Nudging Acceptability for Wood Ash Recycling in Forests : A Choice Experiment

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Abstract

In this paper, our objective is to assess the general French population's acceptability of application of wood ash in forests, a measure currently not allowed but under consideration by the government. The main originality of our approach is that we test how a nudge can be used as an instrument to increase social acceptability, conveying objective information regarding ash recycling. Furthermore, although we do not consider it as a welfare measure, we show how the estimation of the willingness-to-pay can be considered as a complement to the more traditional social acceptability measure. Three nudges were introduced as three treatments in a discrete choice experiment. In the first treatment, the options with wood ash application were highlighted to indicate to the respondents that they corresponded to pro-environmental measures (positive framing). In the second treatment, we changed the wording of the two non-status quo options to highlight the recycling aspect of wood ash application. In the last treatment, we adopted a productive wording to highlight the fact that wood ash application increases wood production. Treatments, in particular positive framing and productive wording, influence the willingness-to-pay but depend on the attitudes of the respondents.

Keywords: Choice experiment; environmental sensitivity; nudge; social acceptability; wood ash.

JEL classification: C24; D91; Q57

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1. Introduction

Facing important transitions in the energy supply raises the question of public acceptability. From a real public policy point of view, public acceptability should receive more attention than it has to date to ensure a successful transition to the future (van Rijnsoever *et al*., 2015; Wüstenhagen *et al*., 2007). Due to climate mitigation policies, we are facing significant changes in energy supply. One of these changes is the increased use of biomass for this purpose. Increased wood harvesting considerably contributes to meeting European countries' targets for renewable energy production (EU, 2009). In addition to the traditional harvesting of firewood, the supply of wood fuels includes the harvesting of whole trees as well as that of the residues from thinning and final felling. However, the increase in wood fuel use is at the root of several environmental issues: first, the generation of considerable amounts of ash that leads to a waste management problem and, second, the depletion of nutrients from forests through wood harvesting. For example, Finland and Sweden generate approximately 260,000 tons and 300,000 tons annually, respectively, of wood ash from power and heating plants, the pulp and paper industry, and the sawmill industry (Emilsson, 2006), and the majority of the wood ash is deposited in landfills (Vesterinen, 2003). In particular, the removal of small branches as a result of whole-tree harvesting and the use of harvest residues has raised concerns about the depletion of nutrients and a future reduction in soil fertility and tree growth (Achat *et al*., 2015; Raulund-Rasmussen *et al*., 2008; Stupak *et al*., 2007; Stupak *et al*., 2011). It has been suggested to fertilize forests to compensate for the loss of nutrients (Paillet *et al*., 2013). The recycling of ash from wood burning could be one option to reduce the negative impact of biomass harvesting (Augusto *et al*., 2008; Väätäinen *et al*., 2011; Ekvall *et al*., 2014). For example, in Sweden, wood ash is spread on approximately 12,000-13,000 ha, representing 30% of the annual final felling (Swedish Forest Agency, 2013).

This paper presents the results of a survey carried out in France in 2017, with the main objective to assess the acceptability of ash recycling in forests by the general population. In France, ash recycling is not currently allowed in forests, but the French government is considering changing the regulations to make it possible (Saint-André *et al*. 2019). Furthermore, it should be noted that the French population is closely attached to its forests as they are frequent users of the forests for recreational purposes. National surveys have shown that around one out of four French adult persons visit a forest at least once a year (Dobré 2005), which was confirmed in the present survey where 77% of the respondent had visited a forest during the last twelve months. Therefore, we expect the respondents to have strong preferences for changes in forest management.

