Is information a good policy instrument to influence the energy behaviour of households?

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Abstract

Despite several financial aids intended to promote the energy transition, the French people continue to buy energy-intensive products and are not interested in improving the energy performance of their homes. We propose a new measure which consists of provision of information to change individual behaviour. Currently, health and the environment are the prime concerns and we propose to encourage individuals to reduce their energy consumption by informing them of the environmental and health consequences linked to energy consumption. To test the validity of our proposal, we use the willingness to pay for more energy efficient equipment and thermal insulation. We conducted an online survey which included messages on the link between environment-energy and health-energy. We showed that it affected households' energy behaviour. We compared this strategy with policies already in place. We found that policies that combined provision of information with a subsidy, increase sales of goods that reduce energy consumption and was the best option from a social welfare perspective.

Keywords : Consumer willingness to pay; Energy efficiency; Energy policy ; Health and environment; Information campaign.

JEL Classification: C83, D12, D60, H23, Q48, Q58.

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Introduction

Saturday, 22 August, 2020 has been called 'Earth overshoot day', and marked the end of the eight-month period during which humanity consumed all the resources produced by the planet in one year. It is clear that, maintaining current ways of life and our energy consumption in particular, implies over-exploitation of ecosystems and threatens their regenerative capacity, human health and the environment.

The French Energy Transition for Green Growth Act of 17 August, 2015 provides an energy transition roadmap. France set the objective of reducing its consumption of fossil energy by 30% by 2030 and reducing its final energy consumption by 20% by 2030 compared to 2012, and by 50% by 2050. Energy saving is a priority for the energy transition. International, national and individual actions are required to achieve sustainability and reduce dependence on energy. The Paris Agreement, concluded in December 2015, reaffirmed that climate actions must always be prioritized. The objective of the Paris Agreement is to contain temperature rise to below 2 degrees C by the end of the century, which implies reducing greenhouse gas emissions by 40% to 70%. Electricity production in France emits very little carbon; almost 90% of electricity production comes from renewable energies and nuclear power, which are carbon-free energy sources. However, the energy consumed still comes mainly from fossil fuels, especially petroleum (45.1% of final consumption). In France, nearly half of greenhouse gas emissions are accounted for by transport (28%) and residential and tertiary sources, mainly heating for buildings (20%). [1] One of the objectives of the energy transition law is to reduce citizens' energy consumption by encouraging purchases of more energy-efficient equipment and installing thermal insulation. So, what political instruments need to be implemented to achieve this?

France intends to promote energy saving by raising awareness among citizens and encouraging them to reduce their energy consumption by providing financial support for energy saving actions (thermal insulation) and use of the most efficient materials and equipment (Grenelle de l'environment in 2007). Several financial measures have been implemented including tax credits,[2] quelle energie premium,[3] the Energy Solidarity Pact,[4] Anah Fund (National Housing Agency),[5] the zero-rate environmental credit,[6] local

[1] Source of all the statistics cited: International Energy Agency (2018).

[2] To encourage citizens to improve the energy performance of their homes, the government has implemented a tax credit for the energy transition. It allows individuals to benefit from a tax credit equivalent to 30% of the amount spent on energy saving work.

[3] This premium is included in the Certificate of Economy system of Energy. It can significantly reduce the cost of energy renovation work, like insulating the house and installing a low-emission boiler.

[4] This pact allows the loft to be insulated from a house for €1.

[5] These funds finance energy improvements in accommodation.

[6] This credit, called Eco-Prêt in French, is a device set up in 2007 to help individuals invest in energy-saving solutions for their homes.

subsidies,[7] energy controls,[8] aid derived from pension funds,[9] credit from the Family Allowance Fund,[10] and a reduced Value Added Tax (VAT) rate of 5.5%.[11] In addition to financial aid, France has launched an information campaign related to various domestic practices such as switching off electrical appliances when not in use, using pan lids, etc., and energy labelling of domestic equipment. However, 60% of French people remain sceptical about the energy transition (Ifop-Primagaz 2019). We are interested in whether more information linking energy to health and the environment will persuade citizens of the need for and benefits of the energy transition?

It seems clear that citizens do not necessarily make the link between their energy consumption and its harmful consequences for the environment and human health and 14.1% of French people either did not know or were wrong about which type of energy will reduce greenhouse gas emissions (IRSN, 2019). The study conducted in France by Ledesert (2013) shows that the French people underestimate the consequences for their health of living in badly insulated buildings with old and/or inefficient heating systems. Nevertheless, health and the environment are the two main preoccupations of the French population (IRSN, 2020) and the link between environment-energy and health-energy has been proven. Lack of energy efficiency leads to air quality degradation and humidity problems (mould), water vapour and waste concentration, and discomfort due to insufficiently heated buildings. It causes allergies, respiratory illnesses such as asthma and bronchitis, conjunctivitis, rhinitis and joint problems such as arthritis, osteoarthritis and rheumatism (WHO, 2016). It also causes air pollution and, by increasing the greenhouse effect, causes global warming. Animal species being threatened (e.g., by the melting permafrost in the Arctic) and vegetation is being devastated (forest fires).[12] In this article, we test whether informing citizens about the harmful effects of their energy consumption, exploiting the health and environment channels, might encourage them to reduce their own energy consumption.

We adopt the Willingness To Pay (WTP) approach which allows us to understand consumer preferences that are essential not only for firms' choices but also for policy making. Creyts et al. (2007), Gillingham and Palmer (2013), Granade et al. (2009) and McKinsey and Company (2009) highlight the potential for reducing energy consumption through investment in energy efficient equipment and appliances. We focus

[7]The city, department or region grants subsidies for energy renovation, for example solar water heaters and geothermal heat pumps.

[8]Implemented 1^{st} January 2018, it makes it possible to reimburse expenditure related to the domestic housing energy improvements.

[9]Aid given to pensioners for pay for thermal insulation and heating.

[10]Credits to contribute to the cost of thermal insulation.

[11]Tax that applies to thermal insulation and more efficient heating systems.

[12]For more details, see Numez (2019).

on these products and, energy efficient boilers (EEB), household appliances consisting of hobs, ovens, fridges (EEHA), and installation of thermal insulation (TI) in particular. We chose a WTP approach rather than a discrete choice experimental method.[13] We conducted an online survey administered to a representative sample of the French population. The questionnaire provided a series of messages clarifying the link between environment-energy and health-energy and asked respondents about their WTP for more energy-efficient equipment and installation of thermal insulation.

Our study makes three contributions. First, it contributes to work on the link between information provision and the energy sector. The effect of information has been addressed in other fields, such as finance and public administration, and shows that it compensates for cognitive bias and bounded rationality (Mastrubuoni, 2011; Fort et al., 2016). Currently, research attention has been focused very much on information (or lack of it) for citizens in relation to energy use (Allcott and Greenstone, 2012; Gillingham and Palmer, 2013; Sanstad and Howarth, 1994; Tietenberg, 2009). This strand of work suggests that non-price policy instruments, such as information campaigns, should be explored to encourage people to reduce their energy consumption. We respond by identify the energy-environment and energy-health links rather than focusing on the effects of feedback energy on consumption behaviour and savings (Jain et al., 2013; Schleich et al., 2013). To our knowledge, this is the first study to propose diffusion of information via these channels to encourage citizens to reduce their energy consumption. Our results show their influence on households' energy consumption behaviour.

