definition of the covariates included in the regression models are reported in Appendix.

[25] We consider the level of utilization of dishwashers, washing machines and tumble dryers.

5.1 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 use data from the two survey questions asking households if they purchased a new appliance or a new light bulb, respectively, between November 2017 and December 2018.[26] Table 2 reports the marginal effects of the intervention on the probability to purchase at least one new home appliance (Columns 1 and 2) or replace an appliance when it was not defective (Columns 3 and 4). Columns (2) and (4) report results obtained including the set of controls. Columns 5 and 6 in Table 2 present the marginal effects of the treatment on the probability to purchase at least one new light bulb.

In the control group, around 17% of the households reported to have purchased at least one new home appliance in the year before the in-home visit, but only 3.4% did so when the appliance was not broken. Despite the positive coefficient associated to the treatment indicator in all estimated models, we cannot reject the null of no effect of our informational intervention on the probability to purchase a new home appliance, or to replace an appliance that was still working.

As shown in Table 2 (Column 6), we do find instead some evidence that the information treatment increases the probability to purchase new light bulbs. Specifically, using our preferred specification that includes the set of covariates, we find that providing households with information about how much they can save from using LED instead of conventional halogen bulbs increases the probability that households purchase any type of new light bulbs by around 8 percentage points. This effect is substantial, provided that the share of participants purchasing at least one new light bulb in the control group is around 68%.

5.2 Efficiency of the newly purchased energy-consuming durables

We are now interested in testing whether the informational intervention had an impact on the type of the newly purchased energy-consuming durables. We analyze the treatment effects on the purchases of new home appliances and light bulbs separately. Among the 546 households in the final experimental sample, 101 households purchased at least one new home appliance between November 2017 and February 2019.[27] 387 households reported having purchased at

[26]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.

[27]We carried out the follow-up survey to the participants in the treatment group that provided us with their purchase decisions only in February 2019, while we collected this information in the control group from mid-October 2018 to mid-January 2019. In order to account for potential technological changes in January and February 2019 we include yearly dummies in our regressions. We conducted our analysis after dropping the 2019 purchases as well but

Table 2: Information treatment effect: probability of purchase of new energy-consuming durables

	Appliances				Light Bulbs	
	Purchase		Replacement		Purchase	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.0248	0.0278	0.0253	0.0320	0.0425	0.0802**
	(0.0358)	(0.0355)	(0.0215)	(0.0215)	(0.0410)	(0.0393)
Controls	No	Yes	No	Yes	No	Yes
Observations	546	546	546	546	546	546
Dependent variable mean control	0.169	0.169	0.034	0.034	0.680	0.680

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 replaced at least one home appliance between November 2017 and December 2018 even though the old appliance was not defective. Dependent variable in Columns (5) and (6) 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), (4) and (6) control for respondents' gender, age, income, education, values, financial literacy and status quo bias as well as for a set of buidling and household characteristics (ownership status, household and dwelling size, building period, moving-in year, utility service area).
Standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

least one new light bulb.

First, we investigate whether the information provision affected the choices of households regarding the energy efficiency of the newly purchased home appliances. We use two indicators of energy efficiency: (i) the average annual electricity consumed by the newly purchased home appliances, for a given level of utilization (i.e., an indicator of energy intensity);[28] (ii) the EU energy label, an indicator of the durables' energy efficiency that takes into account its capacity/size.

Table 3 reports the estimated treatment effects on the average annual electricity consumption of the newly purchased appliances. In particular, Columns (1) and (2) present results for the log of average electricity consumption of the newly purchased appliances, excluding and including the set of controls, respectively. Column (1) shows that the information treatment decreased the average electricity consumption of the home appliances consumers purchase by around 14%, 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.

This result may reflect both a higher energy efficiency of the new appliances or the fact that, due to the informational intervention, households chose to save on their electricity bill by purchasing smaller appliances.[29] To gain more insights about how the information

our main results persist.

[28]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).

[29]The electricity consumed by the home appliances indeed depends on the intensity of utilization, their energy

Table 3: Information treatment effect: energy-efficiency of newly purchased durables

	Appliances				Light Bulbs			
	El cons *(Log Avg)*		A+++		LED		only halogen	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-0.143***	-0.143**	0.373***	0.266***	0.0778***	0.0826***	-0.0559**	-0.0537**
	(0.0544)	(0.0693)	(0.0830)	(0.101)	(0.0280)	(0.0284)	(0.0256)	(0.0259)
Year Dummies	Yes	Yes	Yes	Yes	No	No	No	No
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	101	101	101	101	387	387	387	387
Dependent variable mean control	5.398	5.398	0.267	0.267	0.860	0.860	0.107	0.107

Notes: OLS estimates of the treatment effects are reported in Columns (1) and (2) while the estimated marginal effect of the treatment indicator from the Probit model are reported Columns (3) to (8). 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) and (4) is a binary indicator for households that have purchased only A+++ appliances between November 2017 and December 2018. Dependent variable in Columns (5) and (6) 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 (7) and (8) 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), (6) and (8) control for respondents' gender, age, income, education, values, financial literacy and status quo bias as well as for a set of buidling and household characteristics (ownership status, household and dwelling size, building period, moving-in year, utility service area).
Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

treatment changed the purchasing behavior of treated households, we also consider its effect on the EU energy label. In Columns (3) and (4) we use as dependent variable a binary indicator that is equal to one if (all) the newly household appliances purchased by the household were labelled A+++ as defined by the EU energy label and zero otherwise. We find that the intervention induced a large increase in the probability to buy A+++ appliances. When we include the set of control variables, the results show that the treatment increased the probability for households to purchase A+++ appliances by around 27 percentage points.

