Investment Literacy and Choice of Electric Appliances: The Impact of Educational Programs and Online Support Tools*

Julia E. Blasch[1,2],
Massimo Filippini[2,3],
Nilkanth Kumar[†2], and
Adan L. Martinez Cruz [2]

[1] *Institute for Environmental Studies, VU University Amsterdam*
[2] *Centre of Economic Research (CER-ETH), ETH Zürich*
[3] *Università della Svizzera italiana*

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Abstract

This paper explores the possibility that enhancing individuals' energy and investment literacy increases the rate at which households identify the most cost-effective, and ideally also most energy-efficient, electrical appliances. To test the influence of enhancing an individual's investment literacy on the choice of appliances, we developed an online randomized control trial and implemented them on two independently chosen samples of the Swiss population. One treatment offers a short education program — via a set of information slides. The second intervention provides access to an online calculator that supports the investment decision-making of the individual. Results across the two samples are encouraging. We find that i) pre-treatment investment literacy positively impacts on the probability of identifying the most cost-effective appliance; ii) the reinforcement of the energy and investment literacy increases the rate at which individuals identify the most cost-effective appliance; and iii) while both interventions are effective in increasing the chances that a cost-effective appliance is chosen, the online calculator turned out to be more effective than the educational program. Public policy implications are discussed.

Keywords: energy efficiency; investment literacy; appliance choice; bounded rationality; educational programs; online tool

JEL Classification Codes: D12, D13, D80, Q41, Q48.

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†Center of Economic Research (CER-ETH), ETH Zürich, Zürichbergstrasse 18, 8032 Zürich, Switzerland. Phone: +41 44 633 80 89, Fax: +41 44 632 10 50. <nkumar@ethz.ch>

1 Introduction

Energy efficiency is recognized to be one of the most cost-effective ways to address the challenges of guaranteeing energy security, reducing local air pollution and fighting global climate change (IEA, 2015). Globally, the residential sector consumes about a quarter of total final energy consumption (IEA, 2014). Enhancing the energy efficiency in the residential sector is therefore essential if economies want to reduce total fossil energy consumption (IEA, 2015) and related CO_2-emissions as agreed by the parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris in 2015 (United Nations, 2015).

Recent research has shown that energy and investment literacy can positively influence the level of energy efficiency of a household by supporting consumers' choices of more efficient electrical appliances (Blasch et al., 2016, 2017; Brounen et al., 2013). In fact, identifying the most cost-effective, and ideally also most energy-efficient, electrical appliance can be challenging for the consumer. To make an economically rational choice, an individual should perform an investment analysis before every purchase: he or she should compare not only the purchase prices of the appliances but also their future operating costs. The latter depend on the electricity consumption of the appliance, the expected intensity and/or frequency of use, the expected lifetime of the appliance as well as current and future electricity prices. Performing this calculation requires not only that all this information is available in the purchase situation but also that the consumer is able to process this information. Carrying out an investment analysis or calculating the expected lifetime cost of an electric appliance thus creates both 'information cost' and 'optimization cost' (Conlisk, 1988) for the consumer. These are often also referred to as 'deliberation cost' (Pingle, 2015), a concept that is closely interrelated with the concept of 'bounded rationality' (Simon, 1959; Sanstad and Howarth, 1994), which reflects that information acquisition is costly and the processing of information is cognitively burdensome. Consequently, boundedly rational individuals tend to not optimize when making an investment decision but to follow simple rules of thumb or decision-making heuristics (Wilson and Dowlatabadi, 2007; Frederiks et al., 2015). If the consumer has a low level of energy and investment literacy, the probability increases that he or she may use heuristic decision-making rather then performing an investment calculation when choosing between two appliances (Blasch et al., 2016). A higher level of energy and investment literacy, instead, can make the investment analysis substantially 'less costly' for the consumer, which raises the chances that the individual will optimize over the lifetime cost of an appliance.

In this paper, we define energy literacy to be the individual's prior energy-related knowledge and investment literacy to be the individual's cognitive ability to perform an investment analysis. The latter is closely linked to the concept of financial literacy, i.e. an individual's knowledge of tools that allow to control, invest and manage own finances, which enables an individual to optimize the use of scarce financial resources. The literature on financial literacy suggests that individuals with strong financial skills are able to make efficient financial decisions in various domains (Lusardi and Mitchell, 2011, 2014). In this paper, we argue that a high level of financial literacy, especially investment literacy, has a positive impact on decisions related to investments in efficient electrical appliances. As shown by Attari et al. (2010) for the US, by Brounen et al. (2013) for the Netherlands and by Blasch et al. (2017) for Switzerland, the level of energy-related knowledge and investment literacy in the population tends to be relatively low. Moreover, Blasch et al. (2016) show that a great share of individuals seems to not consider the lifetime cost of electrical appliances when choosing between two appliances. As energy-efficient electrical appliances are usually more costly than less efficient appliances, boundedly-rational consumers will tend to opt for the less efficient appliances with lower upfront cost. This situation can be classified as a behavioural failure (Broberg and Kazukauskas, 2015). In this paper, we are therefore particularly interested in studying the behavioural failure related to the fact that consumers lack financial and investment literacy.

From an energy policy point of view, it would be desirable to improve the level of investment literacy among consumers. To this end, educational programs and decision-support tools that aim at increasing the literacy among consumers could play an important role. In fact, as shown by Lusardi and Mitchell (2014), financial education can generally help consumers in taking financial decisions. In the context of individual energy consumption, studies by Dwyer (2011) and Zografakis et al. (2008) show that an introduction of energy literacy curricula at schools can positively impact on the energy-related behaviour of students. Attari and Rajagopal (2015) compare and discuss various decision aids to help consumers make effective decisions. Among them are: the Energy Star label, the appliance calculators of the US Department of Energy, and the Home Energy Saver online tool of the Lawrence Berkeley National Laboratory. They conclude that simplified versions of these tools are needed to support the decision-making of consumers, yet they do not empirically test the effectiveness of these tools.

The increasing distribution of internet access within households opens the opportunity to propose educational materials that can be accessed quickly and in a relatively easy way. In this paper, we analyze the impact of a short online educational program and an online investment calculator on consumers' ability to identify the most cost-effective electrical appliance when confronted with a choice between two appliances. The first intervention, a set of information slides, is designed to improve the consumers' knowledge on how to do an investment analysis and to compare lifetime cost of appliances. The second intervention provides access to a simple online calculator to compare the lifetime cost of two appliances, which potentially minimizes the cognitive effort that has to be spent on the investment analysis.

Apart from various studies on the effectiveness of energy efficiency labelling (McNeill and Wilkie, 1979; Anderson and Claxton, 1982; Heinzle, 2012; Newell and Siikamäki, 2013; Houde, 2014), very few studies evaluated the effectiveness of decision-support tools in directing consumers towards purchasing more efficient electric appliances. Allcott and Taubinsky (2015), for example, show that disclosing lifetime cost of light bulbs in the purchase situation increased consumers' willingness to pay for compact fluorescent light bulbs. Allcott and Sweeney (2015) test whether energy efficiency information through sales agents in the purchase situation positively impacts on consumers' purchases of energy-efficient appliances but do not find any effect. To our knowledge, this paper is the first to analyze the impact of investment calculators and educational programs in the context of energy efficiency.

The impact of the information slides and of the online calculator was analyzed by performing an online randomized control trial among two independent samples of Swiss households in which participants had to evaluate the lifetime cost of two appliances differing in purchase price and energy consumption. The first sample of 916 households represents the consumers living in the city of Bern, whereas the second sample of $5,015$ households represents the households living in the German- and French-speaking parts of Switzerland. On estimating several bivariate and recursive bivariate probit model specifications, we find that the investment calculator is highly effective in increasing the probability that a consumer identifies the electrical appliance with the lower lifetime cost. This supports the insight that the cognitive effort to calculate and compare the lifetime cost is a major barrier for individuals in identifying the most efficient appliance. At the same time, a simple online calculator is a low cost tool that could support boundedly rational consumers substantially. The educational slides presenting information on how to compute the lifetime cost of an electrical appliance were also effective but to a lesser extent than the investment calculator. This suggests that the information slides reduce the cognitive cost of making the calculation, yet not as strongly as the online calculator.