Second, we highlight the role of information on the individual's WTP. It can be difficult to observe consumer behaviour in the energy market and the WTP has been used to estimate personal preferences related to energy saving (Bull, 2012, for the case of energy efficient washing machines in UK; Galarraga et al., 2011, for energy efficient dishwashers in Spain; Liu et al., 2013, for air conditioners in Taiwan; Ward, 2010, for energy labelling of household appliances in the US). However, although Kahneman and Tversky (1979, 1981) point out that individual is affected by the information they receive, none of these works has investigated the influence of information on people's WTP for products that reduce energy use. Our study fills this gap by specifically analysing the role of information on citizens' WTP for energy efficient products. We found the WTP for energy efficient equipment and for the installation of thermal insulation increases, on average, with the information received. We use the survey data and a random effects model to determine individuals' WTP. The estimates reveal a significant influence of information about the

[13] According to Mangham et al (2009), a discrete choice experiment is a quantitative technique to determine individual preferences. It allows identification of how individuals value selected product attributes based on their choice among different hypothetical alternatives.

negative impact of energy consumption on health and the environment, on the WTP for energy efficient equipment and for the installation of thermal insulation. However, the effects of environmental information and health information differ in relation to the WTP. The order of the information (environment or health first) seems less important, although the information received first seems to have a stronger effect.

Third, we contribute to the literature on public policies aimed at reducing energy consumption. Much effort has been invested in the fight against fuel poverty, but few studies focus on public policies designed to encourage citizens to use energy efficient products. Some exceptions include Allcott and Taubinsky (2015), who find a positive effect for moderate subsidies for low-energy light bulbs, and Parikh and Parikh (2016) whose review of policies to promote energy efficient household appliances in India found that tax incentives could speed up the shift to more energy-efficient rated products. Both these works focus on monetary incentives; we contribute by studying the effect of a non-monetary instrument, a nudge (information) that tries to guide individual behaviour and does not include an economic constraint. Our results show that providing information on the links between environment-energy and health-energy is efficient from a social welfare and number of new buyers' point of view, but that information combined with subsidies is a better alternative.

The article is organized as follows. Section 1 describes the theoretical framework and Section 2 explains the WTP method. Section 3 presents the data collection, the target respondents and the products analysed. Section 4 provides a descriptive analysis and an econometric analysis, based on a random effects model to estimate the impact of information on respondents' WTP for energy efficient equipment and the installation of thermal insulation. Based on an analysis of individual welfare and the variation in the number of buyers, Section 5 examines the effectiveness of several policies (information campaign, subsidy, and a combination of the two) to determine the most effective policy to encourage energy saving behaviour. Section 6 discusses the results and provides some conclusions. The appendix contains the tables and figures.

1 Theoretical framework

Many works (Moser, 2015; Meleddu and Pulina, 2016; Lopez-Mosquera, 2016; S´anchez et al., 2018) adopt the Theory of Planned Behaviour (TPB) or Value-Belief-Norm Theory (VBN) models to study the factors affecting individual decisions. The TPB is based on the connection between beliefs and behaviour while the VBN focuses on values and moral standards.[14] However, both have some limitations, for example, they do not consider the

[14]For more detail on these theories, see Ajzen (1988, 1991) and Stern et al. (1999).

effect of information on individual choice.

Lusk and Briggeman (2009), Disdier et al. (2013) and Orset (2019) show that information and, especially information related to the environment and health, is one of the most effective levers to encourage sustainable consumption. Lusk and Briggeman (2009) and Disdier et al. (2013) analyse the impact of environmental and health information on product choices to promote sustainable diets; Orset (2019) focuses on low-emission transport. All of these studies highlight a statistically significant influence of information on respondents' WTP if the message it underlines the negative impact of the associated product. Disdier et al. (2013) find that both environmental and health information have similar effects on the WTP, while Lusk and Briggeman (2009) and Orset (2019) show that respondents especially value health information. Krarup and Russell (2005) found that environmental concerns were linked positively to respondents' WTP for a product with positive environmental externalities. A similar link has been observed for renewable energies (Roe et al., 2001; Zarnikau, 2003), eco-labelling of household appliances and construction materials (Shen, 2012; Ward et al., 2011), recycled material (Guagnano, 2001) and sustainable food products (Moon and Balasubramanian, 2001; Wandel and Bugge, 1997). However, evidence of the effect on consumer purchases of sustainable products of environmental and health information, is scarce.

Lusk and Shogren (2007) underline the importance of the order of information conveyed in the messages for the responses of individuals. Marette et al. (2008) highlight the importance of the ordering of the information in relation to messages about the risks and benefits of consuming a particular species of fish. However, other studies, which specifically investigate environmental and health information, find different results. Disdier et al. (2013) and Orset (2019) show that the order of the information (environment versus health) is not crucial for individuals' consumption decisions in relation to more sustainable products.

Finally, there is a strand of work in energy economics, which examines the effect of monetary incentives (Allcott and Taubinsky, 2015; Parikh and Parikh, 2016). However, Hausman and Welch (2010), John (2018) and Thaler and Sunstein (2008) suggest that nudges, such as information, are also socially effective policies.

Based on the above, we hypothesize that:

Hypothesis 1. Information on the negative impact of energy consumption on health and the environment has a significant influence on the individual WTP for energy efficient equipment and for the installation of thermal insulation.

Hypothesis 2. Environmental information has a similar effect to health information, on the individual WTP for energy efficient equipment and for the installation of

thermal insulation.

Hypothesis 3. The order of the information (environmental versus health) matters.

Hypothesis 4. Using environmental and health information to reduce energy consumption is a socially effective policy.

2 Methodology: The Willingness to pay method

In this study, we assess the importance of information through both the health and environment channels, to incentive individuals to reduce their energy consumption. Decision-makers face difficult choices when designing policy measures and understanding people's preferences enables implementation of the most effective policies. There are no databases on energy efficient equipment and thermal insulation installation that quantify the impact of the diffusion of information on consumer preferences. This makes a revealed preferences model infeasible. Therefore, to distinguish respondents' preferences, we use a stated preference model, the WTP method. This involves prompting respondents to declare the maximum amount they would be willing to pay for a given good, in our case, energy efficient equipment and thermal insulation installation.

We designed a questionnaire to determine consumers' WTP for energy-efficient products and thermal insulation installation following the diffusion of consecutive messages informing them of the damage to human health and the environment of energy consumption. The questionnaire was structured as follows.

First, it described the purpose of the study: *Economists unrelated to government are conducting this study. This survey focuses on your energy consumption. It is completely anonymous.* In order to limit the framing effect and anchoring bias, we provided no other information.[15]

The first set of questions asked about the respondent's accommodation (house or apartment), surface area of the accommodation, occupancy status (owner or tenant), inclusion of the studied products (boiler, household appliances, and thermal insulation) and type of energy used (electricity, gas, oil). These questions were designed to determine the respondents' living environment.

The next set of questions asked about individual behaviour. Respondents were asked to define preferences related to energy saving among price, health effects, environment, or no efforts to save energy. They were also asked about the importance they assign to brand, price and energy consumption for their purchasing decisions. They were asked

[15]The framing effect refers to the tendency to be influenced by the way a problem is presented. Anchoring bias refers to the tendency to over-use the information as a reference.

also about ecological behaviour (not letting the water run while brushing teeth, turning off appliances rather than leaving them on standby, using low-energy lightbulbs, turning off lights when not in the house, using pan lids on saucepans).

Unlike heating boilers and household appliances, which have defined prices, the cost of thermal insulation is calculated per m^2. In the first pre-test of the survey, we found that respondents found cost per m^2 difficult to understand because it did not correspond to the final bill for the thermal insulation work. We proposed a reference dwelling size of $60m^2$, which, according to INSEE (2015), if the average size of a dwelling in France. In the second pre-test, respondents were asked to consider the cost of thermal insulation work in this dwelling size; this proved more understandable. In the final questionnaire, we presented respondents with a hypothetical scenario: *Suppose you live in a flat of* $60m^2$. This made it more understandable and allowed us quantify the WTP for thermal insulation for a house of average size.