These results provide evidence that the decrease in electricity consumption of the newly purchased appliances is mainly driven by an increase in their energy efficiency. These results allow us to conclude that the informational intervention had a positive impact on the utility households derive from using the newly purchased home appliances, for a same level of utilization (i.e., the *actual energy savings* in equation 1 are positive).

We are also interested in investigating the impact of the information treatment on households' decisions regarding the efficiency of the newly purchased light bulbs, conditional on the decision of purchase. As shown in Section 4.3, replacing halogen light bulbs with efficient LED ones allows households to achieve the most substantial savings in electricity costs. We use two 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 inefficient (halogen bulbs).

intensity as well as their volume/capacity.

The estimates of the treatment effects on the energy efficiency of the newly purchased light bulbs are presented in Table 3. We find a relevant impact of the information treatment on the probability to purchase efficient light (LED) bulbs (Columns 5 and 6). 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 7.8 percentage points, significant at the 1 percent level. The point estimate for the marginal effect increases little when adding covariates to the regression (8.3 percentage points). 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.

As shown in Columns (7) and (8) of Table 3, the information treatment has a sizable impact on the probability for the households to purchase only halogen bulbs. The information treatment reduces the probability that consumers purchase only halogen bulbs by around 6 percentage points (5.6 and 5.4 percentage points when excluding and adding the controls, respectively), significant at the 5 percent level. These results show that the information treatment affected 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 only purchasing the inefficient halogen bulbs).

These results complement the findings in Allcott and Taubinsky (2015), who have shown that providing information on energy costs increases the willingness-to-pay of respondents for LED bulbs in an online stated-choice experiment.[30]

5.3 Intensity of utilization

As described in Section 3.1, our informational intervention included a comparison between the existing appliances and alternative efficient appliances in the market, both in terms of energy intensity (i.e., for one unit of output) as well as for an average level of utilization. This intended to suggest target households about the different potential of monetary savings from the adoption of more efficient appliances, depending on the level of utilization. Further, we explicitly allowed households to gain information about how much they can save when adopting a new appliance based on the level of utilization through the website. We might then expect the information treatment to have an effect also on the intensity of utilization, through a reduction in the misperception of the associated costs, as discussed in Section 2. One of the novel aspects of this study is that we collected data on the level of utilization of dishwashers, washing machines and tumble dryers before and after the informational intervention, allowing us to test this hypothesis.

We first estimate equation 3 for the number of times the home appliances are utilized using the entire experimental sample to obtain an estimate for the overall effect of the information

[30] Allcott and Taubinsky (2015) do not though find significant effects on consumers' purchase decisions of light bulbs exploiting a field experiment implemented in retail stores.

Table 4: Information treatment effect: Intensity of Utilization

	Dishwasher		Washing Machine		Tumble Dryer		Total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-0.612***	-0.440**	-0.556**	-0.489**	-0.533**	-0.256	-1.430***	-0.965**
	(0.212)	(0.187)	(0.244)	(0.214)	(0.230)	(0.225)	(0.503)	(0.421)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	509	509	470	470	371	371	540	540
Dependent variable mean control	4.281	4.281	3.795	3.795	2.105	2.105	8.778	8.778

Notes: OLS estimates of the treatment effects are reported. Dependent variables are the number of cycles per week for each appliance in Columns (1) to (6) and the aggregated number of cycles in Columns (7) and (8). Regression models in Columns (2), (4), (6) and (8) control for respondents' gender, age, income, education, values, financial literacy and status quo bias as well as for a set of buidling and household characteristics (ownership status, household and dwelling size, building period, moving-in year, utility service area).
Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

Table 5: Effects on intensity of utilization: heterogeneity by purchase of new appliance

	Dishwasher		Washing Machine		Tumble Dryer		Total	
Purchase	yes	no	yes	no	yes	no	yes	no
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-1.244*	-0.564**	0.842	-0.690***	-0.152	-0.689***	-1.376	-1.461***
	(0.661)	(0.221)	(0.900)	(0.254)	(1.573)	(0.241)	(1.522)	(0.505)
Controls	No	No	No	No	No	No	No	No
Observations	42	465	26	440	17	344	74	538
Dependent variable mean control	5.692	4.159	3.000	3.890	3.333	2.191	10.818	8.810