Our results are robust in that they manifest in two independently drawn samples of Swiss households. We conclude that online tools such as simple investment calculators that could be provided through mobile phone applications can be particularly effective in supporting consumers' decisions to choose efficient electrical appliances. From a policy point of view, they provide a cost-effective and easy to implement instrument to empower the boundedly rational consumer in the domain of appliance choice.

The remainder of the paper is organized as follows. Section 2 discusses the role of energy literacy and investment literacy for choice of appliances. The dataset and the experiment design is presented in section 3 and the econometric specifications are presented in section 4. Section 5 presents the results and section 6 concludes.

2 The role of energy and investment literacy for appliance choice

2.1 Relevance of energy and investment literacy

Blasch et al. (2016) have shown that an important prerequisite for rational decision-making in the domain of electric appliances is energy literacy, i.e. an individual's ability to make informed and deliberate choices in the domain of household energy consumption (DeWaters and Powers, 2011). Yet, more importantly, individuals need to have the ability to do an investment calculation to compute the lifetime cost of different appliances to be able to identify the most cost- and energy-efficient appliances (Blasch et al., 2016; Brounen et al., 2013).

We define investment literacy as an individual's ability to perform an investment analysis. In the energy context, investment literacy gets relevant when consumers have to decide between different electric appliances, heating systems or energy-efficient renovations: It is important for the consumers to be able to perform an investment analysis as well as to calculate and compare the expected lifetime cost (upfront cost and operating cost) of different electrical appliances. The concept of investment literacy can be closely related to the concept of financial literacy (Lusardi and Mitchell, 2014), i.e. consumers' ability to 'process economic information and make informed decisions about financial planning, wealth accumulation, debt, and pensions' (Lusardi and Mitchell, 2014, p.2). In Lusardi and Mitchell (2011), a simple measure for financial literacy comprising three questions is provided. One question requiring the respondents to make a compound interest calculation, one question asking for the effect of inflation on interest rates and one question testing consumers' knowledge about diversification of risks. The compound interest calculation has been taken up in Blasch et al. (2016) and Blasch et al. (2017) to measure individual investment literacy in the energy context.

The broader literature on financial literacy shows, for example that more educated people are more likely to correctly answer a question on compound interest and that this indicator has a relevant influence on economic decisions in several domains: inter alia, individuals who know about interest compounding are 15 percentage points more likely to be retirement planners (Lusardi and Mitchell, 2007). Brown and Graf (2013) find for a sample of Swiss consumers that respondents scoring high on financial literacy are more likely to have an investment related custody account and to make voluntary retirement savings. In addition, there seems to be a role for education more generally when it comes to energy-related decision-making. While an individual's level of education does not necessarily need to correlate with energy literacy and energy-related investment literacy, some studies find a positive correlation of these two constructs with an individual's general level of education (Mills and Schleich, 2010; Nair et al., 2010; Mills and Schleich, 2012). In an analysis conducted by Ramos et al. (2015) on survey data from Spain, education has a positive impact on the probability to invest in energy efficiency. Finally, also Brounen et al. (2013) find that more educated respondents are more likely to make a rational investment decision when comparing two different heating systems that differ in energy-efficiency and upfront cost.

With respect to the implementation of educational programs, Zografakis et al. (2008) report results from a small-scale energy-related information and education project in Greece that impacts positively on stated energy-saving behaviors. Dwyer (2011) develops an energy literacy curriculum for US students and evaluates its impact on stated energy-related attitudes. Finally, Allcott and Sweeney (2015) evaluate whether providing energy efficiency information through sales agents impacts on consumers' choices of electrical appliances and find it to be little effective. Apart from these studies, we are not aware of a study that investigates the impact of energy-related knowledge and investment literacy on the choice of efficient electrical appliances.

2.2 A theoretical framework

The impact of energy and investment literacy on the choice of efficient electrical appliances can be studied in a theoretical framework that accounts for the influence of decision-making cost as well as energy and investment literacy on the decision to optimize or to follow a decision-making heuristic. Such a framework has been developed by Blasch et al. (2016) who provide a simple 2-period-model of expectation formation in which the impact of energy and investment literacy on the decision to optimize or to follow a decision-making heuristic is formalized. In this paper, we build upon the framework in Blasch et al. (2016) and extend it by separately specifying the influence of energy and investment literacy.

The model relies on previous work of Conlisk (1988) and assumes that an individual assesses the expected lifetime cost of an appliance before purchase. While doing so, the individual minimizes two potential sources of loss: *i)* a loss in inter-temporal utility by either underestimating the lifetime cost of an appliance in period 1 and thus not allocating enough of the budget in period 2 on the consumption of the energy service, or, by overestimating the lifetime cost of an appliance in period 1 and thereby restricting consumption of other goods in period 1 itself due to the individual's budget constraint, and *ii)* spending too much time and resources on decision making itself.

The model by Blasch et al. (2016) assumes that the individual aims at minimizing the following loss function:

$$(E(L(T)) - L)^2 + \beta CT \tag{1}$$

with $E(L(T))$ representing the estimated lifetime cost of the appliance after having spent T units of time and other resources on deliberation, and L representing the true lifetime cost of the appliance. The second component represents the decision cost βCT, which are composed of the unit cost of performing the calculation task C multiplied by the amount of time and other resources devoted to deliberation T as well as the parameter $\beta \in [0, 1]$. The latter captures the individual's capacity for performing the calculation task with $\beta = \epsilon\gamma$ expressing that the capacity is composed of the individual's energy literacy ϵ and investment literacy γ. The lower the product $\epsilon\gamma$, the lower the individual's effort needed to perform the task, and hence the lower his or her overall decision cost.

Following Blasch et al. (2016), we can write the individual's expected lifetime cost of the appliance as:

$$E(L(T^\star)) = \alpha f + (1 - \alpha) r(T^\star) \tag{2}$$

with

$$\alpha = \frac{S}{(S + T^\star)} = S\sqrt{\epsilon\gamma C/\sigma^2} \tag{3}$$

with f representing a free estimator that is based on a simple rule of thumb, $r(T)$ denoting a costly improvement of the free estimator that depends on the time T spent on deliberation. $r(T)$ is as accurate as a sample mean of T independent observations taken from a distribution with mean R, the rational expectation of L, and variance σ^2. Both T and S represent the number of thoughts drawn from a distribution with mean R and variance σ^2.

By definition, α has an upper bound of 1 when the corner solution $T^{\star} = 0$ applies, i.e. when individual's rule of thumb choice is good enough. Equation (2) can be seen to cover both the extremes; when $T^{\star}$ goes to infinity, the expected lifetime cost converges to the rational expectation R. On the other hand, when $T^{\star} = 0$, i.e. when $\alpha = 1$, the expected lifetime cost is the free estimator f. Depending upon the different parameters, an individual could be lying anywhere between the range of unbounded rationality and a rule of thumb approximation (Conlisk, 1988).

The estimation of the lifetime cost of the appliance will thus be more closer to the rational expectation R as α gets smaller. From equation (3), α is the lower

- the lower $\epsilon\gamma$, i.e. the higher the level of the individual's energy and investment literacy and hence the lower the individual's effort to perform the estimation of the lifetime cost of the appliance
- the lower C relative to σ^2, i.e. the lower the decision making cost related to the complexity of the problem
- the lower S, i.e. the lower the amount of (costless) best guesses spent on estimating R, i.e. the less reliable the rule of thumb

Any individual having to decide between several appliances on offer, will first assess the lifetime cost of all the appliances separately and then in a second step compare them to identify the one with the minimum lifetime cost. From the above described model, we derive two hypotheses with respect to whether the individual rather deliberates or follows a rule of thumb when comparing the appliances (choice of decision-making strategy). Depending on the choice of decision-making strategy, the individual will be either more likely, or less likely to identify the more cost-effective appliance (choice of appliance).

We propose that intervening in the decision-making of the individual by means of an educational program or a calculator tool impacts differently on the choice of the decision-making strategy, and consequently on the appliance choice. An educational program will impact on the choice of the decision-making strategy through an individual's level of energy and investment literacy ($\epsilon\gamma$). As literacy will be enhanced by the program, the probability that the individual chooses an optimization strategy rather than heuristic decision-making will be increased. A calculator tool, however, will not directly impact on an individual's level of energy and investment literacy, but reduce the unit costs of decision-making (C), such that the probability to choose an optimization strategy increases, irrespective of the individual's level of energy- and investment literacy (see figure 1).