The respondents received five messages.[16] **Message 1** included the price of a standard boiler, a set of standard household appliances and thermal insulation installation for a house of 60m2. This allowed us to manage the anchoring effect.[17] **Message 2** was about the increasing environmental risks, particularly regarding climate change, related to energy consumption. **Message 3** presented the environmental costs (in euros) generated by energy consumption. **Message 4** was about increased health risks (allergies, asthma, etc.) linked to energy consumption. **Message 5** presented health costs (in euros) associated with energy consumption. In line with the recommendations in Wansink et al. (2004), the messages were short and concise. Following each message, respondents were asked: *How much would you be willing to pay (maximum) to buy an energy-efficient boiler, a set of energy-efficient household appliances (refrigerator, hob, oven) and to install thermal insulation?* This allows us to explore the impact of information on the link between energy and environment (Messages 2 and 3) and the link between energy and health (Messages 4 and 5) on the WTP for products aimed at reducing energy consumption. Moreover, to test the effect of message order on the responses,[18] we prepared two questionnaires, which differed only in the order of the information received by the respondents.

The final section of the questionnaire asked about the respondent's profile (gender, age, income, household composition), personal characteristics (having a child, health history, whether the respondent or a relative had ever been diagnosed with a respiratory problem such as asthma, or allergies). It also asked about knowledge about energy la-

[16] See all the messages in the Appendix.

[17] See Drichoutis et al. (2008) for a discussion of provision of benchmark prices before auctions

[18] According to Powe and Bateman (2003), order effects are defined as occurring if the responses to a given question vary with the order of the focal question relative to the other questions.

belling[19] and ecological behaviour.[20]

Figure 1 depicts the questionnaire design based on the groups and messages received.

Insert Figure 1.

3 Survey administration and sampling

3.1 Target respondents

The survey was conducted between May and June 2017. We initially launched a campaign on various social networks (Facebook, LinkedIn, Twitter) to recruit volunteers to participate in a study on energy consumption. Respondents were selected at random and randomly allocated between the two groups using the quota method.[21] Group 1 included respondents who received the messages about the link between the environment and energy first; Group 2 included respondents who received the link between health and energy first. Our sample was split between Group 1 (112 respondents) and Group 2 (105 respondents).[22]

Table 1 presents the variables for respondent socio-economic characteristics (gender, age, monthly household income, household composition). It includes the proportions of respondents according to each group and for the whole sample. The Pearson chi-squared test indicates differences between the panels and the French population as defined by INSEE (2016). Since the null hypothesis is no difference between the proportions in the two groups, a p-value of less than 1% is considered significant.

Insert Table 1.

The results show that neither the groups nor the whole sample are significantly different from the INSEE 2016 data regardless of the socio-economic variable considered. Similarly, all the samples are representative of the French population.

[19]The European Union energy label provides information on the energy efficiency of homes and household appliances, based on an energy efficiency classification from A to G, where A is the most energy efficient and G the least energy efficient. A^+, A^{++} and A^{+++} were introduced later for various products, with A^{+++} being the most economical user of energy, and A^+ the least efficient.

[20]All the financial subsidies available in France are described in the Introduction.

[21]We obtained 341 volunteers. The quota method requires a sample with similar characteristics (gender, age, income and household composition) to the French population described by the INSEE 2016 census. This allowed us to retain 217 volunteers.

[22]These sample and sub-sample sizes are typical of WTP studies (105 respondents split across 3 subsamples in Schkade and Payne (1993); 125 respondents assigned to two subgroups in Kahneman and Knesch (1992); 130 respondents assigned to two subgroups in Mitchell, Carson and Ruud (1989); 120 respondents assigned to two subgroups in Ay et al. (2017); 125 respondents assigned to two subgroups in Saidi et al. (2020); 119 respondents in Castellari et al. (2019); 263 respondents in Bigerna et al. (2019)).

3.2 Products

We chose to focus on energy efficient boilers and a set of energy efficient household appliances that is, fridge, oven and hob which constitute the basic electrical domestic appliances. We are interested, also, in thermal insulation, which is one of the most effective ways to reduce energy consumption in the home. ADEME (2018) estimates that reductions in energy loss due to thermal insulation amount to : 25% for walls, 30% for roofs, 13% for windows and 7% for floors.

We consider that an energy efficient boiler to be classified A according to European Union energy labelling and a standard boiler B or C. According to the Environment and Energy Management Agency (ADEME, 2019), an A rating means the boiler uses $205gCO_2eq/kWh$, while B and C rated boilers use between 270 and $300gCO_2eq/kWh$. In terms of household appliances, we consider that an A^{++} and A^{+++} energy rating indicates and energy efficient fridge, which reduces electricity consumption by 50% to 70% compared to class A^{+} for a standard fridge. For ovens, an energy labelling of A^{+} indicates a 20% reduction in electricity consumption compared to an A rating. We consider ovens with a rating A^{+} as energy efficient and others as standard. The European Union energy labelling does not apply to hobs, but, according to the ConsoGlobe website, induction hobs use 40% less energy than ceramic hobs and 60% less energy than gas hobs. We therefore considered induction hobs to be energy efficient and other types as standard.

In May 2017, average prices were €3,934 an energy-efficient boiler and €2,500 for a standard boiler. and €1,942 for a set of energy efficient household appliances, and €1,200 for a set of standard household appliances. Finally, the average price for installing thermal insulation for a $60m^2$ dwelling was €4,800.[23]

4 Results

4.1 Descriptive analysis

Table 2 represents the average WTP of respondents, in euros, following each message, and the standard deviation. For each group of respondents, we employed the Wilcoxon test[24] for paired samples to test the significance of the different WTP related to the different

[23]The average prices are the market prices in May 2017. For the boilers and household appliances, we based our calculations on the information available at https: // www.boulanger.com /, https: //www.but.fr, https://www.leroymerlin.fr/, and https://www.mychauffage.com/. According to Calculeo (https://www.calculeo.fr/), the cost of installing thermal insulation is between €40 and e€120 per m^2. We used an average price of €80 per m^2.

[24]The Wilcoxon test is a nonparametric average comparison test of two independent or matched samples. For more details, see Tanizaki (2004, Ch. 7).

information messages. We considered these differences at the 1%, 5% and 10% levels. The test was carried out as follows: we compared the average WTP before and after each message. This allows us to identify the effect of the ordering of the information and to measure the impact of each messages on the respondent's average WTP for a given piece of energy efficient equipment and for the installation of thermal insulation.

Insert Table 2.

Table 2 presents the results from the provision of information on the negative impacts of energy consumption on health and the environment. First, the information provided in the different messages generally changed the WTP, although the level of the variation is not always significant. For Group 1: following Message 2 (environmental message), the relative increase in the WTP was equal to 3.15% for an energy efficient boiler, 1.96% for a set of energy efficient household appliances and 1.71% for thermal insulation; following Message 4 (health message), the relative increase in WTP was equal to 0.92% for thermal insulation; following Message 5 (health message), the relative increase in the WTP was equal to 1.62% for a set of energy efficient household appliances. For Group 2: following Message 2 (environmental message), the relative increase in the WTP was equal to 0.35% for an energy efficient boiler ; following Message 4 (health message), the relative increase in the WTP was equal to 0.74% for an energy efficient boiler and 1.02% for thermal insulation; following Message 5 (health message), the relative increase in the WTP was equal to 0.73% for a set of energy efficient household appliances and 0.50% for thermal insulation. Messages that have a significant effect, have a positive influence. Message 3 was the only message that had no significant impact on the respondents' average WTP. We observed that Message 2 had a stronger effect on the WTP than Message 3. It seems that the first environmental message cancelled out the effect of the second message, which suggests that providing only one set of information on the environment would have been sufficient.