However, before significant changes can be made in policies/regulations, it is important to consider to which degree and under which conditions the French population will accept a change in regulations. As emphasized in Klenert *et al*. (2018) in a different context, carbon pricing is a well-known and efficient solution to reduce carbon emissions. However, its implementation often raises public acceptability issues. In France, the recent attempts to implement an ecological tax on heavy trucks (in

Brittany in 2013-2014) and to increase taxes on gasoline (in 2018) raised a lot of protestation, causing both projects to be cancelled by the government. These two failures highlight the necessity, when considering the implementation of new environmental policies, to better communicate to avoid social acceptability issues, if it is anticipated that opposition may be due to lack of knowledge or misperception. They also reveal the necessity to understand the determinants of the social acceptability of environmental policies (Deroubaix and Lévèque, 2006). It is not sufficient that the measure is considered to be advantageous by most policymakers and experts.

In the literature, Batel *et al*. (2013) define social acceptability with two dimensions: *acceptance* and *support*. The first term refers to the way an individual tolerates a given policy, whereas the latter refers to the way an individual undertakes actions (talking to peers, writing a comment on social networks, etc.) in favor/against a given policy. In their studies, Dreyer and Walker (2013) and Dreyer *et al*. (2015) add two dimensions more: *perceived fairness* (a policy that is perceived as fair among the citizens is more likely to be accepted) and *perceived effectiveness* (an effective policy is more likely to be accepted). We follow Dreyer and Walker (2013) and Dreyer *et al*. (2015)'s approach and define social acceptability with these four dimensions (acceptance, support, perceived fairness and perceived effectiveness), because it allows us to detect the dimensions that account the most for the respondents. However, differently from these authors, we also try to complement this approach with other indicators. In particular, following Ščasný *et al*. (2017), we also compute the respondents' willingness-to-pay (WTP) for that new environmental measure. To this end, we consider a choice experiment approach. A multi-attribute choice experiment allows to assess the impact of different policy characteristics on acceptability. Notwithstanding, it is worth noticing that the elicitation of the WTP is not our primary objective. Therefore, we are not aiming at estimating welfare economic consequences.

This is the first study, to the best of our knowledge, to assess the general population's acceptability for ash recycling. Up until now, a large body of studies has analyzed the impact of fertilizers and ash spreading on forest ecosystems, and economic studies have focused on estimating the cost of wood ash spreading (Väätäinen *et al*., 2011; Pukkala, 2017) and on the forest owner's WTP for this new measure (Abildtrup *et al*., 2017, Ouvrard *et al*., 2019). We therefore carried out a survey where the respondents were told that the French government was considering the possibility of recycling wood ash in French forests. We also explained that while the forest owner may benefit from better soil fertility, the private economic gain from ash recycling may not be sufficient to cover its cost. For example, in Finland, public subsidies exist to recycle ash in forests and a recent assessment of the direct costs of ash recycling in France (Saint-André *et al*., 2019) shows that the expected net present value of increased timber production will not be sufficient to cover the direct costs of ash–recycling and, correspondingly, a survey revealed that private forest owners' WTP was lower than the cost of treating, transporting, and spreading ash in forest. Our survey included a choice experiment (CE) where respondents were asked to choose between different scenarios to regulate ash recycling. The advantage of the choice experiment is that we are able to identify how different characteristics of a

policy may influence the acceptability and it provides the possibility of getting a cardinal measure of the importance – not only a ranking. The proposed scenarios included a fee (applied to the electricity bill) that could be used to cover the forest owner's cost of implementing ash recycling. In addition to the benefits of increased timber production, ash recycling also gives rise to positive externalities, like avoiding forest health issues related to soil impoverishment and reducing landfill usage (recycling aspect). Therefore, our hypothesis is that the general public has a positive WTP for ash recycling.

Although wood ash recycling seems to be an obvious environmental solution, it has also some drawbacks. For instance, individuals who enjoy walking in forests may experience some disutility because of the presence of ash on the soil (disturbance of visible quality). Another issue is the possibility that ash contains some heavy metals (Narodoslawsky and Obernberger, 1996; Karltun *et al*., 2008; Vassilev *et al*., 2014), therefore presenting a risk of pollution of the soils. Moreover, extensive reviews have highlighted other challenges or drawbacks of ash-recycling as, for example, the issue of the ash quality which depends on tree species and burning process (Pitman *et al*. 2006, Augusto *et al*. 2008), potential adverse effects on soil biology on certain soils (Pitman *et al*. 2006), and logistic and legal challenges of spreading ash in forests (Hannam *et al*. 2018).