Notes: OLS estimates of the treatment effects are reported. Dependent variables are the number of cycles per week for each appliance in Columns (1) to (6) and the aggregated number of cycles in Columns (7) and (8).
Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

Table 6: Effects on intensity of utilization: heterogeneity by pre-treatment intensity

	Dishwasher		Washing Machine		Tumble Dryer		Total	
Pre-treatment utilization	high	low	high	low	high	low	high	low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-0.921***	0.153	-1.584***	0.0585	-1.172***	0.0237	-2.681***	-0.0465
	(0.214)	(0.152)	(0.372)	(0.139)	(0.338)	(0.105)	(0.636)	(0.277)
Controls	No	No	No	No	No	No	No	No
Observations	188	308	228	250	179	134	270	270
Dependent variable mean control	6.616	2.515	5.899	2.129	3.660	0.723	13.067	4.391

Notes: OLS estimates of the treatment effects are reported. Dependent variables are the number of cycles per week for each appliance in Columns (1) to (6) and the aggregated number of cycles in Columns (7) and (8).
Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

treatment on appliances utilization. This includes both 'short-run' effects (i.e., keeping the capital stock constant) as well as 'long-run' effects (i.e., considering changes in the behavior due to changes in the appliances stock). Further, to isolate the effect of the information treatment on utilization, we run the same equation only for households that did not purchase any new appliances. Table 4 reports the estimates for the overall effect of the informational intervention on the level of utilization of dishwashers (Columns 1 and 2, excluding and including the set of controls, respectively), washing machines (Columns 3 and 4), tumble dryers (Columns 5 and 6) and the sum of the number of times any of these appliances is used in a typical week (Columns 7 and 8). Table 5 reports the results obtained distinguishing between households that did or did not purchase a new home appliance between pre- and post-treatment periods.

The results show a substantial negative effect of the information treatment on the usage of home appliances, with the overall intensity of utilization decreasing by around 16 percent in the treatment group. These results are confirmed when we restrict our sample for the analysis to households that did not purchase a new appliance between pre- and post-treatment periods (Column 8 of Table 5). On the one hand, this finding shows that an informational intervention about the energy costs of using appliances may also have implications in terms of the level of utilization of the existing appliances at home and, on the other, it provides additional evidence that consumers overall undervalue the energy costs of using home appliances.

Interestingly, we do not find any significant "long-run" effects on the utilization of washing machines and tumble dryers (Columns 3 and 5) as well as total utilization (Column 7).[31] A possible explanation of the latter result (besides the small sample size) is that the higher marginal capital costs of using the newly purchased dishwashers may be more than compensating the associated perceived savings from energy efficiency.

Finally, Table 6 reports estimates for the effects of the informational intervention on intensity of utilization by the pre-treatment intensity of usage.[32] These results show that the informational intervention induced a reduction in the intensity of appliances utilization among households that were utilizing the appliances more (i.e., with higher potential of monetary savings from a behavioral change) prior to the treatment.

5.4 Falsification test

As discussed in Section 3, the validity of our empirical strategy crucially relies on the absence of unobservable differences between treatment and control groups, i.e., the treatment

[31] In contrast, we find that the level of utilization of dishwashers decreases also among households that did purchase a new appliance (Column 1).

[32] We split the sample conditioning on the median of the distribution of intensity of utilization in the pre-treatment period.

assignment was random, conditional on observables, 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 choices of the two groups of households.

To support the credibility of the identifying assumption, we first exploit the information collected during the in-home visits about the year of purchase and electricity consumption of the existing appliances to test the hypothesis that the choices of purchase of energy-consuming durables did not differ between households in treatment and control groups before the intervention. Then, we compare the intensity of home appliances' utilization of households in the control group (observed in the year 2018) with that of households in the treatment group before the treatment (observed in the year 2017).[33]

Table 7: Falsification test: "placebo" treatment effects

	Electricity consumption *(Log Avg)*		A+++		Energy Services *(No of cycles)*	
Period	Post	Pre	Post	Pre	Post	Pre
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.143**	-0.019	0.266***	0.078	-0.965**	0.088
	(0.0693)	(0.110)	(0.101)	(0.113)	(0.421)	(0.430)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	101	81	101	81	540	530
Dependent variable mean control	5.398	5.512	0.267	0.296	8.778	8.778

Notes: OLS estimates of the treatment effects are reported in Columns (1), (2), (5) and (6) while the estimated marginal effect of the treatment indicator from the Probit model are reported Columns (3) and (4). Dependent variable in Columns (1) and (2) is the log of average annual electricity consumption of appliances purchased in 2016, a binary indicator for households that have purchased only A+++ appliance between November 2017 and December 2018 in Columns (3) and (4), and the number of aggregated weekly cycles of dishwashers, washing machines and tumble dryers in columns (5) and (6). All regression models control for respondents' gender, age, income, education, values, financial literacy and status quo bias as well as for a set of buidling and household characteristics (ownership status, household and dwelling size, building period, moving-in year, utility service area).
Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

We regress the log average electricity consumption of the home appliances purchased in the year 2016 on the treatment indicator, controlling for covariates.[34] The results presented in Column (2) of Table 7 show that, before the intervention, households allocated to control and treatment groups purchased home appliances with the same average electricity consumption. We also find no difference in the probability to purchase A+++ appliances or in the average

[33]Clearly, the test for absence of pre-treatment differences in utilization is valid under the assumption of no significant time trend in utilization.