Second, for Group 1, the environmental information (Message 2 + Message 3) had a higher impact compared to the information on health (Message 4 + Message 5). The results are reversed in the case of Group 2. However, these differences related to provision of environmental or health information are small. Therefore, we cannot draw conclusions about whether the effect of environmental information dominates, is similar, or is dominated by the effect of health information.

Third, providing environmental information had no significant difference on the differences in the WTP of the two groups. This applies also to health information. It seems that the order in which the information is provided does not matter.

Table 2 presents average values; however, these hide the strong reactions from some respondent. Table 3 presents the numbers and proportions of respondents whose WTP was zero and who were indifferent to the messages.

Insert Table 3.

Table 3 shows that the number of respondents willing to pay for energy efficient equipment and installation of thermal insulation (with a WTP different from zero) is high. This would suggest that respondents are very interested in energy consumption issues.

However, nearly three quarters of respondents are indifferent about these issues (with a similar strictly positive WTP for the products at the beginning and at the end of the experiment). This might be because after receipt of the first message, respondents indicated the maximum amount they could pay, meaning that, even if affected by the subsequent messages, their WTP could not increase. They had already reached the limits of their budget. Another explanation might be that the environmental and health link between energy did not produce a reaction. The econometric analysis allows us to disentangle these possibilities.

4.2 Econometric analysis

4.2.1 Econometric model and dependent variable

The econometric analysis provides alternative explanations for the results presented in Tables 2 and 3 and investigates the determinants of the WTP. We regress the difference in the respondents WTP between rounds $i+1$ and i as $i \in \{1, ..., 4\}$.[25] Since our sample includes 217 respondents, the number of observations for the estimations is 868 (=217*4).

We used a random effects model and pooled data. Use of this model is recommended to explain a quantitative variable in the case of individuals selected at random from a large population, which matches our study.[26] The random effects model is written as follows:

$$y_{ht} = \beta_0 + x_{ht}^{'}\beta + \alpha_h + u_{ht}, \text{ with } \alpha_h \sim iid(0, \sigma_\alpha^2) \text{ and } u_{ht} \sim iid(0, \sigma_u^2),$$

where the subscripts h and t are individuals and time, y_{ht} is the dependent variable, β_0 is the intercept, x_{ht} is a K-dimensional vector of the explanatory variables, β is a $(K * 1)$ vector, α_h are individual intercepts and u_{ht} is the error term.

[25] Disdier et al. (2013) investigate the determinants of the WTP using this method.

[26] The Hausman and Breusch-Pagan tests confirm that, in our case, the random effects model is better than a fixed effects or an ordinary least square model.

4.2.2 Explanatory variables

Our first explanatory variable is all the socio-economic variables presented in the Table 1. To estimate the different WTP in the random effects model, we transformed all the categorical socio-economic variables into dummy variables. This results in Income being split into four dummy variables: 0-1499, 1500-2499, 2500-5999 and over 6000, and the variable Household composition split into four dummy variables: One, Two, Three-Four and Five or more.[27]

We defined the other explanatory variables based on the questions about living environment, behaviour, personal characteristics and individuals' knowledge. Additional explanatory variables were introduced to analyse the impact of the content and the ordering of the messages. Table 4 presents the explanatory variables.

Insert Table 4.

4.2.3 Econometric estimations

We tested the influence on the WTP of all the above described explanatory variables. We decided to exclude from the estimations those explanatory variables with not statistically significant estimated coefficients. Table 5 confirms the influence of information on the WTP highlighted in Table 2.

Insert Table 5.

First, we tested for the influence of information on the negative impact of energy consumption on health and the environment on the WTP for energy efficient equipment and the installation of thermal insulation. All the estimated coefficients are positive and significant at the 5% or 10% level, showing a significant influence of Message 2 on respondents' WTP for all the products, of Message 4 on the WTP for an energy efficient boiler and thermal insulation, and of Message 5 on the WTP for energy efficient household appliances. With the exception of the information provided in Message 3, if the message emphasizes the negative impact of energy consumption, it has a significant influence on the WTP for energy efficient equipment and installation of thermal insulation. This induces individual altruistic behaviour. The health information described the negative effects on health from high energy consumption. These effects are indirect and are considered only to the extent that the respondent cares about the health of the population since the respondent's own contribution to energy consumption is marginal. This applies

[27] 0-1499 is a dummy variable equal to 1 if the respondent earns less than €1499 and 0 otherwise; One is a dummy variable that is equal to 1 if the respondent lives alone and 0 otherwise. The other dummy variables are defined in the same way.

also to environmental effects. Therefore, Hypothesis 1 is confirmed for all the messages except Message 3. We proposed an initial explanation for this above. However, it might be due to the message content. Message 3 provides information on the high financial implications of energy consumption for the environment. Non-reaction to this message might be explained by defensive denial. Diekmann and Preisendörfer (2003), and Tyler et al. (1982) suggest that high cost implications induce a psychological mechanism which leads to lack of reaction from the individual despite awareness of the problem. This might explain the different reactions to this message from our respondents.

Second, we investigated the effect of environmental and health information on the WTP for each product. We found that in the case of the set of energy efficient household appliances, the estimated coefficient of environmental information (Message 2; 14.615) was lower than the estimated coefficient of health information (Message 5; 15.556), and that the estimated coefficient of environmental information (Message 2; 49.501) was higher than the estimated coefficient of health information (Message 4; 49.066) for thermal insulation installation, but the difference is not significant in either case. In line with Disdier et al. (2013), we observe that, similar to health information, environmental information affects the WTP for both of the energy efficient products. However, for the energy efficient boiler, the estimated coefficient on environmental information (Message 2; 45.747) is significantly higher than the coefficient of health information (Message 4; 33.076). This is an interesting result and highlights the respondents' real concern for the environment compared to the priority generally given by respondents to health. IRSN (2019, 2020) suggests that health takes precedence of the environment among the French population; therefore, we expected the information on the health-energy link would have a stronger effect on the WTP of respondents than the information on the environment-energy link. Our results also contrast with those in Lusk and Briggeman (2009) and Orset (2019) showing that respondents prioritized information about health. Our results for energy efficient household appliances and thermal insulation support Hypothesis 2, but do not support energy efficient boilers.

Next, we test the effect of ordering. The estimated coefficient is positive and significant at the 10% level, showing that receipt of environmental information before health information has a significant influence on the WTP for an energy efficient boiler. However, for the other items, the estimated coefficients are not significant. Therefore, Hypothesis 3 is supported in for the case of energy efficient boilers. Our result show that message ordering effects are not always relevant. In line with Lusk and Shogren's (2007) and Marette et al.'s (2008) findings, we find an effect of order of information in the case of energy efficient boilers, no effect the other products, which mirrors the results in Disdier et al. (2013) and Orset (2019). Our results contribute to the lack of consensus on the effect of order. This issue would benefit from more research.

We tested, also, for the influence on the WTP of our respondents' living environment, behaviour, knowledge, and personal and socio-economic characteristics. Only a few of the estimated coefficients of these control variables are statistically significant, suggesting that they do not affect the WTP for energy efficient equipment and the installation of thermal insulation.

However, we found that type of accommodation and surface area of the accommodation both have a significant effect on the WTP for an energy efficient boiler and a set of energy efficient household appliances. This is an interesting result that shows the importance of living conditions in relation to the WTP for energy efficient products.

We found that more knowledge about ecological behaviours, and being the parent of at least one child also have a significant impact on the WTP for an energy efficient boiler. In the former case, this might be because ecological behaviours may be aimed at improving the heating in the dwelling.