Our second contribution to the literature is on social acceptability, testing the possibility to nudge the respondents' choices in a choice experiment, to give them incentive to choose an option different from the status quo. As defined in Thaler and Sunstein (2008), a nudge is a simple, costless and non-coercive action to orient agents' decisions in a given direction. Encouraging results have been obtained in the literature, in particular, in field experiments on energy conservation (Allcott, 2011; Costa and Kahn, 2013; Ferraro and Price, 2013). The characteristics of a nudging tool make it easy to implement from a public policy point of view. It is not necessary to set up a specific agency to implement the nudge, contrary to a tax with the collection of revenues. However, in contrast with previous studies assessing the effect of nudges we tested nudges in a hypothetical context. In our case, we consider nudges as a communication tool to provide some piece of information to the respondents that may favor the social acceptability of a new policy. Moreover, knowing that economic agents are not only *homo oeconomicus*, as traditionally assumed in economics (Thaler and Sunstein, 2008) because of some limits (cognitive biases, limited attention, etc.), our informative nudges are also intended to make them better understand the proposed policy. Finally, we are interested in comparing the impact of different nudges because we cannot anticipate, *a priori*, the size of their effects.

Evaluation of nudging approaches has already been considered in a choice experiment by Kuhfuss *et al*. (2016). Their nudge was based on a collective bonus that farmers received if at least 50 percent of their land was enrolled in the agro-environmental measure the authors consider. Contrary to these authors, our nudges were not included in the set of attributes. Instead, we used a framing (*i.e*., a specific presentation of the alternatives) and a wording approach (*i.e*., the use of specific words) to influence the respondents' choices. Moreover, contrary to Kuhfuss *et al*. (2016), we controlled for the

effect of the nudges with a control group that corresponds to the traditional and neutral way of presenting the alternatives in a choice experiment.

Our objective when using nudges in this survey is neither to manipulate the respondents towards answering in a particular manner desired by policymakers, nor to try to obtain the highest WTP as possible for them. Nevertheless, given that we consider the WTP as a complement measure to the more traditional measures of social acceptability, the size of the WTP is an indication of the effect of the nudge, and therefore to which piece of information, the respondents were the most responsive.

Overall, our main contribution is to provide two measurements of respondents' acceptability of ash recycling in forests: their WTP for such a measure and their answers to the questions that directly assess social acceptability.

The rest of the paper is organized as follows. We present our methodology and the behavioral hypotheses in Section 2. The design of our survey is presented in Section 3. Its implementation is described in Section 4. The results are given in Section 5, and Section 6 contains a discussion of the results and the conclusion.

2. Methods

i) Behavioral hypotheses

To compare the effects of the nudges, we adopted an approach similar to that of LaRiviere *et al.* (2014), carrying out a choice experiment with different treatments (one for each nudge) in addition to a control group. The respondents were randomly allocated to one of these groups. The advantage of this approach, directly inspired from behavioral and experimental economics, is that it makes it possible to compare the causal effects of the tested nudges. Moreover, it allows us to determine the effect of nudges on social acceptability by comparing the total score on all the dimensions (acceptance, support, perceived fairness and perceived effectiveness) between the different treatments.

We also elicited the respondents' environmental preferences using a questionnaire developed in the psychological literature (Milfont and Duckitt, 2010). In the literature, relationships between environmental preferences and WTP have already been investigated (Taye *et al.*, 2018). In our case, the intuition is that a higher WTP for the distribution of wood ash in forests may be linked to such preferences because it is a form of recycling. In this paper, these environmental preferences are characterized by what we refer to as *environment sensitivity*, *i.e.*, the way individuals take the impact of their actions on environmental quality into account.