[34]We do not consider households' choices of purchase in the "transition" year 2017 because the treatment group started to fill in the baseline survey in April 2017 and received the first in-home visits in October 2017.

intensity of appliances utilization (results in Columns 4 and 6 of Table 7, respectively) between treatment and control groups before the informational intervention.

Because these results show that, in the pre-treatment period, the two groups made the same investment choices, they provide further credibility to the validity of the assumption of unconfoundness of the treatment, and then to the interpretation of our estimates as causal effects of the informational intervention.

5.5 Potential of monetary savings and households responses

We have shown that the informational intervention induced households to purchase new energy efficient durables and to reduce their utilization. However, one might wonder whether our treatment induced these behavioral changes through enhanced knowledge about energy costs and potential of savings from adopting a more efficient technology, or other channels. For instance, the intervention might have also induced pro-environmental behavior through the role of warm glow or acted as a sort of "advertisement" for new energy efficient products. If the case was the latter, households would be responding to the letter they received regardless of its informational content. In contrast, larger responses of households to greater potential of monetary savings from the adoption of new technologies (i.e., treatment intensity) would be consistent with the idea that imperfect information or limited attention to such savings represent a barrier to households' investment efficiency.

Table 8: Information treatment effects: heterogeneity by treatment intensity

	Purchase				Efficiency			
	Appliance		Light bulb		log(Electricity)		EE light bulb	
Potential savings	high	low	high	low	high	low	high	low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	0.124**	-0.0679	0.0640	-0.00693	-0.179**	-0.115	0.0911**	0.0795**
	(0.0545)	(0.0460)	(0.0554)	(0.0590)	(0.0878)	(0.0766)	(0.0462)	(0.0352)
Controls	No	No	No	No	No	No	No	No
Observations	281	265	265	281	51	50	189	198
Dependent variable mean control	0.206	0.162	0.781	0.641	5.234	5.308	0.894	0.944

Notes: OLS estimates of the treatment effects are reported in Columns (5) and (6) while the estimated marginal effects of the treatment indicator from the Probit models are reported in the other columns. 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. Dependent variable in Columns (5) and (6) is the log of average annual electricity consumption of the newly purchased home appliances. Dependent variable in Columns (7) and (8) is an indicator for whether the household has purchased at least one energy efficient (LED) bulb between November 2017 and December 2018.
Standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

We exploit the household-specific potential of monetary savings from adopting more energy efficient home appliances and light bulbs reported in the letter we sent to treated households. We then estimate equation 3 for the probability to purchase a new home appliance and the electricity consumption of the newly purchased appliances, separately for above- and below-median levels of potential of monetary savings from adopting appliances with highest energy efficiency rating. Similarly, we estimate the treatment effects on the probability to purchase a new light bulb, and on the lighting efficiency separately for above- and below-median levels of potential of monetary savings from replacing existing halogen bulbs with LED bulbs. Results are reported in Table 8.

The results show that the informational intervention induced an increase in the probability to replace the existing home appliance with a new one by around 12 percentage points when, ex-ante, households had greater potential of monetary savings from replacing the existing appliances. When the ex-ante savings potential was below-median, we find no significant effect on the probability to purchase a new appliance. Further, the intensity of the treatment plays a role also for the energy efficiency of the newly purchased appliances, with a larger (though not statistically different) negative estimated effect of the intervention for above-median potential of savings. The treatment intensity seems to play a less important role for the response of households with respect to the purchase of new light bulbs, consistently with the significantly larger savings potential from adopting LED bulbs across the treatment intensity distribution.

Overall, these results show that our informational intervention affected mostly the behavior of purchase of those households that, ex-ante, had the larger potential of monetary savings from the adoption of new efficient durables, lending support to the hypothesis that the informational intervention affected households' choices through enhanced knowledge about energy costs or attention to savings.

5.6 The value of the informational intervention for treated households

To gain more insights into whether households' responses to the informational intervention in terms of home appliances purchases have been consistent with rational decision making (i.e., a minimization of the total costs for obtaining a flow of utility from using the durable goods), we compare the net present values of the investments undertaken by households in treatment and control groups. This is important in that more energy efficient products are often associated higher purchase prices and it may be then optimal (from a private perspective) for households to purchase less energy efficient durables.

Using the notation defined in Section 2, the impact of the informational intervention at the individual level on the lifetime costs NPV_i of home appliance j can be written as:[35]

$$NPV^T_{i,j} - NPV^C_{i,j} = P^C_{i,j} \underbrace{\tau^P}_{\text{TE: prices}} + Lc^e m^C_{i,j} e^C_{i,j} \left[(1 + \underbrace{\tau^e}_{\text{TE: energy intensity}})(1 + \underbrace{\tau_m}_{\text{TE: utilization}}) - 1 \right] \tag{4}$$

[35]This formulation assumes discount rates equal to zero.