We found that income matters. In the case of installing thermal insulation, the estimated coefficient of the groups receiving incomes of between €0 and €1,499 and €2,500 and €5,999 are positive and significant at the 5% level. This underlines the importance of income in deciding about thermal insulation.

Our results show that the home environment, personal characteristics, knowledge about energy use and income all play a role in energy behaviour. Hence, these criteria are crucial for influencing individual behaviour and should be considered in the design of measures to reduce energy consumption.

5 Welfare analysis and policy recommendations

Previous results show that information matters for the respondents' WTP for energy efficient equipment and installation of thermal insulation. Therefore, to test Hypothesis 4, we study the effect on social welfare of implementation of an information campaign by the public authorities.

We apply economic theory, specifically, first, we measure the consumer surplus based on the difference between what the consumer is willing to pay for a unit of a good and the purchase price. Second, each unit sold generates a marginal surplus for the producer, that is equal to the difference between the selling price and the marginal cost of production. The producer surplus is derived by multiplying the number of units sold by the marginal surplus. The sum of the producer surplus and all consumer surpluses is equal to the economic surplus and, therefore, to the social welfare. Third, a consumer is considered as having purchased a unit of product as soon as the consumer's WTP for this unit is

greater than or equal to the purchase price. Since we cannot observe the real choice only the WTP, we infer the choice.

We propose various energy policies aimed at encouraging people to reduce their energy consumption by purchasing an energy efficient boiler and energy efficient household appliances, and by installing thermal insulation. We test the different policies on the full panel not distinguishing among groups.[28] These policies we test are: an information campaign on the health-energy and environment-energy links; a subsidy for purchase of energy efficient products; and a mix of these two. We do not introduce taxation since increasing the price of an energy efficient product would reduce the motivation to purchase.[29] To provide recommendations for public decision-makers, we consider effectiveness based on increased WTP for the products measured by consumer surplus, producer surplus, social welfare and number of buyers compared to the absence of these measures.

5.1 Information campaign

We assume that the regulator conducts a comprehensive information campaign, covering all the information provided in the messages included in our study. The information currently provided in France is confined to an energy performance diagnosis and an energy label. We consider a comprehensive public intervention to comprise an intensive information campaign that is perfectly understood by all consumers and provides information on the damage to health and the environment caused by energy consumption (Round 5).

Following the information campaign, consumers are perfectly informed. Consumers directly internalize all information provided. We consider that the product purchase choices (energy efficient boiler - set of energy efficient household appliances - and thermal insulation) are conditioned by the consumer k's WTP for EEB, EEHA and TI given by WTP_{k5EEB}, WTP_{k5EEHA}, and WTP_{k5TI}, respectively. We assume consumers will be likely to buy a product if their WTP is higher than or equal to the market price, which is P(EEB) for the energy efficient boiler, P(EEHA) for the energy efficient household appliances, and P(TI) for thermal insulation. All prices are in Euros. Because consumers perfectly internalize complete information, no other tool can improve welfare. The consumer surplus for respondent $k \in N$ and product $j \in \{EEB, EEHA, TI\}$ is as follows:

$$W^L_{k,j} = max\{0, WTP_{k5}j - P(j)\}.$$

For $N = 217$, the producer surplus for the product $j \in \{EEB, EEHA, TI\}$ with the

[28] In this part, we focus on the information campaign, i.e., all the messages. We do not consider their order.

[29] In Section 6, we discuss the possibility of imposing a tax on high energy-consuming products to encourage individuals to substitute these products with more energy efficient products.

information campaign is defined as:

$$\pi_j^L = \sum_{k=1}^{N} [P(j) - C_j] * \mathbb{1}[j,k]$$

where C_j is the marginal cost of production and $\mathbb{1}[j,k] = \begin{cases} 1 \text{ if consumer } k \text{ buys the product } j; \\ 0 \text{ otherwise.} \end{cases}$.

5.2 Subsidy policy

Public intervention consists of the adoption of a per-unit subsidy for each energy efficient product. We define the subsidies as follows: s^{EEB} for an energy efficient boiler, s^{EEHA} for the set of energy efficient household appliances, and s^{TI} for the installation of thermal insulation. To simulate the subsidy scenario, we consider that consumers do not have precise knowledge about the energy-health and energy-environment links, which corresponds to the situation in Round 1. Consumer k can buy: an energy efficient boiler at price $P^s(EEB) = P(EEB) - s^{EEB}$ euro, the set of energy efficient household appliances at price $P^s(EEHA) = P(EEHA) - s^{EEHA}$ euro and thermal insulation at price $P^s(TI) = P(TI) - s^{TI}$ euro. The consumer surplus for respondent $k \in N$ and product $j \in \{EEB, EEHA, TI\}$ is:

$$W_{k,j}^s(s^j) = max\{0, WTP_{k1}j - P^s(j)\}. \quad (1)$$

For $N = 217$, the producer surplus for the product $j \in \{EEB, EEHA, TI\}$ with a per-unit subsidy is defined as:

$$\pi_j^s(s^j) = \sum_{k=1}^{N} [P(j) - C_j] * \mathbb{1}[j,k]$$

where C_j is the marginal cost of production and $\mathbb{1}[j,k] = \begin{cases} 1 \text{ if consumer } k \text{ buys the product } j; \\ 0 \text{ otherwise.} \end{cases}$.
The regulator also considers the possible cost of the subsidy. It reduces the price paid by the consumers only for those consumers who buy product j. Using trial and error, we can determine the optimal subsidy s^{j*} chosen by the regulator, which maximizes the expected average social welfare:

$$\frac{1}{N}\left[\sum_{k=1}^{N}\left[W_{k,j}^s(s^j) - s^j * \mathbb{1}[j,k]\right] + \pi_j^s(s^j)\right]$$

for $N = 217$ respondents with $j \in \{EEB, EEHA, TI\}$.

5.3 Information campaign and subsidy policy

We next propose an information campaign and subsidy policy that combines information with a per-unit subsidy. We assume that the regulator provides complete information

(including the information in all of the messages in this study) and sets a per-unit subsidy for each energy efficient product. Following information campaign, consumers are perfectly informed, which corresponds to the situation in Round 5. Therefore, by changing WTP_{k1} to WTP_{k5} in (1), we get the consumer surplus with an information campaign and subsidy policy. Calculation of optimal subsidies also considers this change.

5.4 Welfare analysis

We consider a baseline scenario in which the energy efficient boiler, the set of energy efficient household appliances, and the installation of thermal insulation are sold without any additional regulation. This baseline welfare is defined by (1) with $s^j = 0$. We compare among the welfare effects and compare among the number of buyers of various energy policies.

We define the average variation in the consumer surplus for product j as $\Delta W_N^L = \sum_{k=1}^{N} \left[W_{k,j}^L - W_{k,j}^s(0)\right]/N$ for information campaign. We then define the average variation in the consumer surplus for product j as $\Delta W_N^s(s^{j*}) = \sum_{k=1}^{N} \left[W_{k,j}^s(s^{k*}) - W_{k,j}^s(0)\right]/N$ for a subsidy s^{j*}. The average variation in the producer surplus for selling the product j is $\left[\pi_j^L - \pi_j^s(0)\right]/N$ for information campaign. Then, the average variation in the producer surplus for selling the product j is $[\pi_j^s(s^{j*}) - \pi_j^s(0)]/N$ for a subsidy s^{j*}. The average cost of the subsidy for product j is $s^{j*} * \left[\sum_{k=1}^{N} \mathbb{1}[j,k]/N\right]$. Then, the average variation in social welfare for product j is represented by the sum of the average variation in the consumer surplus and the producer surplus for product j for the information campaign, and by the sum of the average variation in the consumer surplus and the producer surplus for product j minus the average subsidy expense for product j for the subsidy. Ultimately, we calculate the variation in the number of buyers of product j, as the difference between the number of buyers of product j under the regulation and the number of buyers of product j in the baseline scenario.