Although the derivation of the French general population's WTP is not used for carrying out a welfare economic analysis in this study, we nevertheless carefully followed the recommendations formulated by Johnston *et al.* (2017) regarding the description of our choice experiment, as for example the pretesting of information content of valuation scenarios and the realism of payment vehicle. Still, we acknowledge that the piece of information we provided to the respondents with our nudges

may have biased their answers. It is implemented in the same spirit as Boyle (1989), Bergstrom *et al*., (1989), Munro and Hanley (1999), even if these studies consider contingent valuation, and also Needham *et al*. (2018). We argue that in our case this information strategy is very specific and implemented on purpose (to see how it impacts the respondents' social acceptability of wood ash recycling).

Our approach allows policymakers to design relevant communication strategies to achieve an acceptable level of social acceptability for a new policy that enhances ash recycling in forests. In that sense, we are the first to study the effect of nudge implementation on the social acceptability of a public policy.

In our survey, the use of the framing and the wording treatments has two objectives. We first wanted to assess whether it is possible to orient the respondents' decision towards the choice of one of the two alternatives, instead of choosing the status quo. We therefore formulated the following hypothesis:

Hypothesis 1 (H1): The use of the (positive) framing and of the recycling and productive wordings increases the likelihood that a respondent chooses a scenario with ash recycling.

The intuition was that the positive framing increases the visibility of the alternatives, contrary to the one of the status quo that becomes less "visible". Regarding the two wording treatments, the intuition was that they both highlight two different roles of wood ash: the recycling wording highlights the fact that wood ash is not pure waste and can be re-used, while the productive wording highlights the fertilizing effect of wood ash.

We also wanted to assess whether it is possible to influence the respondents' social acceptability of such a new environmental measure. Our hypothesis is:

Hypothesis 2 (H2): The social acceptability of wood ash application, measured by traditional scores of acceptability, is higher in the different treatments than in the control group.

The intuition was that each treatment highlights either the utility of wood ash (under the wording treatments) or the environmental aspect (with the positive framing), contrary to the control group (where none of these aspects is emphasized).

Hansen and Jespersen (2013) have proposed to classify nudges according to the cognitive effort required by those who receive the nudge, following the distinction between *System 1* and *System 2* established by Kahneman (2003). System 1 corresponds to the system that is quick and automatic, whereas System 2 is slow and reflective. A nudge based on a reaction of System 1 is more often perceived as a form of manipulation because agents do not have the impression of inferring information. Indeed, when System 1 is used, agents generally act by reaction, without being necessarily conscient. This distinction between these two systems is important to understand how a nudge works. According to the distinction regarding S*ystem 1* and *System 2* (Kahneman, 2003), and the recent work of Jung and Mellers (2016) and Reisch and Sunstein (2016), it appears that the nudges

based on a reaction of System 2 are generally more socially accepted than those based on a reaction of System 1. To clarify this point, we note that nudges may take several forms (information disclosure, use of default options, use of framing, simplification, etc.), and that they do not all require the same "cognitive effort" by those who are nudged, in the sense that some nudges have to be interpreted before making a decision, while other nudges are subtler.

In our case, the positive framing is a subtle approach, that is not necessarily detectable by the respondents, *a priori*. Therefore, our point is that when choosing their preferred options, the respondents will not necessarily detect the nudge. On the opposite, the use of the two wordings necessitates some reflection, although they are also subtle. When reading them, the respondents first have to think in terms of consequences the wordings refer to: the recycling wording refers to environmental consequences (the idea that wood ash is recycled), and the productive wording refers to consequences in terms of productivity of the soils. We could therefore test whether the perception of the nudge used has an impact on the acceptability of the proposed measure. We thus proposed testing the following hypothesis:

Hypothesis 3 (H3): The social acceptability of wood ash application is higher in the wording treatments than in the positive framing treatment.

The positive framing treatment uses a specific presentation of the alternative, thus based on a reaction of System 1 (there is no real interpretation). On the other hand, the wording treatments use specific words that need to be inferred by the respondents. They are thus based on a reaction of System 2.

ii) Econometric modelling

To determine the respondents' acceptability regarding wood ash recycling, we estimated first a conditional logit model.