We thus expect that increasing an individual's level of energy and investment literacy through an educational program, represented by a lower $\epsilon\gamma$ in the theoretical model, will raise the probability that the individual chooses to conduct an investment analysis as the decision-making strategy (*H1a*) and, in a second step, will also make it more likely that consumers identify the more cost-effective appliance (*H1b*).

In addition, we expect that an individual, for which a calculator tool minimizes the per unit cost of decision making C will be more likely to perform an investment analysis rather than using a heuristic decision-making strategy (*H2a*). Analogously, we expect in a second step that the minimization of the per unit decision making costs C increases the probability that the individual identifies the more cost-efficient appliance (*H2b*).

We thus derive the following four hypotheses from our theoretical framework:

- *H1a:* Educating individuals and enhancing their level of energy and investment literacy ($\epsilon\gamma$) has a positive impact on the individuals' ability to follow an optimization strategy rather than a heuristic decision-making strategy.

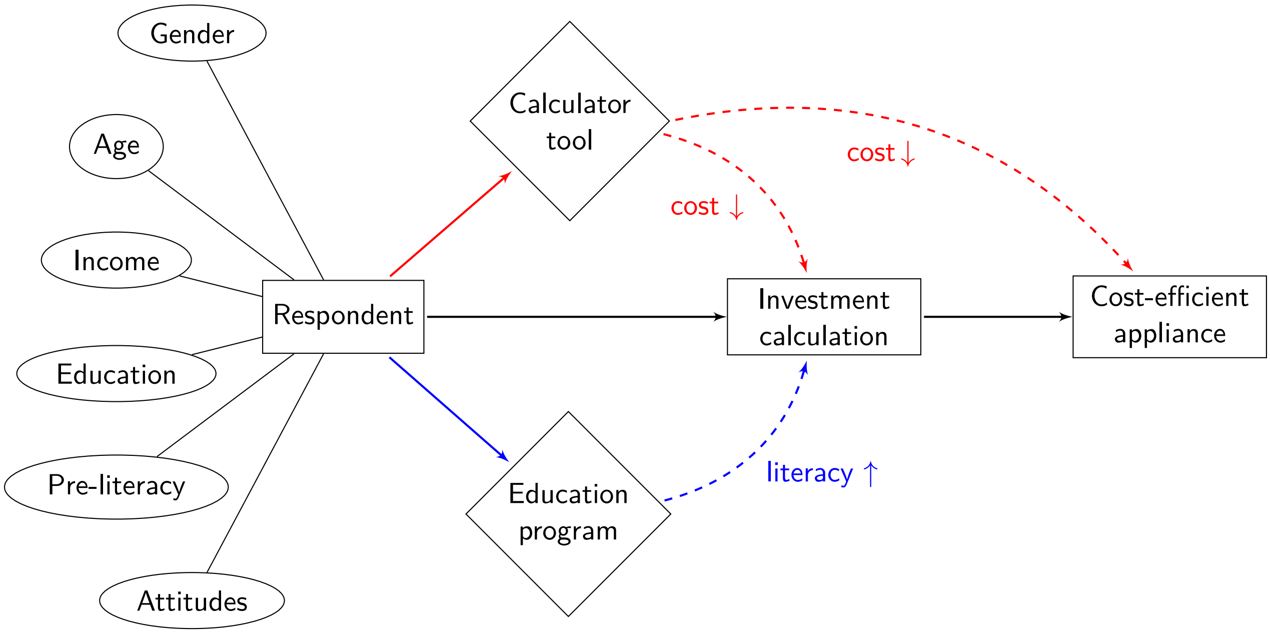


Figure 1: Decision making, interventions, and the choice of appliance.

- *H1b:* Educating individuals and enhancing their level of energy and investment literacy ($\epsilon\gamma$) has a positive impact on an individual's probability to identify the most cost-efficient appliance.
- *H2a:* Minimizing the unit cost of performing the calculation (C) has a positive impact on an individual's ability to follow an optimization strategy rather than a heuristic decision-making strategy.
- *H2b:* Minimizing the unit cost of performing the calculation (C) has a positive impact on an individual's probability to identify the most cost-efficient appliance.

3 Data

We use two different data sources, both of which implemented an online randomized controlled experiment asking the respondents to identify the most cost-efficient appliance among two refrigerators. One of the samples is part of the household survey on energy usage which relates to customers of an electric and gas utility serving the region of Bern in Switzerland (hereafter, referred to as HSEU-Bern). Another sample is part of the Swiss Household Energy Data Survey (SHEDS) data covering a broader population belonging to the French and German parts of Switzerland.

The online randomized controlled experiment, which is described later in section 3.3, is the same in both samples. So are most of the survey questions that captured demographic and socio-economic information used in our analysis. There are, however, some noteworthy differences. HSEU-Bern has an additional variable (whether or not the respondent knows the cost of 1 kWh in Switzerland) included in the definition of energy literacy when compared to SHEDS. Furthermore, the investment literacy is measured using a separate compound interest question which is not available in the SHEDS data.[1] Nonetheless, SHEDS dataset exhibits a broader coverage of the Swiss population than the HSEU-Bern data. Each of these datasets are further described below.

[1]A related information whether the respondent has a university education is captured by both datasets.

3.1 HSEU-Bern

The data gathered for the analysis here comes from a large web-based household survey on household energy use conducted by the Centre for Energy Policy and Economics (CEPE) in co-operation with participating electrical and gas utilities across several cities throughout Switzerland. The experiment considered here was run as an online randomized controlled experiment as part of the household survey for the customers of Energie Wasser Bern (EWB) in 2016.

EWB customers were invited with a letter accompanying one of their electricity (or gas) bills to access an online questionnaire.[2] The invitation letter was sent to a total of $29,000$ customers of which $1,145$ accessed the survey page (corresponding to a response rate of about 4%). After accounting for the correct target group and incomplete surveys, we have valid and complete data for 916 survey respondents that can be used for our analysis.[3]

The representativeness of this sample is difficult to comment on due to limited availability of a reference socio-economic data at the regional level. Nevertheless, we compare our sample to the average values available at the city/cantonal/national level and the observed sample are found largely to be representative of the Swiss population living in urban and sub-urban regions. More importantly, the share of respondents who donated money to an environmental organization within the 12 months preceding the survey is largely in line with the share reported for the Swiss population, which suggests that our sample does not seem biased towards households with pro-environmental attitudes.

3.2 SHEDS

The Swiss Household Energy Data Survey (SHEDS) has been designed as part of the research agenda of the Competence Center for Research in Energy, Society and Transition (SCCER-CREST). Researchers collaborating in the SCCER-CREST aim to contribute in the generation of an energy transition plan in Switzerland. Consequently, SHEDS has been designed to obtain a comprehensive description of the energy-related behaviour in Switzerland. Due to budgetary and data availability reasons, SHEDS has gathered information about the French and German residential sectors of Switzerland. The first wave of SHEDS was implemented in April 2016 via a web-based instrument, and three more waves are planned.

The target survey group in SHEDS consists of about 5,000 households that are representative of Switzerland (without Ticino). SHEDS gathers information energy-related behaviour in two realms —residential and transportation. In addition, a substantial share of the first wave of SHEDS has been used to gather attitudinal, psychological, and socio-economic variables. Also, this first wave included the randomized control trial that we describe below.

[2] In general, the utilities in consideration had a rolling billing cycle over few months. After discussion with the utilities, the survey was open for about 19 to 21 weeks as a guideline so that customers have sufficient time to take part. For EWB, the survey was open for about 19 weeks during January to May in 2016.

[3] A total of 987 respondents were filtered-in as the target group, of which 916 completed the survey. The target group consists of respondents (i) for whom the electricity/gas bill refers to their primary residence; (ii) who moved in their current residence before 01.01.2015; and (iii) who are one of the persons in their residence who decides about the purchase of goods and/or pays the bills.