For our calculations, we use the market price observed in May 2017, which is P(EEB)=€3,934 for the energy efficient boiler, P(EEHA)=€1,942 for the energy efficient household appliances, and P(TI)=€4,800 for the installation of thermal insulation. From INSEE-ESANE 2015 and Adie 2016,[30] we obtain average mark-ups: for the boiler producer 36.3%, for the household appliances 37.6%, and for installation of thermal insulation is 27,3%. This allows us to estimate that C_{EEB}=€2,886, C_{EEHA}=€1,411, and C_{TI}=€3,770.[31]

Based on the respondent's WTP, Table 6 presents the average variation in consumer

[30] See www.adieconnect.fr.

[31] To check the robustness of our results, we also estimate the impacts of the policies by varying the values of C_{EEB}, C_{EEHA}, C_{TI}. The results do not change.

and producer surpluses, average cost of the subsidy, average variation in social welfare and the variation in the number of buyers depending on the information campaign policy, the subsidy policy or the information campaign and subsidy policy combined.

Insert Table 6.

First, we see that all the policies studied lead to an increase in consumer surplus, producer surplus, social welfare and number of buyers. Therefore, the three proposed policies are efficient for these criteria. This suggests support for Hypothesis 4 that provision of environmental and health information to reduce energy consumption is a socially effective policy. However, is it the most efficient? The most efficient policy is the policy which induces the greatest increases in consumer surplus, producer surplus, social welfare and number of buyers. It is clear that, from any perspective, information combined with subsidy is the most efficient policy. Note that the optimal level of subsidy represents 26.28% of the sale price for the energy efficient boiler, 25.33% of the sale price of the set of energy efficient household appliances and 20.83% of the sale price for installation of thermal insulation.

Voelkner (2006) shows that individual WTP can be overestimated by as much as 30% due to hypothetical bias. To test the robustness of our results, we conducted a welfare analysis based on the data presented in Table 7 and reducing them by 30%. The results are unchanged: an information campaign combined with a subsidy remains the most effective policy.

Our results show that a policy mix that combines provision of information on health and environmental damage caused by energy consumption, with subsidies is the best option. However, in France and other European countries, energy policies aimed at promoting the energy transition, focused on reducing demand for energy through better insulation of housing and use of less energy-consuming equipment (boilers and appliances), do not include this nudge mechanism. For example, in Germany and Switzerland, significant financial aid is provided via grants and preferential rates for green renovation works, similar to the UK *Green Deal* and Belgium's *Energy Company Obligation* and *Ecopack*. Germany also has a *Stromsparcheck plus* programme, which involves financial inducements for replacing an old fridge with an energy efficient fridge. Our results suggest that, in addition to these financial inducements, a nudge in the form of an awareness campaign, highlighting the damage to health and the environment linked to energy consumption, would have a positive impact on encouraging consumers to make the energy transition and would increase social welfare. A policy combining subsidies with information is the most effective.

6 Discussion and conclusions

We were interested in whether information on the damage to health and the environment has an influence on households' energy behaviour. We also examined whether it would encourage consumers to choose more energy efficient products (boilers and appliances) and to install thermal insulation in their homes. Linking the environment and energy, and health and energy, and making consumers aware of these links through an information campaign would appear to raise awareness about the need to reduce energy consumption. We tested our intuition on a representative sample of the French population.

We found that provision of information increased the average WTP for energy efficient equipment and installation of thermal insulation in the home. The change in consumer WTP shows that consumers are interested in the consequences of their energy use on health and the environment. Individuals internalize the consequences of their energy consumption behaviour. Our results underline the need to consider individual living environments, personal characteristics, knowledge about energy saving and income.

Based on our finding that provision of information had an effect on responses, we examined whether an information campaign might be a socially effective policy. We show that it would be effective. Perhaps not the most effective policy. The results of our analysis show that a mix of information and subsidy is the most effective policy and provide evidence of the effectiveness of a nudge to incentivize citizens to reduce their energy consumption. However, no countries currently include a nudge in the form of information on health and the environment. But, the Netherlands have introduced another type of nudge in the form of their *Gele Energie bus* programme, which encourages energy savings by low-income households, based on providing low-income families with energy-saving products. It is hoped that including a nudge in addition to financial aid, to facilitate the energy transition, will gain momentum in future years.

Although the findings from this study can be generalized to other country contexts, it has some limitations. As is common to all WTP approaches, our study might suffer from a hypothetical bias. However, since the rate of respondents answering zero is very low, this bias might be limited. We conducted a robustness test to check whether hypothetical bias led our respondents to overestimate their WTP, as suggested by Voelkner (2006). We did not consider a tax policy because this would have had the effect only of increasing the price of energy efficient equipment and, therefore, demotivating consumers. But, taxation could be applied to energy-intensive equipment with the idea that a higher tax on these products would induce consumers to substitute them for the most energy efficient products. However, in this study, we consider basic equipment and introducing a price

increase for these products could reinforce fuel poverty.

Appendix

Messages

Message 1: *For information, the average price of a standard boiler (water heater and heating) is €2,500, the average price of standard appliances including a fridge, an oven and a hob is €1,200, and the average price for the installation of thermal insulation accommodation of 60m^2 is €4,800.*

Message 2: *According to the Ministry of the Environment, housing represents 30% of energy consumption and 16% of CO_2 emissions in France. CO_2 emissions are at the origin of global warming which generates the rise in sea level, the melting of glaciers, desertification... According to the International Energy Agency (IEA), a reduction of 40% of energy demand would reduce CO_2 emissions by 66%.*

Message 3: *According to an article published in Economics in 2012, the cost to society of the consequences of CO_2 emissions would be between €50 and €245 per tonne. According to official statistics, more than 50 million tons of CO_2 are emitted each year by the residential sector.*

Message 4: *According to an article published in Environment, Risks and Health, in 2010, insufficient interior temperatures can lead to condensation phenomena inside the house. Excess humidity promotes the growth of moulds, fungi and dust mites, which increases the risk of allergies and asthma in individuals.*

Message 5: *According to the World Health Organization (WHO) residential energy consumption (hob, oven, refrigerator and heating) generates indoor pollution. According to the Indoor Air Quality Observatory (OQAI), prolonged exposure to indoor pollution increases the risk of respiratory, neurological and cardiovascular diseases. The cost of this pollution is estimated between €12 and €38 billion per year in France, or for an empty and not thermally insulated apartment between €180 and €570 per inhabitant. Better insulation and the use of more efficient products would reduce this cost.*