Equation 4 highlights that the overall monetary value of the informational intervention for treated households depends on the combination of the treatment effect on appliances' purchase prices τ^P, energy intensity τ^e (i.e., electricity consumed by the purchased appliances to produce one unit of output) and utilization τ^m.[36] In general, higher purchase prices of the more energy efficient appliances may (at least in part) compensate the monetary savings from greater energy efficiency. Further, the possible presence of a rebound effect may as well decrease the reduction in energy costs from utilizing the durables with higher energy efficiency.

Table 9: Information treatment effects: home appliances prices and NPVs

	log(Price)		log(NPV)			
			Individual usage		Standardized usage	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.117	-0.267*	-0.137	-0.206*	-0.101	-0.181*
	(0.110)	(0.143)	(0.0911)	(0.106)	(0.0751)	(0.0937)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes
Observations	98	98	95	95	98	98
Dependent variable mean control	7.069	7.069	7.506	7.506	7.525	7.525

Notes: OLS estimates of the treatment effects are reported. Dependent variable in Columns (1) and (2) is a measure of the average market price in a given time period. Dependent variable in Columns (3) and (4) is the total lifetime cost considering individual intensities of utilization. Dependent variable in Columns (5) and (6) is the total lifetime cost assuming a standardized intensity of utilisation as suggested by the EU energy label. We assume a lifetime of 15 years for the appliances and a 0% discount rate for the calculation of the lifetime cost. Regression models in Columns (2), (4), (6) and (8) control for respondents' gender, age, income, education, values, financial literacy and status quo bias as well as for a set of buidling and household characteristics (ownership status, household and dwelling size, building period, moving-in year, utility service area).
Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

We compute the lifetime costs of each home appliance j, purchased by household i, as $NPV_{i,j} = P_{i,j} + Lc^e m_{i,j} e_{i,j}$ assuming a lifetime $L = 15$ years and a constant electricity price $c^e = 0.20$ CHF/kWh. We collect market prices P for each appliance purchased by households in the experimental sample in 2018.[37] To highlight the importance of allowing for changes in the behavior of utilization for gauging the overall value of the informational intervention, we report results for constant levels of utilization $m^T_{i,j} = m^C_{i,j}$, for all i, j, as well as using household-specific intensity of utilization for each appliance.[38] We estimate equation 3 for log

[36] Clearly, this general formulation applies to energy-consuming durables of which households can adjust utilization (dishwashers, washing machines and tumble dryers). $\tau^m = 0$ is assumed throughout the paper for fridges and freezers.

[37] As list prices commonly include unrealistically high mark-ups, we obtained our prices from toppreise.ch. This website collects offers from several retailers and records the lowest market price at different points in time. We took the average between the lowest offer at the beginning and at the end of 2018 as market price.

[38] The calculation of lifetime costs that assumes constant utilization uses 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

purchase prices and log total lifetime costs (with and without household-specific appliances utilization).

The estimates of the treatment effects on purchase prices (Columns 1 and 2) and total lifetime costs (Columns 3 to 6) are reported in Table 9. We find a negative effect of the informational intervention on purchase prices, with treated households speding around 25 percent less for the new appliances. This result is interesting in that it shows that treated households could buy new appliances that were more energy efficient (see results presented in Section 5) without higher initial investments. Coherently, we find that our intervention reduced the overall lifetime costs of home appliances, as shown in Columns 4 and 6. The treatment effect on lifetime costs is slightly larger when we consider household-specific utilization, suggesting the importance of considering the endogeneity of individuals' utilization choices when evaluating the overall impact of behavioral intervention aimed at affecting choices of purchase of new durables.

These results provide evidence that investment in energy efficient appliances can deliver in terms of private benefits, confirm that the information provision is welfare increasing (at least from a private perspective), and are consistent with an enhanced rationality (i.e., cost minimization for the production of consumption goods) of households following the informational intervention. This in turn provides further evidence that imperfect information or limited attention about energy costs represent an important barrier to optimal decision making in the context of investment in home appliances.

6. Conclusion

In this paper we have provided experimental evidence about the role of individuals' imperfect information or rational inattention about energy costs on their durable and utilization choices. We have analyzed the impact of a personalized informational intervention. Exploiting unique data on the energy efficiency of home appliances and light bulbs that each household in the sample owns, the intervention provided customized information about the potential of monetary savings on the electricity bill each household could achieve from the adoption of new comparable energy efficient durables.

We document a relevant impact of our informational intervention on households' choices. First, treated households purchased new home appliances and light bulbs that are substantially more energy efficient. Second, even when households did not purchase a new home appliance in the post-treatment period, the information treatment induced them to significantly reduce the intensity of utilization of home appliances such as dishwasher, washing machine and tumble dryer. Third, we show that the intervention induced households to purchase home appliances with lower total lifetime costs. This result has two implications:

clothes dryers, respectively).