3.3 Experiment design

The online randomized controlled experiment was embedded within the two household surveys.[4] All respondents were randomly assigned to one of the three groups – control group (CONTROL), a treatment group with education-slides (TRSLIDE), and another treatment group with access to an online calculator (TRCALC). Within HSEU-Bern, each respondents had an equal probability of being assigned to any of the three groups. In the SHEDS experiment however, about 20% of the total $5,015$ respondents were randomly selected to be part of one of the two treatment groups with equal probability, the rest being the control.[5]

The respondents were asked to imagine a situation in which they need to replace their refrigerator. They were given a choice between two refrigerators that differed only in terms of their purchase price and their energy consumption (in kWh/year). Respondents were asked which of the two refrigerators would minimize their expenditure on the cooling of food and beverages during 10 years of planned usage (figure 2). The two refrigerator alternatives, and the two answer options within the decision making question, were presented to the respondents in a random order to control for any order bias.

Assume that you need to replace your fridge. You expect that you live in your current residence for another 10 years. In a shop you find the following two fridges which are identical in terms of size and cooling service.

	Fridge - A	Fridge - B
Purchase Price:	3300 CHF	2800 CHF
Electricity Consumption:	100 kWh/year	200 kWh/year

Assuming that one kilowatt hour (kWh) of electricity will cost about 20 Rappen on average during the next 10 years and that the value of 1 CHF in 10 years is the same as the value of 1 CHF today:

Which of the two fridges minimizes your expenditure for cooling food and beverages during the lifetime of 10 years?

- ◯ The fridge for 3300 CHF
- ◯ The fridge for 2800 CHF

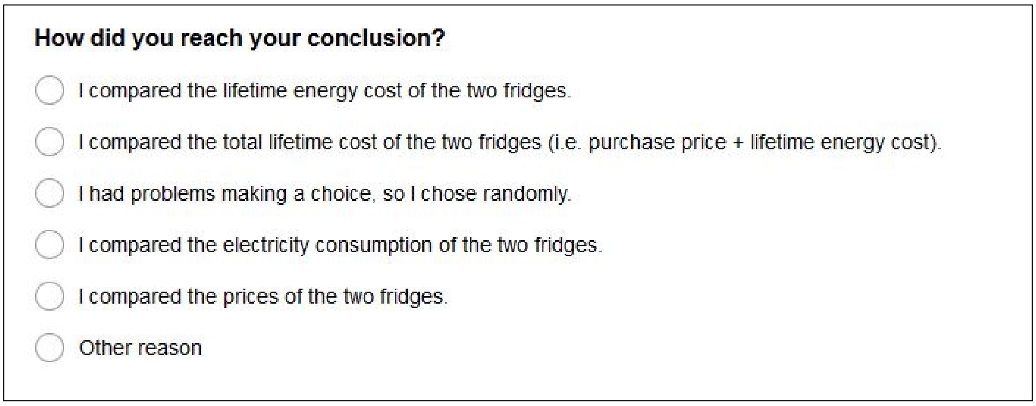
Figure 2: The refrigerator question as presented to all respondents.

It is worth pointing-out that the question was not about the respondent's subjective preference for either of the refrigerator, but about which of the two creates less lifetime costs from an objective point of view. In principle, the result of the comparison of lifetime cost will also be driven by the individual's subjective discount rate. Assuming that the average participant of our study is not familiar with the concept of discounting and would need a calculator to incorporate variable discounting in the analysis, they were asked to assume that 1 kWh of electricity will cost about 20 Rappen on average during the next 10 years and that the value of 1 CHF in 10 years is the same as the value of 1 CHF today.

[4]Note that the online experiment is a RCT (and not simply a stated choice exercise) because (i) the framework encompasses impact of an actual decision, which in this case is identification of the most cost-efficient appliance among two given refrigerators; and (ii) the assignment of respondents to control or treatment groups is completely random.

[5]SHEDS was a relatively long survey, and a smaller percentage of the respondents was chosen to be part of the intervention (presumably) as a restraint to the length of the survey. Nonetheless, we still have about 500 respondents for each of the two treatment groups.

After the decision question, we ask each respondent about their respective decision strategy, i.e. how did they reach their conclusions (figure 3). Again here, the answer options to the debriefing question (except the 'Other reason' option) were presented in a random order to avoid any order-bias.[6]


How did you reach your conclusion?

- I compared the lifetime energy cost of the two fridges.
- I compared the total lifetime cost of the two fridges (i.e. purchase price + lifetime energy cost).
- I had problems making a choice, so I chose randomly.
- I compared the electricity consumption of the two fridges.
- I compared the prices of the two fridges.
- Other reason

Figure 3: Debriefing question for all respondents asking about their decision strategy.

For the CONTROL group, no additional support tool was provided to assist in identifying which of the two refrigerators would minimize their expenditure over 10 years.

The TRSLIDE treatment group underwent the first intervention: a set of education-slides designed to improve the consumers' knowledge on how to do an investment analysis and to compare lifetime cost of appliances (figure 4 in the appendix). After this, the respondents were asked the same question as the control group to identify the most cost-efficient refrigerator.

The TRCALC treatment group was part of the second intervention: access to a simple web-based tool in the form of an online calculator to compute the lifetime cost of an appliance. After the page with a link to the online calculator, the respondents were asked the same question as the control group to identify the most cost-efficient appliance.[7]

Table 1 gives a summary on how the respondents were distributed as control and treatment groups, and also their responses for the two outcomes of focus in this study: the choice of investment analysis as their decision strategy, and the correct identification of the cost-efficient refrigerator.

Table 1: Overview of the responses from the randomized controlled experiment

	HSEU-Bern ($N = 916$)			**SHEDS** ($N = 5,015$)		
	N	*INVES=1*	*CHOICE=1*	*N*	*INVES=1*	*CHOICE=1*
CONTROL	311	179	95	4,031	1,606	1,075
TRSLIDE	291	195	117	494	286	162
TRCALC	314	175	139	490	217	178
Total =	**916**	**549**	**351**	**5,015**	**2,109**	**1,415**

INVES=1: investment analysis selected as the decision strategy.
CHOICE=1: correct identification of the most cost-efficient refrigerator.

[6] Each of the two treatment groups had another debriefing question asking about the usefulness of the education-slide or the online calculator in supporting their decision (figure 7 in the appendix).

[7] The online calculator required a user to input the purchase price and yearly energy consumption in kWh/year of two refrigerators (figure 5 in the appendix). Following this, it calculates and presents a side-by-side comparison of the yearly energy cost, the total energy cost over appliance lifetime, and the total costs (i.e. purchase price + total energy costs).

In addition to the RCT, the questionnaire in both datasets included several other questions related to the household's energy consumption, socio-demographics of the respondents, their attitudes towards energy conservation as well as their energy and investment literacy. Specifically, we control for respondents' socio-economics — i.e. gender, age, ownership of the house, income, and education. Gender is represented by a binary variable (FEMALE) that takes value one if the respondent is female, and zero otherwise. Respondents' age is captured through three binary variables that define age groups —less than 40 years (AGE40M as reference category), between 40 and 60 (AGE40_59), and older than 60 (AGE60P). Ownership of the house is captured through a binary variable (OWNER) that takes value one if the respondent owns the house, and zero otherwise. Monthly gross household income is included through three binary variables that define income groups —less than CHF 6,000 (HHI6K as reference category), between 6,000 and 12,000 (HHI6_12K), and more than CHF 12,000 (HHI12K).[8] UNIV is a binary variable that takes value one if the respondent has attended the university, and zero otherwise. For the SHEDS sample, we also include the variable LANG_FR which takes value one if the respondent speaks French as preferred language, and zero otherwise. Additionally, the binary variable ALPS is one if the respondent lives in the alpine region. We also control for pro-environmental attitude towards energy conservation by asking for agreement or disagreement to a statement, "I feel morally obliged to reduce my energy consumption", on a 5-point Likert scale. The binary variable ATTMORAL is one if the respondent chose 'agree' or 'strongly agree'.

All econometric specifications also control for the pre-treatment energy literacy of the respondents. ENLIT_IN refers to an index summarizing the literacy of the respondent over several dimensions of energy-related knowledge. The index is built based on correct responses to several questions that examine (i) knowledge of the average price of a kilowatt hour of electricity in Switzerland; (ii) knowledge of the usage cost of different household appliances; and (iii) knowledge of the electricity consumption of various household appliances. This index ranges from 0 to 11 in the HSEU-Bern data, and from 0 to 9 in the SHEDS data.[9] The specifications on the HSEU-Bern data also control for pre-treatment investment literacy. INVLIT is a binary variable that takes value one if the respondent correctly solved a compound interest rate calculation, and zero otherwise.[10] Compound interest rate calculations are usually used to assess an individual's financial literacy (Lusardi and Mitchell, 2007, 2009; Brown and Graf, 2013).