Tables and figures

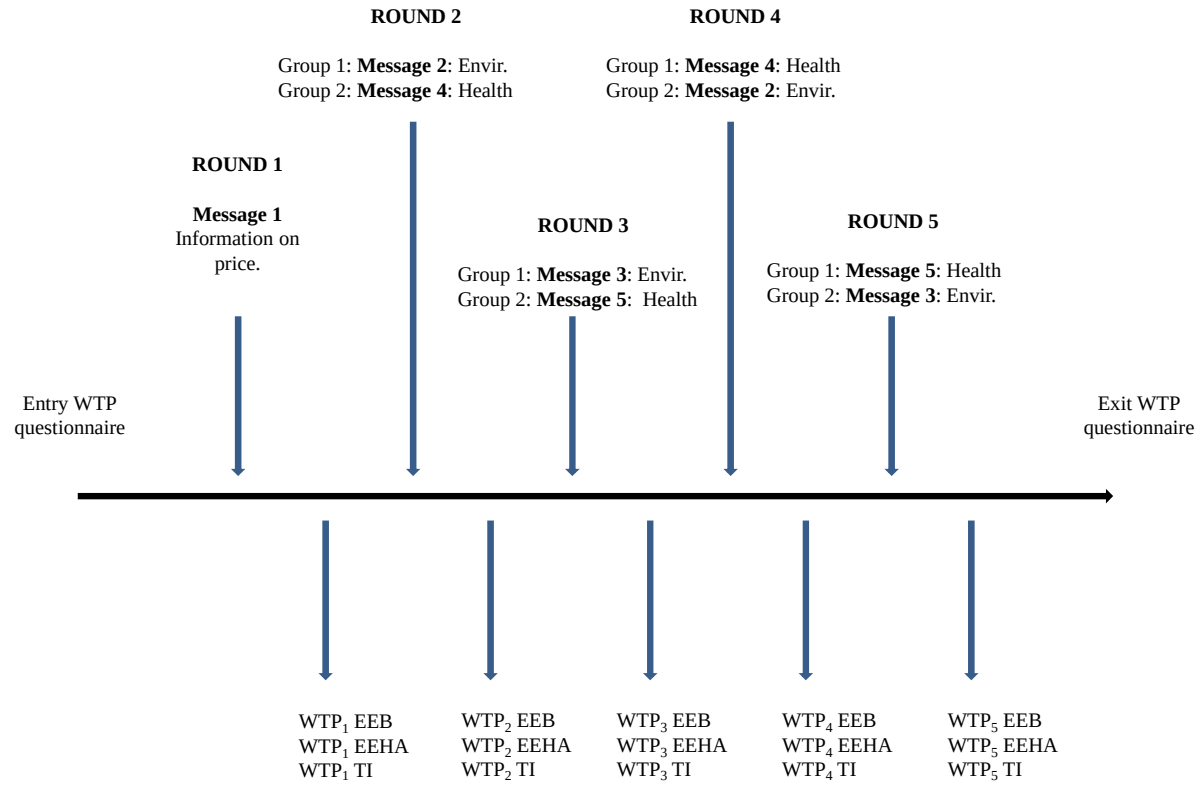

Figure 1: Questionnaire design.

Table 1: Socio-economic variables and comparison between the panels and INSEE 2016 data.

			Group 1 112 resp.	Group 2 105 resp.	All the Groups 217 resp.	INSEE 2016
Variable	Definition	Value	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
Gender	A dummy variable equal to 1 if the respondent is a man and to 0 if the respondent is a woman.	0	41.07	39.05	40.09	48
		1	58.93	60.95	59.91	52
	Chi2 test p-value between the samples and INSEE 2016		0.14	0.06	0.02	
Age	A dummy variable equal to 1 if the respondent is between 18 and 24 years old and to 0 if the respondent is not.	0	84.82	87.62	86.18	89
		1	15.18	12.38	13.82	11
	Chi2 test p-value between the samples and INSEE 2016		0.22	0.67	0.23	
Income	A categorical variable which takes the value "0-1499" if the respondent earns an income between €0 and €1,499; or "1500-2499" if it is an income between €1,500 and €2,499; "2500-5999" if it is an income between €2,500 and €5,999; or "6000 and more" if it is an income equals and higher than €6,000.	0-1499	27.68	24.76	26.27	30
		1500-2499	24.11	19.05	21.66	20
		2500-5999	37.50	48.57	42.86	40
		6000 and more	10.71	7.62	9.21	10
	Chi2 test p-value between the samples and INSEE 2016		0.74	0.31	0.58	
Household composition	A categorical variable which takes the value "One" if the respondent has a household made up of one person; or "Two" if it is a household made up of two persons; "Three-Four" if it is a household made up of three or four persons; or "Five and more" if it is a household made up of at least five persons.	One	25.00	28.57	26.73	35
		Two	38.39	31.43	35.02	33
		Three-Four	30.36	35.24	32.72	27
		Five and more	6.25	4.76	5.53	5
	Chi2 test p-value between the samples and INSEE 2016		0.11	0.30	0.05	

Table 2: Average, standard deviation and variations of the respondents' WTP for the energy-efficient boiler, the energy-efficient household appliances and the thermal insulation installation.

		Group 1 - 112 resp.				Group 2 - 105 resp.		
	Messages	Mean of the WTP	Standard deviation of the WTP	Variation of the WTP in % between round i+1 and i	Messages	Mean of the WTP	Standard deviation of the WTP	Variation of the WTP in % between round i+1 and i
Energy Efficient Boiler (EEB)	Message 1	2791.52	1229.11		Message 1	2964.05	1213.58	
	Message 2	2879.46	1284.41	3.15***	Message 4	2985.95	1245.20	0.74**
	Message 3	2880.36	1285.93	0.03	Message 5	2988.81	1247.12	0.10
	Message 4	2933.04	1280.64	1.83	Message 2	2999.29	1250.83	0.35**
	Message 5	2943.32	1286.91	0.35	Message 3	3004.05	1247.24	0.16
Energy Efficient Household Appliances (EEHA)	Message 1	1500.45	753.80		Message 1	1434.76	554.32	
	Message 2	1529.91	780.06	1.96**	Message 4	1443.33	556.39	0.60
	Message 3	1529.46	780.67	-0.03	Message 5	1453.81	557.97	0.73**
	Message 4	1530.79	780.79	0.09	Message 2	1457.62	563.25	0.26
	Message 5	1555.62	801.53	1.62*	Message 3	1458.10	563.56	0.03
Thermal Insulation (TI)	Message 1	4652.23	2087.58		Message 1	4491.43	1609.06	
	Message 2	4731.70	2111.04	1.71***	Message 4	4537.14	1647.16	1.02**
	Message 3	4767.41	2109.17	0.75	Message 5	4560.00	1643.96	0.50**
	Message 4	4811.17	2148.67	0.92**	Message 2	4568.57	1650.60	0.19
	Message 5	4832.60	2198.89	0.45	Message 3	4569.52	1651.17	0.02

Note: iє[1,4]; Average WTP of respondents (in euros); ***, ** and * denote significant differences at the levels 1\%, 5\% and 10\%, respectively, as tested by the Wilcoxon test.

Table 3: Zero responses and insensitivity to messages.

	Group 1 - 112 resp.		Group 2 - 105 resp.	
	Number of respondents	Proportion in %	Number of respondents	Proportion in %
Zero responses for Energy Efficient Boiler, i.e., its $WTP_{ij}=0$ for all i={1,…,5} and j={EEB}	5	4.46	4	3.80
Zero responses for Energy Efficient Household Appliances, i.e., WTPij=0 for all i={1,…,5} and j={EEHA}	3	2.67	2	1.90
Zero responses for Thermal Insulation, i.e., WTPij=0 for all i={1,…,5} and j={TI}	2	1.78	4	3.80
Zero responses for all Energy Efficient Products, i.e., WTPij=0 for all i={1,…,5} and j={EEB, EEHA, TI}	1	0.89	1	0.95
Non-zero responses for Energy Efficient Boiler but insensitive to messages, i.e., WTPij≠0 and WTPij=WTPi+1j for all i={1,…,5} and j={EEB}	88	78.57	93	88.57
Non-zero responses for Energy Efficient Household Appliances but insensitive to messages, i.e., WTPij≠0 and WTPij=WTPi+1j for all i={1,…,5} and j={EEHA}	92	82.14	93	88.57
Non-zero responses for Thermal Insulation but insensitive to messages, i.e., WTPij≠0 and WTPij=WTPi+1j for all i={1,…,5} and j={TI}	87	77.67	88	83.80
Non-zero responses for all Energy Efficient Products but insensitive to messages, i.e., WTPij≠0 and WTPij=WTPi+1j for all i={1,…,5} and j={EEB, EEHA, TI}	76	67.85	84	80