(i) the investment in energy efficient home appliances can have positive private financial returns; (ii) the information treatment has been private welfare enhancing. We also find a larger durable choice response to the intervention among those households that were associated greater treatment intensity (i.e., the potential of monetary savings from the purchase of new efficient durables). These results point then more towards the informational intervention operating through enhanced individuals' knowledge about energy costs and less through the role of warm glow or "advertisement" for new energy efficient products. Because the information treatment was not provided on the marketplace at the time of the decision of purchase, but prior to the time of purchase, we can also exclude that the intervention acted through enhanced salience of energy costs.

Overall, our results suggest, together with the evidence of limited energy-related knowledge among households in our sample in the pre-treatment period, that (some) consumers are not fully informed about or do not pay attention to energy costs when purchasing and utilizing home appliances and light bulbs. These findings are important because they show that customized information can significantly improve consumers choices not only in health, education and finance (Hastings and Weinstein, 2008; Bertrand and Morse, 2011; Kling et al., 2012) but also in the energy sector. Moreover, they complement findings of previous studies that have shown that investment in energy efficient home renovations in the US do not deliver (Fowlie et al., 2018), and that American drivers are informed about fuel costs when buying a new vehicle (Allcott and Knittel, 2019). Investment in home appliances differs from that in home retrofits and vehicles for at least two important aspects. First, while Fowlie et al. (2018) show that the upfront investment costs of home improvements are about twice the actual energy savings in the US, we show that investment in energy efficient home appliances allows to reduce their total lifetime costs. Second, the market for home appliances is very different from that of vehicles. On the one hand, consumers are likely to value vehicles' characteristics other than energy costs significantly more than they do in the case of home appliances. On the other hand, automotive advertising expenditure is much larger than the advertising spending in the household appliance industry.[39] Finally, our findings complement those in Allcott and Taubinsky (2015), providing experimental evidence on the role of imperfect information in consumers' actual choices of light bulbs.

Our results show that an informational intervention on the energy costs of home appliances and light bulbs can induce a substantial behavioral choice response when it is personalized to the households' existing stock of durables and is provided with a letter that is available to households before they access the marketplace. They thus inform policy makers that informational campaigns that provide personalized information can increase the adoption of energy efficient durables and help reach the goals of energy conservation. Building on

[39] Automotive advertising expenditure (18 billion dollars) was around 20 times larger than the advertising spending in the household appliance industry (0.9 billion dollars) in the US market in 2018.

the findings in this paper, an important avenue for future research would be the investigation of which are the most efficient ways to deliver this customized information treatment in a cost-effective, scalable manner. For instance, an online platform using a centralized database with information on the efficiency of the household appliances on the market could provide similar personalized information to that whose effectiveness we evaluated in this paper. Provided the potential of private and social benefits from the diffusion of energy efficient home appliances, the development of such a policy tool would be highly cost effective. Further, more studies on the role of imperfect information or limited attention about energy costs are needed to investigate how individual, institutional and market characteristics influence the effectiveness of such informational interventions. Finally, more research is needed to understand to what extent individuals' limited knowledge about energy costs results from rational considerations or limitations in their decision making process.

References

Abaluck, J. and Gruber, J. (2011). Choice inconsistencies among the elderly: evidence from plan choice in the medicare part d program. *American Economic Review*, 101(4):1180–1210.

Allcott, H. and Greenstone, M. (2012). Is there an energy efficiency gap? *Journal of Economic Perspectives*, 26(1):3–28.

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., Mullainathan, S., and Taubinsky, D. (2014). Energy policy with externalities and internalities. *Journal of Public Economics*, 112:72–88.

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.

Bertrand, M. and Morse, A. (2011). Information disclosure, cognitive biases, and payday borrowing. *The Journal of Finance*, 66(6):1865–1893.

Bhargava, S. and Manoli, D. (2015). Psychological frictions and the incomplete take-up of social benefits: Evidence from an irs field experiment. *American Economic Review*, 105(11):3489–3529.

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.

Blasch, J. and Daminato, C. (2020). Behavioral anomalies and energy-related individual choices: the role of status-quo bias. *The Energy Journal*, 41(6).

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.

Brown, J., Hossain, T., and Morgan, J. (2010). Shrouded attributes and information suppression: Evidence from the field. *The Quarterly Journal of Economics*, 125(2):859–876.

Caplin, A. and Dean, M. (2015). Revealed preference, rational inattention, and costly information acquisition. *American Economic Review*, 105(7):2183–2203.

Chetty, R., Looney, A., and Kroft, K. (2009). Salience and taxation: Theory and evidence. *American economic review*, 99(4):1145–77.

Chetty, R. and Saez, E. (2013). Teaching the tax code: Earnings responses to an experiment with eitc recipients. *American Economic Journal: Applied Economics*, 5(1):1–31.

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.