Finally, all specifications include two variables reflecting the two treatments described earlier. TRSLIDE takes value one if the respondent received an education-program through a series of education-slides, and zero otherwise. TRCALC takes value one if the respondent had access to help from an online calculator, and zero otherwise. The reference category is CONTROL which takes value one if the respondent was neither treated with slides nor with a calculator.

An overview of the summary statistics for the variables used in our econometric models for both datasets are presented in table 2. The two samples are found to be quite similar in terms of the socio-economic variables like age, sex and income. However, we do observe some notable deviations, e.g., HSEU-Bern has less share of people living in owned residences and has a higher share of respondents with a university level degree. This could be explained by the difference in geographical reach of the two surveys — unlike SHEDS, HSEU-Bern concerns only to an urban region. We also notice that about 60% of respondents in the HSEU-Bern sample employed investment calculation as their decision strategy compared to 42% in the SHEDS dataset. Furthermore, a higher share of respondents in HSEU-Bern were able to correctly identify the most cost-efficient refrigerator.

[8] Missing values on monthly household income (HHI_MISS) were imputed using a standard multiple imputation approach that makes use of socio-economic information like employment status of respondent, number of people within the house, type of dwelling, size of dwelling and postcode.

[9] SHEDS dataset did not have one question on the average price of 1 kWh of electricity which is worth 2 points when constructing the index.

[10] The investment literacy question was not present in the SHEDS dataset. As a proxy we rely on the dummy variable UNIV which captures whether the respondent had an university level education.

Table 2: Summary Statistics for HSEU-Bern and SHEDS datasets

	HSEU-Bern ($N = 916$)		**SHEDS** ($N = 5,015$)			
	Mean	*Std.Dev.*	*Mean*	*Std.Dev.*	*Min.*	*Max.*
FEMALE	0.467	0.499	0.509	0.500	0	1
AGE40M	0.406	0.491	0.391	0.488	0	1
AGE40_59	0.367	0.482	0.393	0.489	0	1
AGE60P	0.227	0.419	0.216	0.411	0	1
OWNER	0.248	0.432	0.365	0.482	0	1
HHI6K	0.265	0.442	0.270	0.444	0	1
HHI6_12K	0.468	0.499	0.446	0.497	0	1
HHI12K	0.159	0.366	0.136	0.343	0	1
HHI_MISS	0.107	0.309	0.148	0.355	0	1
UNIV	0.524	0.500	0.404	0.491	0	1
ATTMORAL	0.778	0.416	0.609	0.488	0	1
LANG_FR	—	—	0.261	0.439	0	1
ALPS	—	—	0.214	0.410	0	1
ENLIT_IN#	4.669	2.796	3.191	2.452	0	11
INVLIT	0.717	0.451	—	—	0	1
CONTROL	0.340	0.474	0.804	0.397	0	1
TRSLIDE	0.318	0.466	0.099	0.298	0	1
TRCALC	0.343	0.475	0.098	0.297	0	1
INVES	0.599	0.490	0.421	0.494	0	1
CHOICE	0.383	0.486	0.282	0.450	0	1

ENLIT_IN varies from 0 to 9 in SHEDS dataset.

4 Econometric Specification

Empirically, our interest is on identifying the determinants of two decisions —whether a respondent identifies the most cost-effective refrigerator, and whether he or she carries out an investment calculation. Among the determinants of such decisions, we pay particular attention to the treatments described in section 3.

Similarly to Blasch et al. (2016), our identification strategy relies on the estimation of a recursive bivariate probit. This econometric strategy is equipped to handle i) the binary nature of both decisions; ii) their correlation; and iii) the sequential nature of the decision process.

The correlation in the decisions under analysis arises from their simultaneity, and can be modelled through a bivariate probit (BP) model. The BP models the two binary decisions as a seemingly unrelated system of two probit equations, and captures the correlation in the decisions via the correlation between the errors terms.

Formally, let y_1 be a binary variable that takes value one if the respondent performs an investment analysis, and zero otherwise. Also, let y_2 be a binary variable that takes value one if the respondent selects the most cost-efficient refrigerator, and zero otherwise. These binary variables are indicators of whether their latent continuous counterparts are larger than zero —i.e. $y_1 = 1$ if $y_1^* > 0$, and $y_2 = 1$ if $y_2^* > 0$. These latent continuous variables can be thought as measuring, in the form of a continuous normalized index each, the disposition to perform an investment calculation (y_1^*) and the ability to correctly identify the most cost-efficient refrigerator (y_2^*). Thus, the seemingly unrelated system of two probit equations assumed by a BP looks as follows

$$y_1^* = \boldsymbol{\beta}_1' \boldsymbol{x}_1 + \epsilon_1 \quad , \quad y_1 = 1 \quad \text{if} \quad y_1^* > 0 \quad , \quad y_1 = 0 \quad \text{otherwise}, \tag{4}$$

$$y_2^* = \boldsymbol{\beta}_2' \boldsymbol{x}_2 + \epsilon_2 \quad , \quad y_2 = 1 \quad \text{if} \quad y_2^* > 0 \quad , \quad y_2 = 0 \quad \text{otherwise,} \tag{5}$$

$$\begin{pmatrix} \epsilon_1 \\ \epsilon_2 \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right] \quad ,$$

where the vectors $\boldsymbol{x}_1$ and $\boldsymbol{x}_2$ include the variables of particular interest in this paper —i.e. the level of energy and investment literacy; and the treatments described in section 3— plus additional control variables that capture the socio-economic characteristics of the respondent and his or her household.

The polychoric correlation ρ of the error terms in equations (4) and (5) is equivalent to the tetrachoric correlation between the observed binary variables y_1 and y_2.[11] Consequently, ρ is expected to be positive. That is, a respondent that aims to choose the most cost-effective refrigerator more likely decides to carry out an investment calculation. And the reasoning works the other way around —a respondent that does not care about choosing the most cost-effective refrigerator decides to skip the investment calculation.

However, a BP does not capture all relevant features of the decision process we are interested on. In particular, the BP misses the sequential nature of the decisions. Schematically, once a respondent has taken the seemingly unrelated decisions described by equations (4) and (5), he or she carries out two sequential steps to choose the most cost-effective refrigerator. In the first step, an investment calculation is carried out —or not. In the second step, conditional on the result of the investment calculation, the respondent chooses the refrigerator that he or she believes is the most cost-effective.

This sequential nature is modelled by the recursive bivariate probit (RBP) model. Building upon the BP, a RBP assumes that the error ϵ_2 in equation (5) has two components —one that is deterministic (δy_1^*), and other that remains random (ν_2). Thus, a RBP looks as follows

$$y_1^* = \boldsymbol{\beta}_1' \boldsymbol{x}_1 + \epsilon_1 \quad , \quad y_1 = 1 \quad \text{if} \quad y_1^* > 0 \quad , \quad y_1 = 0 \quad \text{otherwise,} \tag{6}$$

$$y_2^* = \boldsymbol{\beta}_2' \boldsymbol{x}_2 + \delta y_1^* + \nu_2 \quad , \quad y_2 = 1 \quad \text{if} \quad y_2^* > 0 \quad , \quad y_2 = 0 \quad \text{otherwise,} \tag{7}$$

$$\begin{pmatrix} \epsilon_1 \\ \nu_2 \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \zeta \\ \zeta & 1 \end{pmatrix} \right] \quad ,$$

where ζ is the polychoric correlation of the error terms ϵ_1 and ν_2 in equations (6) and (7).

Notice, however, that ζ does not capture the correlation between the observed binary variables y_1 and y_2. By construction, the error term ν_2 is free of the influence from y_1^* —i.e. $\nu_2 = \epsilon_2 - \delta y_1^*$—, and consequently ζ cannot be informative of the correlation between the observed indicator variables. Actually, it can be shown that the direction of ζ is mechanically determined by the sign of δ.[12]

The implications in terms of empirical analysis are that i) the estimation of a BP is necessary to test whether the decisions under analysis are, as hypothesized, positively correlated; and ii) the estimation of a RBP is necessary to incorporate the impact of the investment calculation decision on the selection of the refrigerator —keeping in mind that the RBP offers no extra information about

[11] Because y_1^* and y_2^* are latent, i.e not observed, the calculation of the conventional Pearson correlation coefficient is not feasible. Instead, the polychoric correlation technique is used when the variables of interest are theorized to be normally distributed continuous latent variables. The tetrachoric correlation is the technique used when the corresponding observed variables are binary. These labels refer to the polychoric and tetrachoric series used for estimation of these correlations. For details, see Drasgow (1988).