Table 4: Descriptive statistics - Explanatory variables

Variable	Definition	Value	Frequency (%) on 217 resp.
Living environment			
Accommodation	A dummy variable equal to 1 if the respondent lives in a flat and to 0 if the respondent lives in a house.	0	49.77
		1	50.23
Owner	A dummy variable equal to 1 if the respondent is an owner and to 0 if the respondent is a tenant.	0	45.16
		1	54.84
Having a boiler	A dummy variable equal to 1 if the respondent has a boiler and to 0 if she does not.	0	52.08
		1	47.92
Having household appliances	A dummy variable equal to 1 if the respondent has household appliances and to 0 if she does not.	0	35.95
		1	64.05
Having thermal insulation	A dummy variable equal to 1 if the respondent has a thermal insulation and to 0 if she does not.	0	13.83
		1	86.17
Using low polluting energy	A dummy variable equal to 1 if the respondent uses low-polluting energy (electricity) and to 0 if she uses high-polluting energy (gas and oil).	0	58.99
		1	41.01
Surface area	Quantitative variable equal to the surface of the respondent's home in square meters.	Mean	95.81
		Standard deviation	58.22
Behaviour			
Conserves energy Price	A dummy variable equal to 1 if respondent prioritizes the reduction of the expenditure first when saving energy and to 0 otherwise.	0	46.55
		1	53.45
Conserves energy Health	A dummy variable equal to 1 if respondent prioritizes health concerns first when saving energy and to 0 otherwise.	0	97.23
		1	2.77
Conserves energy Environment	A dummy variable equal to 1 if respondent prioritizes environmental concerns first when saving energy and to 0 otherwise.	0	58.52
		1	41.48
No energy saving	A dummy variable equal to 1 if respondent does not want to save energy and to 0 otherwise.	0	97.70
		1	2.30
Importance of the brand	A dummy variable equal to 1 if the respondent considers that the brand of the product is important at the time of purchase and to 0 if she does not.	0	54.38
		1	45.62
Importance of price	A dummy variable equal to 1 if the respondent considers that the price of the product is important at the time of purchase and to 0 if she does not.	0	2.30
		1	97.70
Importance of energy consumption	A dummy variable equal to 1 if the respondent considers that the energy consumption of the product is important at the time of purchase and to 0 if she does not.	0	6.91
		1	93.09
Making actions to reduce energy consumption	A dummy variable equal to 1 if the respondent makes eco-gestures and to 0 otherwise.	0	9.22
		1	90.78
Personal characteristic			
Children	A dummy variable equal to 1 if the respondent has at least a child and to 0 otherwise.	0	53.00
		1	47.00
Respiratory problem	A dummy variable equal to 1 if the respondent or a relative has respiratory problems such as asthma or allergies and to 0 otherwise.	0	76.03
		1	23.97
Knowledge			
Knowledge of energy label	A dummy variable equal to 1 if the respondent knows the energy label and to 0 otherwise.	0	1.38
		1	98.62
Knowledge of ecological aids	A dummy variable equal to 1 if the respondent knows the ecological aids and to 0 otherwise.	0	45.62
		1	54.38
Information			
Message on the environment received first	A dummy variable equal to 1 if the respondent first received the messages on the environment (i.e., the respondent is in Group 1) and 0 if the respondent first received the messages on health (i.e., the respondent is in Group 2).	0	
		1	
Message 2	A dummy variable equal to 1 if at that point of the survey the respondent has just received the message 2 and to 0 otherwise.	0	
		1	
Message 3	A dummy variable equal to 1 if at that point of the survey the respondent has just received the message 3 and to 0 otherwise.	0	
		1	
Message 4	A dummy variable equal to 1 if at that point of the survey the respondent has just received the message 4 and to 0 otherwise.	0	
		1	
Message 5	A dummy variable equal to 1 if at that point of the survey the respondent has just received the message 5 and to 0 otherwise.	0	
		1	

Table 5: Results from the random effects model on the difference in WTPs between choices $i+1$ and i pooled into levels for energy efficient boiler, energy efficient household appliances, and thermal insulation.

Model: Random effects model	Difference in WTP for energy efficient boiler in €		Difference in WTP for energy efficient household appliances in €		Difference in WTP for thermal insulation in €	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Const	-73.312***	26.701	-32.238***	8.677	-48.522*	26.226
Surface area	0.481***	0.168	0.290***	0.054		
Accommodation	38.074**	18.807	13.744**	6.341		
Knowledge of ecological aids	28.213*	15.868				
Children	-33.683*	18.008				
0-1499					69.933**	32.077
2500-5999					60.174**	28.525
Message on the environment received first	25.879*	15.298				
Message 2	45.747**	18.632	14.615**	6.402	49.501*	29.601
Message 4	33.076*	18.632			49.066*	29.601
Message 5			15.445**	6.402		
Observations	868		868		868	
Log-likelihood	-5925.604		-5000.240		-6328.860	

Note: * p<0.1; ** p<0.05; *** p<0.01.

Table 6: Welfare analysis for energy efficient boiler, energy efficient household appliances, and thermal insulation according to policies. 217 respondents. Respondents willingness to pay.

	Average variation in consumer surplus in €	*Average variation in producer surplus in €*	*Average subsidy expense in €*	*Average variation in social welfare in €*	*Variation in number of buyers*
	Energy Efficient boiler				
Information Campaign	38.70	28.98	-	67.68	6
Subsidy s^{EEB^*} = €1,034	251.19	531.24	648.04	134.36	110
Information Campaign and Subsidy s^{EEB^*} = €1,034	321.25	555.39	671.86	204.78	115
	Energy Efficient household appliances				
Information Campaign	21.27	4.89	-	26.16	2
Subsidy s^{EEHA^*} = €492	143.00	188.42	278.88	52.54	77
Information Campaign and Subsidy s^{EEHA^*} = €492	172.50	200.65	290.21	82.94	82
	Thermal insulation				
Information Campaign	97.70	23.73	-	121.43	5
Subsidy s^{TI^*} = €1,000	715.21	104.42	788.02	31.61	22
Information Campaign and Subsidy s^{TI^*} = €1,000	835.48	113.92	797.24	152.16	24

Table 7: Welfare analysis for energy efficient boiler, energy efficient household appliances, and thermal insulation according to policies. 217 respondents. Respondents' willingness to pay decreased by 30%.

	Average variation in consumer surplus in €	*Average variation in producer surplus in €*	*Average subsidy expense in €*	*Average variation in social welfare in €*	*Variation in number of buyers*
	Energy Efficient boiler				
Information Campaign	2.45	9.66	-	12.11	2
Subsidy s^{EEB^*}= €784	24.13	43.47	46.97	20.63	9
Information Campaign and Subsidy s^{EEB^*}= €994	57.35	82.10	96.19	43.26	17
	Energy Efficient household appliances				
Information Campaign	3.80	7.34	-	11.14	3
Subsidy s^{EEHA^*}= €402	15.87	9.79	20.38	5.28	4
Information Campaign and Subsidy s^{EEHA^*}= €402	27.16	22.02	29.64	19.54	9
	Thermal insulation				
Information Campaign	19.12	14.24	-	33.36	3
Subsidy s^{TI^*}= €950	87.56	161.38	205.76	43.18	34
Information Campaign and Subsidy s^{TI^*}= €950	129.82	213.59	253.92	89.49	45

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