For an individual n, the (random) utility of choosing alternative j in choice situation t, where p_{jt} is the price of alternative j in scenario t and the other attributes included in the vector x_{jt}, is given by:

$$\boldsymbol{U_{njt} = \alpha_n p_{jt} + \beta'_n x_{jt} + \varepsilon_{njt}} \qquad (\mathbf{1})$$

where α_n and β_n are the estimated parameters, and ε_{njt} is the random unobserved utility component, with ϵ assumed to be identically and independently distributed according to an extreme value distribution.

In addition to working in this preference space, we elicited the respondents' WTP in the willingness-to-pay space (Train and Weeks, 2005). By rearranging eq. (1), we obtain the respondents' preferences in the WTP space:

$$U_{njt} = \alpha\left(p_{jt} + c_n' x_{jt}\right) + \varepsilon_{njt} \quad (2)$$

where $c_n' = \frac{\beta_n}{\alpha_n}$ is the vector of marginal WTP estimates.

3. Study design

We carried out a choice experiment to elicit the general French population's WTP for wood ash spreading in forests. While forest owners may benefit from ash recycling since it could maintain or increase forest production, the cost of ash treatments (making granulates) plus transport and spreading costs may be higher than the expected private benefits considered by the forest owners. On the other hand, society may place a higher value on long-term fertility effects such as the positive externalities associated with not depositing wood ash in landfills. Therefore, the government may consider subsidizing ash recycling. However, since an important objective of the present study is to assess and understand the acceptability of a new regulation, we combined a choice experiment, often used in the environmental valuation of non-market goods and services, with approaches to assess acceptability of new policy measures. All the respondents first chose their preferred options in the choice experiment (described in the first subsection). Then, they answered the social acceptability questions ("Social acceptability questions"). Finally, we assessed their environmental preferences to verify their role in the choices the respondents made ("Environmental sensitivity questions").

i) The discrete choice experiment

We proposed a simple discrete choice experiment with four attributes to estimate the French population's WTP for wood ash application given different assumptions about the application.

Before we presented the different attributes to the respondents, we explained to them that the French government is considering the distribution of wood ash in French forests to preserve soil fertility because the removal of biomass contributes to nutrient exportation. We emphasized that wood ash would be applied just once, and that the effects would last for 30 years. In a French context ash spreading is expected to take place one time during a rotation (Saint-André *et al*., 2019). Finally, to finance this measure, we told them to imagine that a new fee would be applied just once in 2018 on their electricity bill. We chose the electricity bill because it already includes different taxes and the wood ash is a by-product of generating energy. Our impression was that a one-time payment made more sense to the respondents as the ash recycling policy does not imply that ash spreading takes place each year but maximum once per 30 years (in a same forest) and related to a significant biomass harvest. However, ash spreading will take place each year but not in the same forest. While it has been recommended that payments are periodical (Egan *et al*., 2015) we decided to adapt the payment vehicle to the valuation context (Johnston *et al*. 2017). According to Myers *et al*. (2017), applying an one-time payment leads to conservative WTP estimates relative to estimates based on periodical