Duflo, E. and Saez, E. (2003). The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment. *The Quarterly Journal of Economics*, 118:815–42.

d'Adda, G., Gao, Y., and Tavoni, M. (2020). Making energy costs salient can lead to low-efficiency purchases. *E2e Working Paper 045*.

Fowlie, M., Greenstone, M., and Wolfram, C. (2018). Do energy efficiency investments deliver? Evidence from the weatherization assistance program. *The Quarterly Journal of Economics*, 133(3):1597–1644.

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.

Gillingham, K., Rapson, D., and Wagner, G. (2016). The rebound effect and energy efficiency policy. *Review of Environmental Economics and Policy*, 10(1):68–88.

Hastings, J. S. and Weinstein, J. M. (2008). Information, school choice, and academic achievement: Evidence from two experiments. *The Quarterly Journal of Economics*, 123(4):1373–1414.

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

Kling, J. R., Mullainathan, S., Shafir, E., Vermeulen, L. C., and Wrobel, M. V. (2012). Comparison friction: Experimental evidence from medicare drug plans. *The Quarterly Journal of Economics*, 127(1):199–235.

Liebman, J. B. and Luttmer, E. F. (2015). Would people behave differently if they better understood social security? evidence from a field experiment. *American Economic Journal: Economic Policy*, 7(1):275–99.

Lusardi, A. and Mitchell, O. S. (2014). The Economic Importance of Financial Literacy: Theory and Evidence. *Journal of Economic Literature*, 52(1):5–44.

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.

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.

A. Appendix

A.1 Covariates definition and missing values

This Section provides further details on the set of covariates used in the analysis and reports the number and share of missing values in the final sample used for the estimation of the information treatment effects. We observe household income in ranges for gross monthly income. In the regression models for the estimation of the information treatment effects, we include three household income dummies: (i) below 6,000 CHF; (ii) 6,001 to 9,000 CHF; (iii) 9,001 to 12,000 CHF. Total gross household income above 12,000 CHF serves then as base category.

The advanced financial literacy index adds up the score from each of the "Big Three" financial literacy questions (Lusardi and Mitchell, 2014) and a question asking respondents to compare the lifetime costs of two refrigerators differing for their level of energy efficiency.

We build an indicator for status-quo bias following the same set of questions and the definition of the main index in Blasch and Daminato (2020).

The biospheric index is a measure of the respondent's environmental values, that uses the definition of biospheric value orientations as defined by Steg et al. (2014). Respondents were asked to rate how important some values were for them as a guiding principle in their life. We measure respondent's environmental values by adding up the ratings to four values: respecting the earth, unity with nature, preventing pollution and protecting the environment.

Table 10: Missing values in covariates

	Missing	Total	Percent Missing
female	0	546	0.00
age	1	546	0.18
household size	12	546	2.20
university	0	546	0.00
income: 6000 or less	1	546	0.18
income: 6001-9000	1	546	0.18
income: 9001-12000	1	546	0.18
tenant	0	546	0.00
multi-family house	0	546	0.00
living area	5	546	0.92
biospheric index	12	546	2.20
advanced financial literacy	0	546	0.00
status-quo index	2	546	0.37
building period: 1970-2000	7	546	1.28
building period: after 2000	7	546	1.28
moved in before 2012	0	546	0.00
Lugano	0	546	0.00

Notes: The Table reports the number and share of missing values of covariates used in the analysis.

A.2 Attrition

Table 11: Attrition

	(1) audit	(2) followup
treatment	-0.0431	
	(0.0280)	
female		0.0202
		(0.0329)
age		-0.000360
		(0.00184)
household size		-0.0158
		(0.0191)
university		0.00306
		(0.0394)
income: 6000 or less		0.0101
		(0.0499)
income: 6001-9000		0.0186
		(0.0436)
income: 9001-12000		0.0576
		(0.0435)
tenant		-0.122**
		(0.0589)
multi-family house		0.0260
		(0.0517)
living area		-0.000285
		(0.000324)
biospheric index		0.0219
		(0.0202)
advanced financial literacy		-0.00833
		(0.0245)
status-quo index		-0.00506
		(0.0107)
building period: 1970-2000		-0.0328
		(0.0462)
building period: after 2000		0.0629
		(0.0418)
moved in before 2012		-0.0689
		(0.0475)
Lugano		-0.0983**
		(0.0384)
Constant	0.431***	0.933***
	(0.0242)	(0.233)
Observations	1601	458
R^2	0.002	0.052
F	2.369	1.395
p_value	0.124	0.134

Notes: OLS estimates of the treatment effects are reported. Dependent variable in Column (1) is a binary indicator for households that booked an in-home visit. Dependent variable in Column (2) is a binary indicator for households that took the follow-up survey withing the treatment group. Robust standard errors are reported in parentheses. */**/*** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

Working Papers of the Center of Economic Research at ETH Zurich

(PDF-files of the Working Papers can be downloaded at www.cer.ethz.ch/research/working-papers.html).