[12] Re-write equation (7) as $\nu_2 = y_2^* - \boldsymbol{\beta}_2' \boldsymbol{x}_2 - \delta y_1^*$. Then use equation (6) to show that $\nu_2 = y_2^* - \boldsymbol{\beta}_2' \boldsymbol{x}_2 - \delta \boldsymbol{\beta}_1' \boldsymbol{x}_1 - \delta \epsilon_1$. Then, it can be seen that the direction of $\partial \nu_2 / \partial \epsilon_1$ is mechanically determined by the sign of δ.

the correlation between the two decisions.

5 Empirical results

In this section, we report results from the estimation of two types of models: a bivariate probit (BP) and a recursive bivariate probit (RBP). Both models are estimated on the two datasets described in section 3 —HSEU-Bern and SHEDS. Both models analyse the choices of interest as simultaneous decisions.

5.1 Econometric specifications

Table 3 reports results from four econometric specifications. The first two specifications are estimated on the HSEU-Bern data, and the last two on the SHEDS data. The first and third sets of results are obtained through a BP estimated on, respectively, the HSEU-Bern and the SHEDS data. The second and fourth sets of results are obtained through a RBP estimated on, respectively, the HSEU-Bern and the SHEDS data.

Table 3 reports parameter estimates that are not interpretable as marginal effects, and thus we present the discussion about the magnitude of the impacts in section 5.2.

Here, we first briefly comment on the direction of the effects from the control variables. When analysing the HSEU-Bern sample, both BP and RBP yield insignificant effects from most socio-economic and attitudinal controls. With respect to the investment calculation decision, owners carry out an investment calculation with more probability than tenants; and college-educated respondents also choose the investment calculation with a higher probability than respondents with less years of education. With respect to the selection of the refrigerator, females choose the most cost-effective refrigerator with less probability than men; and respondents older than 60 are less likely to choose the most cost-effective refrigerator in comparison to respondents younger than 40.

When analysing the SHEDS sample, both BP and RB yield the same directions in the effects from most socio-economic and attitudinal variables. With respect to the investment calculation decision, females respondents are less likely to carry out a calculation; respondents older than 40 are less likely to carry out a calculation neither; and college-educated respondents or with household income higher than CHF $12,000$ are more likely to carry out an investment calculation. With respect to the selection of the refrigerator, the RBP yields only one significant effect from the socio-economic controls: respondents with household income between CHF $6,000$ and CHF $12,000$ are less likely to carry out an investment calculation.

We discuss now the estimates of the correlation parameter (CORR) from the BP specifications — reported at the bottom of table 3. As explained in section 4, when a BP is estimated, CORR refers to ρ which captures the correlation between the two simultaneous decisions. According to the results in table 3, CORR is statistically significant and positive for both datasets — 0.721 for HSEU-Bern, and 0.579 for SHEDS. Thus, as expected, the decision of carrying out an investment calculation is positively correlated with the selection of the most cost-effective refrigerator. This positive correlation is itself a policy-relevant result because it confirms that an education program that increases the chances that potential consumers perform an investment calculation will also positively impact the probability that cost-effective appliances be purchased. However, up to here, no causality can be inferred —as CORR measures only association.

Table 3: Estimation results

	HSEU-Bern		SHEDS	
	BP	*RBP*	*BP*	*RBP*
...Stage 1: Choice of Investment Calculation Approach...				
Constant	-0.6273***	-0.7379***	-0.2782***	-0.3309***
	(0.1827)	*(0.1839)*	*(0.0591)*	*(0.0590)*
FEMALE	-0.1059	-0.0931	-0.3419***	-0.3308***
	(0.0975)	*(0.0973)*	*(0.0379)*	*(0.0378)*
AGE40_59	-0.0471	-0.0064	-0.1886***	-0.1824***
	(0.1081)	*(0.1079)*	*(0.0433)*	*(0.0429)*
AGE60P	-0.1147	-0.0705	-0.3261***	-0.3293***
	(0.1326)	*(0.1335)*	*(0.0539)*	*(0.0536)*
OWNER	0.2058*	0.2096*	0.0361	0.0488
	(0.1180)	*(0.1183)*	*(0.0417)*	*(0.0414)*
HHI6_12K	0.1293	0.0508	0.0555	0.0604
	(0.1033)	*(0.1043)*	*(0.0407)*	*(0.0406)*
HHI12K	0.3252**	0.2226	0.2507***	0.2466***
	(0.1485)	*(0.1498)*	*(0.0595)*	*(0.0590)*
UNIV	0.2876***	0.4482***	0.2112***	0.2824***
	(0.0847)	*(0.0905)*	*(0.0361)*	*(0.0361)*
ATTMORAL	0.1223	0.0769	0.0235	0.0264
	(0.1096)	*(0.1118)*	*(0.0379)*	*(0.0376)*
LANG_FR	—	—	-0.0124	-0.0219
			(0.0427)	*(0.0424)*
ENLIT_IN	0.0652***	0.0618***	0.0533***	0.0544***
	(0.0165)	*(0.0165)*	*(0.0077)*	*(0.0077)*
INVLIT	0.4499***	0.4433***	—	—
	(0.1005)	*(0.0997)*		
TRSLIDE	0.0465	0.2664**	0.4066***	0.3878***
	(0.1027)	*(0.1034)*	*(0.0565)*	*(0.0585)*
TRCALC	-0.1827*	-0.1013	0.1122*	0.1173*
	(0.1067)	*(0.1062)*	*(0.0623)*	*(0.0618)*
...Stage 2: Choice of the Cost-effective Refrigerator...				
Constant	-0.8891***	-1.7026***	-0.4357***	-1.3154***
	(0.1875)	*(0.2023)*	*(0.0606)*	*(0.0657)*
FEMALE	-0.2800***	-0.2115**	-0.3397***	-0.0488
	(0.0993)	*(0.1045)*	*(0.0396)*	*(0.0471)*
AGE40_59	-0.1489	-0.0567	-0.1067**	0.0554
	(0.1066)	*(0.1167)*	*(0.0448)*	*(0.0456)*
AGE60P	-0.3534***	-0.2416*	-0.2296***	0.0511
	(0.1363)	*(0.1394)*	*(0.0566)*	*(0.0592)*
OWNER	0.0092	-0.1369	0.0219	-0.0125
	(0.1175)	*(0.1172)*	*(0.0438)*	*(0.0430)*
HHI6_12K	0.2147**	0.0284	-0.031	-0.0956**
	(0.1078)	*(0.1183)*	*(0.0424)*	*(0.0414)*
HHI12K	0.3778***	0.0085	0.1419**	-0.1008
	(0.1418)	*(0.1577)*	*(0.0604)*	*(0.0639)*
ATTMORAL	-0.0284	-0.1137	-0.0936**	-0.1069***
	(0.1082)	*(0.1000)*	*(0.0393)*	*(0.0386)*
ORDEFF	0.0415	0.0387	—	—
	(0.0810)	*(0.0825)*		
LANG_FR	—	—	0.0563	0.0574
			(0.0456)	*(0.0438)*
ALPS	—	—	-0.0052	0.0075
			(0.0462)	*(0.0445)*
ENLIT_IN	0.0512***	-0.003	0.0351***	-0.0085
	(0.0162)	*(0.0183)*	*(0.0080)*	*(0.0087)*
INVLIT	0.4687***	0.0351	—	—
	(0.1056)	*(0.1338)*		
TRCALC	0.2255**	0.4248***	0.2560***	0.1971***
	(0.0936)	*(0.0996)*	*(0.0621)*	*(0.0653)*
INVES	—	2.4078***	—	2.0235***
		(0.1736)		*(0.1028)*
CORR	0.7212***	-0.7617***	0.5797***	-0.7175***
	(0.0374)	*(0.2027)*	*(0.0187)*	*(0.0930)*

***, **, * ⇒ Significance at 1%, 5%, 10% level. Robust standard error in parenthesis.

In order to make causal statements, we turn our discussion to the estimates of the parameter associated with the investment decision (INVES) together with the estimates of the correlation parameter (CORR) from the RBP specifications. The estimates of the parameter associated to INVES are reported in the second to last row of table 3. This parameter is statistically significant and positive for both datasets — 2.408 for HSEU-Bern, and 2.024 for SHEDS. Restraining ourselves from interpreting these coefficients as marginal effects, we still can conclude that choosing to perform an investment calculation increases the probability of recognizing the most cost-effective refrigerator.