payments. We also reminded the respondents that should they accept to pay for wood ash, it would lower their budget for other expenditures. We considered six levels for the *Costs* attribute (€0, €4, €8, €15, €30 and €50). Besides the tax attribute our choice experiment included three other attributes which derived from the literature and tested with our focus group. Two attributes addressed remedies to avoid potential negative impact of ash recycling on the recreational use of forests: period restrictions and signalling. The attribute, *Period*, indicates whether wood ash spreading is temporally constrained to be outside gathering periods or not (two levels). Indeed, our point is that some individuals may be worried that wood ash is present on berries, mushrooms, etc. that they would like to gather. An alternative approach to cope with recreational visitors' concern is to give information about ash spreading. With the attribute "*Signal*" we wanted to assess to which degree the presence of a sign indicating that ash has been applied in the forest would increase acceptability of ash-recycling. Being informed about whether or not ash recycling has taken place allows forest visitors the choice to enter the forest or not (or to allow their children to play on the forest ground). Indeed, in the public regulation of ash-recycling in forest, in Denmark they take recreational users interest into account by the following requirements: "*When spreading [ash] in forests, it must be signalled around the area for at least three months after the application that picking of berries, mushrooms and the like is not recommended unless the wood ash is injected to the soil or pre-treated so that it does not dust during application"* (Miljøministeriet, 2008, § 15 art. 2). As highlighted in the introduction, wood ash recycling may be negatively perceived by some individuals visiting forests (visual disturbance on the soils or on vegetation for instance). The attributes *Signal* and *Application period* were considered to account for such negative effects. The attribute *Fertility* describes by how much the soil fertility increases following the application of wood ash (+5% or +15%). Results established in the literature were used to determine the levels. In their study, Pérez-Cruzado *et al*. (2011) compared two quantities of ash, 10 tonnes and 20 tonnes per hectare, and showed that the diameter of trees increased, on average, by +16%, and the height by +11%. In another study, Saarsalmi *et al*. (2014) observed that the use of three tonnes of ash per hectare on Scots pine stands led to an increase in productivity of +11% after four years of treatment. On peatland sites, they did not find any significant changes in productivity during the six first years after treatment. In other words, the expected impact on fertility are uncertain but our levels represent a potential range of impact. The attributes and their levels are summarized in Table 1.

[Table 1 here]

The choice experiment consisted of 12 choice tasks, *i.e*, 12 scenarios in which respondents had to choose between two options with ash recycling and one option to stay in the current situation (status quo). We used the Ngene software to generate a D-efficient design. On the basis of results from a pilot

test (114 respondents), an experimental design with an informative Bayesian update to improve design efficiency was constructed using NGENE software (Scarpa *et al*., 2007).

The originality of this experiment lies in the fact that we carried out three treatments in terms of the presentation of the choice tasks, in addition to a control group (an example is provided with Fig. 1), to verify whether it is possible to influence the estimated WTP. We used nudges for this purpose, *i.e*., simple modifications of the choice architecture, by providing information (wording approach) or just a signal (framing approach) to test their influence on the respondent's choice in a given direction, without preventing respondents from choosing their preferred option. In contrast with Kuhfuss *et al*. (2016), the nudges we considered were not one of the attributes of the policy. Indeed, contrary to these authors, in this paper we consider nudging as a communication tool aiming at improving individuals' social acceptability of spreading wood ash. We used split samples where the choice alternatives with ash were more visible (framing) or highlighted the role of ash (on the environment or on soil fertility) using some specific words (wording). In all the treatments, the description of the policy that was proposed to the respondents was the same (common knowledge). The only change appeared at the level of the presentation of the choice cards, whether through the use of wording or through the positive framing, therefore allowing us to assess to which argument the respondents were the most responsive. The treatments are detailed below.

The ***control group*** was conducted in the traditional way of representing a choice task: the respondents had to choose between "Option 1", "Option 2" and "Current situation", knowing that the two first options corresponded to wood ash application. In the ***positive framing treatment***, "Option 1" and "Option 2" were displayed in large green letters, compared to the "Current situation" that was displayed in small letters. The objective of this treatment was to highlight the environmental options (with the use of a larger font and green letters). While the positive framing we are using could be considered subtle, such small changes have been proven to be efficient nudges. One example is the use of default options, that is to say options that are directly pre-selected for economic agents (Löfgren *et al*., 2012; Egebark and Ekström, 2016). Another example which was shown to be efficient is the fact to reduce the size of plates to reduce food intake (Freedman and Brochado, 2010). In the ***recycling wording treatment***, the choice cards were similar to the ones in the control group, except that we talked about "Ash recycling 1" and "Ash recycling 2", instead of "Option 1" and "Option 2". With this treatment, we wanted to emphasize the environmental role of wood ash as a waste product (ash) that is being recycled. Finally, in the ***productive wording treatment***, we also used different wording than in "Option 1" and "Option 2" to emphasize that wood ash application increases soil fertility and, consequently, wood production. We used "Option to ensure soil productivity 1" and "Option to ensure soil productivity 2". Note that the wording treatments we consider here, that is to say the use of "Ash recycling" and "Option to ensure soil productivity", are different from classic CE labelled alternatives because each option refers to the same policy (wood ash implementation).