20/334 N. Boogen, C. Daminato, M. Filippini, A. Obrist
Can Information about Energy Costs Affect Consumers Choices? Evidence from a Field Experiment

20/333 M. Filippini, N. Kumar, S. Srinivasan
Nudging the Adoption of Fuel-Efficient Vehicles: Evidence from a Stated Choice Experiment in Nepal

20/332 L. Bretschger, E. Grieg
Exiting the fossil world: The effects of fuel taxation in the UK

20/331 H. Gersbach, E. Komarov
Research Bubbles

20/330 E. V. Dioikitopoulos, C. Karydas
Sustainability traps: patience and innovation

19/329 M. Arvaniti, C. K. Krishnamurthy, A. Crepin
Time-consistent resource management with regime shifts

19/328 L. Bretschger, K. Pittel
Twenty Key Questions in Environmental and Resource Economics

19/327 C. Karydas, A. Xepapadeas
Climate change financial risks: pricing and portfolio allocation

19/326 M. Filippini, S. Srinivasan
Investments in Worker Health and Labor Productivity: Evidence from Vietnam

19/325 H. Gersbach
Democratizing Tech Giants! A Roadmap

19/324 A. Brausmann, M. Flubacher and F. Lechthaler
Valuing meteorological services in resource-constrained settings: Application to smallholder farmers in the Peruvian Altiplano

19/323 C. Devaux and J. Nicolai
Designing an EU Ship Recycling Licence: A Roadmap

19/322 H. Gersbach
Flexible Majority Rules for Cryptocurrency Issuance

19/321 K. Gillingham, S. Houde and A. van Benthem
Consumer Myopia in Vehicle Purchases: Evidence from a Natural Experiment

19/320 L. Bretschger
Malthus in the Light of Climate Change

19/319 J. Ing and J. Nicolai
Dirty versus Clean Firms' Relocation under International Trade and Imperfect Competition

19/318 J. Ing and J. Nicolai
North-South diffusion of climate-mitigation technologies: The crowding-out effect on relocation

19/317 J. Abrell, M. Kosch and S. Rausch
How Effective Was the UK Carbon Tax? - A Machine Learning Approach to Policy Evaluation

19/316 D. Cerruti, C. Daminato and M. Filippini
The Impact of Policy Awareness: Evidence from Vehicle Choices Response to Fiscal Incentives

19/315 M. Filippini, N. Kumar and S. Srinivasan
Energy-related financial literacy and bounded rationality in appliance replacement attitudes: Evidence from Nepal

19/314 S. Houde and E. Myers
Heterogeneous (Mis-) Perceptions of Energy Costs: Implications for Measurement and Policy Design

19/313 S. Houde and E. Myers
Are Consumers Attentive to Local Energy Costs? Evidence from the Appliance Market

19/312 N. Kumar
A model-based clustering approach for analyzing energy-related financial literacy and its determinants

19/311 C. Karydas and A. Xepapadeas
Pricing climate change risks: CAPM with rare disasters and stochastic probabilities

19/310 J.Abrell,S. Rausch and C. Streitberger
Buffering Volatility: Storage Investments and Technology-Specific Renewable Energy Support

19/309 V. Britz
Negotiating with frictions

19/308 H. Gersbach and S. Papageorgiou
On Banking Regulation and Lobbying

18/307 V. Britz, A. Ebrahimi and H. Gersbach
Incentive Pay for Policy-makers?

18/306 C. Colesanti Senni and N. Reidt
Transport policies in a two-sided market

18/305 A. Schäfer and A. Stünzi
The impact of green preferences on the relevance of history versus expectations

18/304 M. Filippini and S. Srinivasan
Impact of religious participation, social interactions and globalisation on meat consumption: evidence from India

18/303 H. Gersbach and M.-C. Riekhof
Permit Markets, Carbon Prices and the Creation of Innovation Clusters

18/302 M. Hersche and E. Moor
Identification of Causal Intensive Margin Effects by Difference-in-Difference Methods

18/301 L. Kleemann and M.-C. Riekhof
Changing background risk and risk-taking - Evidence from the field

18/300 J. Blasch and C. Daminato
Behavioral anomalies and energy-related individual choices: the role of status-quo bias

18/299 S. Rausch and H. Schwerin
Does Higher Energy Efficiency Lower Economy-Wide Energy Use?

18/298 H. Gersbach, U. Schetter and M. Schneider
Economic Rationales for Investments in Science

18/297 K. Borissov and L. Bretschger
Optimal Carbon Policies in a Dynamic Heterogenous World

18/296 L. Bretschger and C. Karydas
Economics of Climate Change: Introducing the Basic Climate Economic (BCE) Model

18/295 A. Pattakou and A. Vlahakis
Effectiveness of renewable energy subsidies in a CO2 intensive electricity system

18/294 H. Gersbach, V. Hahn and Y. Liu
Macroprudential Policy in the New Keynesian World

18/293 H. Schwerin
Swap Bonds or Stocks, or Balance Trade! A Game of Implicit Environmental Policy