Notice that the RBP yields correlation parameters that are significant and negative for both samples under analysis. This negative sign is, however, counter-intuitive —as the decisions are expected to be positively correlated As explained in section 4, the correlation parameter loses interpretability in the RBP. In this case, the positive impact of the investment calculation decision is already taken care through the coefficient associated with `INVES`, leaving the sign of the correlation parameter to be mechanically determined.

5.2 Marginal effects

Indeed, statements about magnitude of effects can only be drawn from marginal effects estimates. Table 4 reports total marginal effects (TME) on the identification of the most cost-effective refrigerator. For a given variable, TME result from adding the indirect effects that occur via the effects on the investment calculation decision and the direct effects on the selection of the refrigerator —details on these calculations are described by Blasch et al. (2016). We report TME yielded from the RBP —as it is the model that appropriately accommodates the simultaneous and sequential nature of our the decisions under analysis.

Table 4: Total Marginal effects on the selection of the most cost-effective refrigerator

	HSEU-Bern	**SHEDS**
TRSLIDE#	0.0488	0.0871
	(0.0237)	*(0.0190)*
TRCALC#	0.1698	0.1222
	(0.0404)	*(0.0275)*
INVES	0.6784	0.6459
	(0.0021)	*(0.0003)*
ENLIT_IN	0.0104	0.0089
	(0.0068)	*(0.0036)*
INVLIT#	0.1081	—
	(0.0446)	—

Robust standard error in parenthesis.
Effects are at means and for the recursive bivariate probit setting.
Marginal effects of exogenous dummy variables on `INVES=1`.

Thus, from tables 3 and 4, we learn that both treatments increase the probability of identifying the most cost-effective refrigerator. Moreover, from table 4, we learnt that the impact from the online calculator is larger. For the case of HSEU-Bern, the effect from the online calculator is almost four times larger than the impact from the four-slide treatment —17 versus 4.9 percentage points. For the case of SHEDS, the effect from the online calculator is around 1.5 times larger than the impact from the four-slide treatment —12.2 versus 8.7 percentage points. These relative magnitudes imply that the online calculator is more effective in terms of increasing the probabilities that a respondent identifies the most cost-effective refrigerator.

With respect to the impact from the decision of performing an investment calculation, results from both datasets are remarkably similar: an increase of 67.8 percentage points in the HSEU-Bern dataset versus an increase of 64.6 percentage points in the SHEDS dataset. This consistency across datasets can be interpreted as evidence of robustness of our results.

Finally, we discuss the marginal effects from pre-treatment energy and investment literacy. Respondents with better pre-treatment energy literacy do have a higher probability of recognizing the most cost-effective refrigerator, a result that holds across datasets —1 percentage point for HSEU-Bern, and 0.9 percentage point for SHEDS. For the case of HSEU-Bern, pre-treatment investment literacy has a positive impact on the selection of the most cost-effective refrigerator —with TME of 10.8 percentage points.

6 Conclusions

An increase of energy efficiency in the residential sector is seen as a priority to improve energy security and to reach the level of CO_2 emissions agreed in Paris through the United Nations Framework Convention on Climate Change. A higher adoption rate of energy efficient appliances is expected to contribute to this goal. However, consumers' investment decisions have not aligned yet — even though the most energy-efficient appliances in the ideal case also reduce the lifetime cost of consuming a specific energy service for the consumers.

We point out that the identification of the most cost-effective and energy-efficient appliance may be a challenging task because, to make economically rational decisions, individuals need to compare the lifetime costs of the electrical appliances, which requires a certain level of energy and investment literacy. Building upon previous research (Blasch et al., 2016, 2017), we have explored in this paper the possibility that an improvement of the consumers' energy and investment literacy increases the rate at which households identifies the most cost-effective appliance.

We designed two online random control trials and implemented them on two independently chosen samples of the Swiss population. One intervention consisted in providing a short education program —via information slides. The second intervention consisted on providing an online calculator supporting the respondent's investment decision.

The similarities in the results obtained from the two samples are encouraging. In both samples, evidence suggest that pre-treatment investment literacy positively impacts on the probability of selecting the most cost-effective refrigerator. Also, results on both samples support our hypothesis that the reinforcement of the energy and investment literacy increases the rate at which individuals select the most cost-effective refrigerator. A relevant nuance has become clear in both samples: while both interventions are effective at increasing the chances that a cost-effective refrigerator is chosen, the online calculator is more effective than the educational program. This suggests that making an investment calculation is one important barrier for boundedly rational consumers when it comes to the choice of electric appliances. From an energy policy point of view, the results imply that the promotion of web-based educational programs to improve the level of investment literacy as well as the provision of online or mobile phone calculator tools could be effective instruments to promote energy-efficient investment decisions of households.

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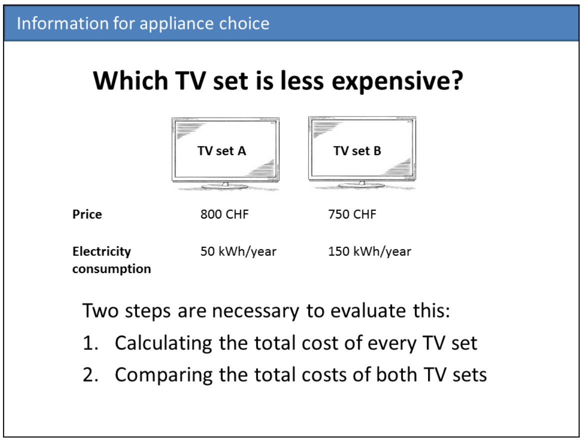
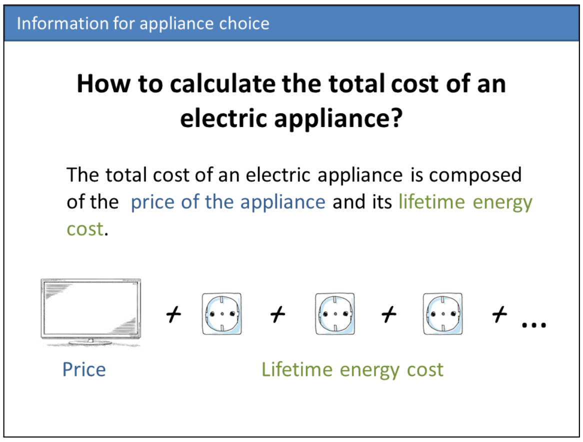
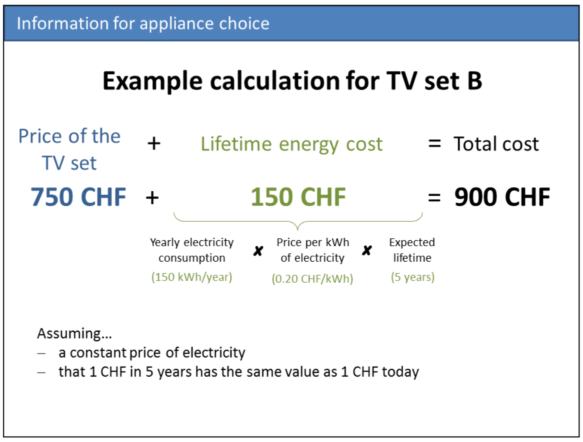
Appendix



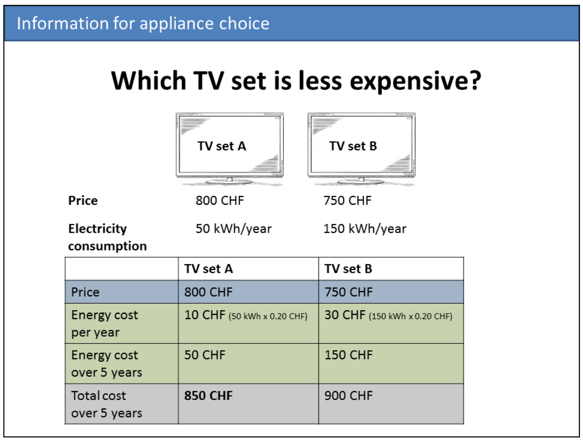
(a) Slide-1



(b) Slide-2



(c) Slide-3



(d) Slide-4

Figure 4: Education-slides as intervention for the TRSLIDE treatment group.