[Figure 1 here]

With the wording treatments, we simply emphasized one element of the policy that had been described to the respondents, by re-using it in the choice cards, without attaching any judgment on it. Therefore, we were conveying objective information. Note that no additional "recycling" or "productivity" wording was used beyond what was shown on the choice cards. The respondents were randomly assigned to one of these treatments and participated only once in this study (no respondent participated in more than one treatment). We obtained 245 respondents in the baseline, 257 in the positive framing treatment, 251 in the recycling wording treatment and 257 in the productive wording treatment. Once the respondents finished with their 12 choice cards, those who always responded "Current situation" were asked to explain the reason for this choice.

ii) Environmental sensitivity questions

In our study, we also attempted to establish a link between the general French population's WTP for this new measure (wood ash application) and its environmental sensitivity. To do this, after the choice experiment we asked a series of ten questions from Milfont and Duckitt (2010) that are intended to measure whether a given individual has an interest in the conservation of the environment. Indeed, the role of wood ash, in addition to increasing soil fertility, contributes to the recycling of what is currently considered to be waste.

This questionnaire consists of ten affirmations describing five pro-environmental behaviors and five anti-environmental behaviors. The respondents had to give their level of agreement according to a 5-Likert scale, between "*I totally disagree*", "*I disagree*", "*Neutral*", "*I agree*" and "*I totally agree*" (the questionnaire is detailed in the Appendix A).

iii) Social acceptability questions

Based on the studies proposed by Dreyer and Walker (2013) and Dreyer *et al*. (2015), we elicited the respondents' social acceptability according to four dimensions: acceptance, support, perceived fairness and perceived effectiveness (the questions are detailed in the Appendix B). For each of these dimensions, the respondents had to answer a minimum of two questions, according to a 5-Likert scale.

4. Data

Before carrying out our survey, we tested our questionnaire on a focus group of 13 individuals in October 2017. While our survey also includes the questions on environmental and social acceptability, we focused the test on the choice experiment. The questionnaire was printed out, and we told the respondents that they could write on it whenever they did not understand a question, if they had any comments to formulate regarding their understanding of a sentence, or to discuss the relevance of the

attributes. Once they finished reading the questionnaire, we debriefed the participants about the questionnaire in general.

The respondents received an email inviting them to respond to our questionnaire through the online survey platform Limesurvey.[5] The objective was to obtain answers from the most representative sample as possible of the general French population. The respondents were contacted in November 2017. A total of 1010 respondents completed our questionnaire (1208 respondents did click on the link to the questionnaire but 196, corresponding to 16%, did not answer all questions). The first 114 respondents were used as a pilot, allowing a preliminary estimation of the choice model considered for updating the statistical design used in the choice experiment and thereby improve the statistical efficiency of the experiment.

[Table 2 here]

We also collected data on the respondents' education. In our sample, 13.56% have a master's degree or higher, 41.39% have a bachelor's degree (or attended a university for a short time), 26.14% have a high school education, 16.63% have a secondary school education, and 2.28% have no diploma.

Regarding age, gender and location, our sample is, overall, representative of the French population, except that respondents older than 55 years old are underrepresented, as well as respondents from the Southwest of France. Note also that 77% of the sample visited a forest at least once during the last 12 months. This corresponds to previous estimates of the French population's use of forests (Dobré *et al.*, 2005).