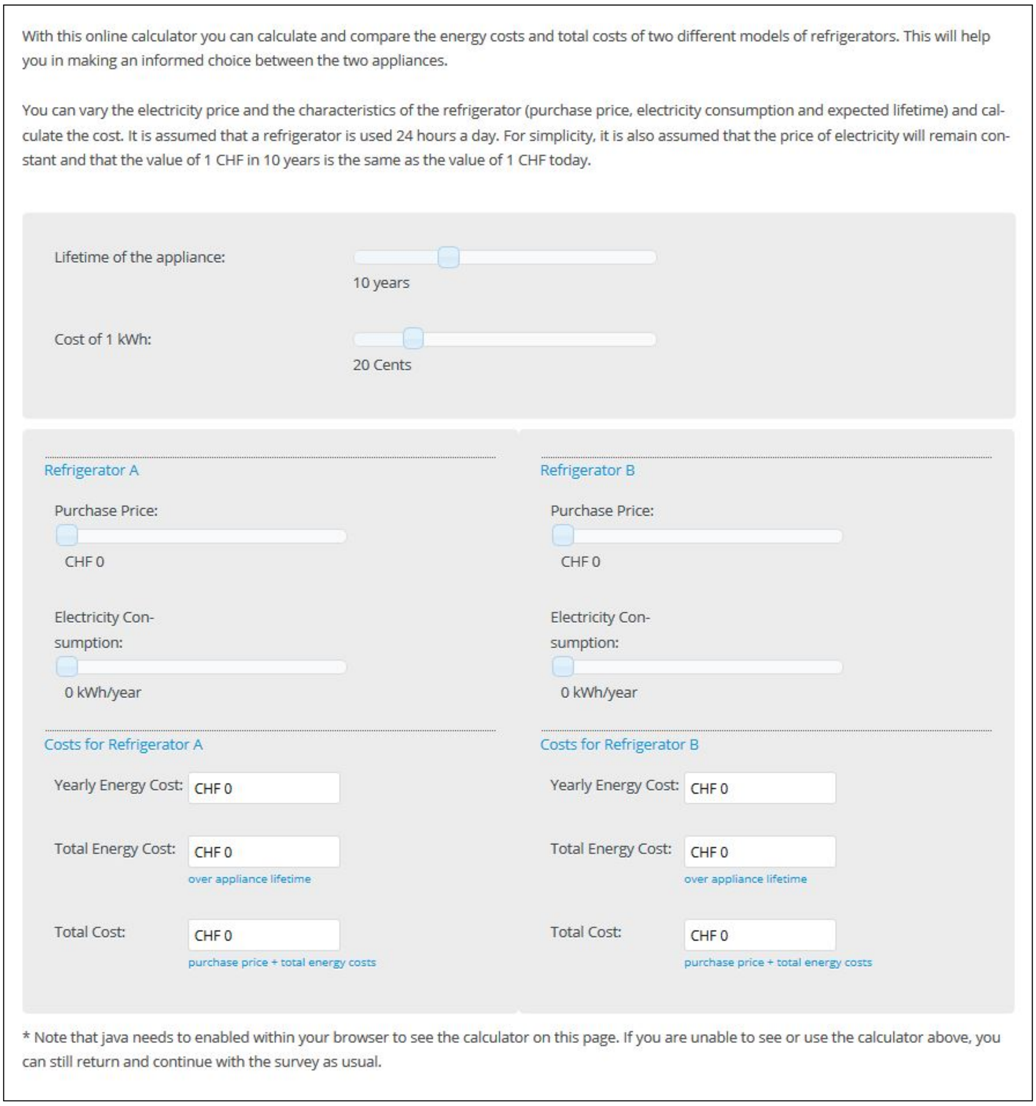
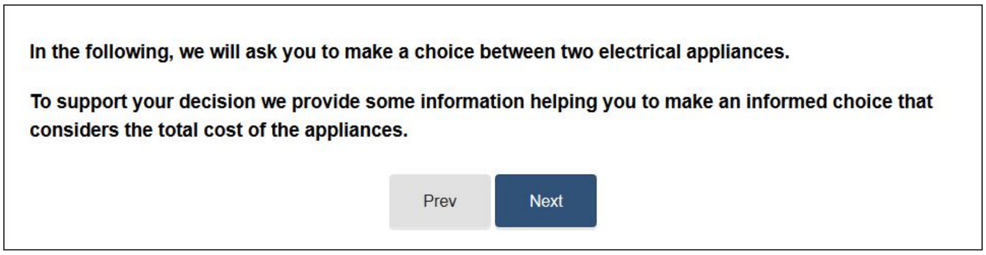
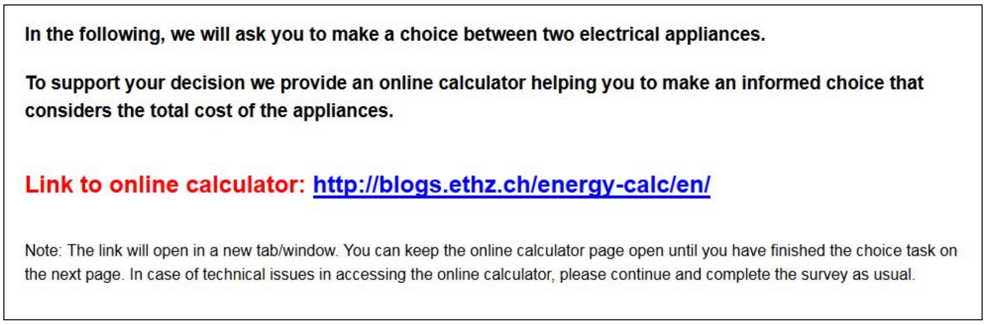


Figure 5: Online calculator as intervention to the TRCALC treatment group.

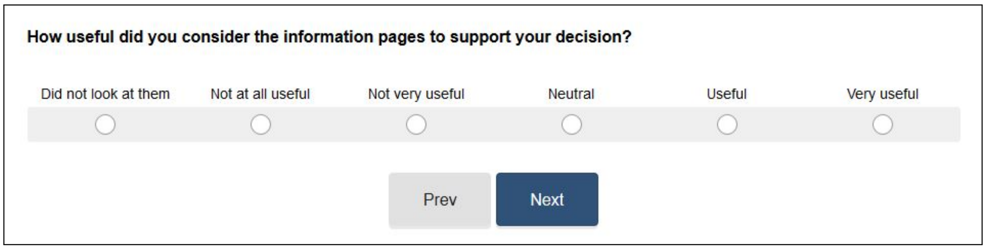


(a) TRSLIDE group

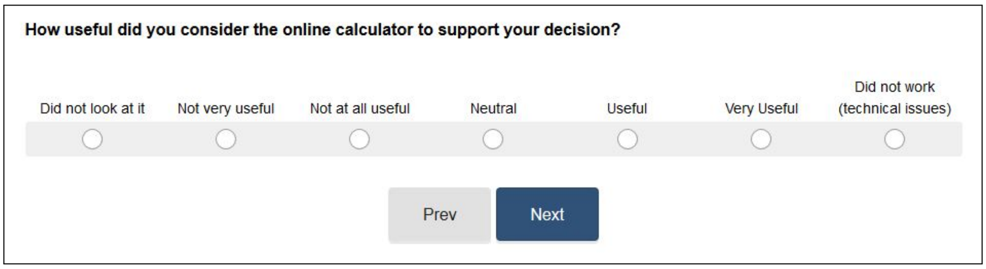


(b) TRCALC group

Figure 6: Pages shown to the two treatment groups prior to the experiment.



(a) TRSLIDE group



(b) TRCALC group

Figure 7: Debriefing questions specific to the two treatment groups.