5. Results

We begin here with an analysis of the results of the environmental sensitivity and social acceptability questions, and then turn to the study of the choices made by the respondents, depending on the treatment.

i) *Environmental sensitivity and social acceptability questions*

Regarding the environmental questions, we recoded the respondents' answers from 1 (for "I totally disagree") to 5 (for "I totally agree") for the pro-environmental affirmations and, conversely, for the anti-environmental ones. We found a Cronbach's α equal to 0.78, showing that our ten affirmations measure only one dimension, environmental sensitivity.[6] The mean score per item is 3.77, with a standard deviation of 1.18.

[5] The respondents were contacted by the firm *Lightspeed Research*.

[6] The Cronbach α measures whether the answers to a questionnaire capture one dimension (environmental sensitivity in our case), or several ones.

We compared the total score of the environmental sensitivity between treatments (t-tests). We did not find any significant difference between treatments, *i.e.*, the framing and the wordings had no effect on the respondents' answers to the environmental sensitivity questions (see Appendix C).

Regarding the questions to measure the social acceptability of wood ash application, we measured four dimensions: acceptance, support, perceived fairness and perceived effectiveness. These dimensions were evaluated with a 5-Likert scale that we recoded from 1 to 5, and then added the scores for each dimension. In Table 3, we report the total score per dimension and treatment (see Appendix D for more results).

[Table 3 here]

It appears that the mean scores per dimension and per treatment are quite homogeneous. Over the four dimensions, the positive framing treatment induces the smallest score for three of them: support, perceived fairness and perceived effectiveness (acceptability is the lowest under the recycling wording treatment). The productive wording treatment induces the highest scores for three dimensions: acceptability, perceived fairness and perceived effectiveness (support is the highest in the control group).

To test for these differences, we conducted t-tests on the mean scores. We report the results for the perceived fairness dimension only in this subsection because it is the only dimension in which we observe significant differences between treatments.[7] The results are presented in Table 4.

[Table 4 here]

The positive framing treatment induces a significantly smaller score for the fairness dimension in comparison with all the other treatments. Hypothesis **H3** (namely that the social acceptability of wood ash application is higher in the wording treatments than in the positive framing treatment) is thus partially verified, while hypothesis **H2** (namely that the social acceptability of wood ash application, measured by traditional scores of acceptability, is higher in the different treatments than in the control group) is not. We can therefore reject hypothesis **H2**, whereas we cannot reject **H3**.

ii) *Effect of the treatments*

Following is an analysis of the effect of the treatments on the respondents' choice of an alternative. Note that, since all the dimensions of the social acceptability questions are correlated (the results are

[7] The results for the other dimensions are reported in the Appendix E.

reported in Appendix D), we used only *perceived fairness* in our regressions, which is not significantly correlated with *environmental sensitivity* ($\rho = 0.023$ and *p-value* = 0.341).[8]

We estimated the respondents' choice using the variables *Period* (a dummy variable is equal to one if wood ash spreading is restricted to periods when berries and mushrooms are not gathered), *Fertility* (a dummy variable is equal to one if there is a 15% increase in soil fertility), *Signal* (a dummy variable is equal to one if a sign is installed when wood ash is spread), *Cost* (coded as a continuous variable), a dummy variable *SQ* (equal to one if the status quo alternative is chosen). We also considered the cross-variables *SQ*sensitivity* (to capture the effect of environmental sensitivity on the choice of the status quo) and *SQ*fairness* (to capture the effect of perceived fairness on the choice of the status quo). The variables *sensitivity* (for environmental sensitivity) and *fairness* (for perceived fairness) are dummy variables. To compare the control group with each of the treatments, we added a dummy variable for the treatment *Treat* (that is equal to one if the respondent receives the treatment) that we first multiply with the variables SQ (*Treat*SQ*) and then with the variable *sensitivity* (*Treat*SQ*sensitivity*), or with the variable fairness (*Treat*SQ*fairness*). The results are presented in Table 5.

[Table 5 here]

Except for the comparison Control vs. Productive, we observed that the coefficient associated with the variable *Period* is always positive and significant, indicating that the respondents prefer having wood ash spread outside of gathering periods. Regarding the coefficients concerning the other attributes and the status quo variable, they are always significant: respondents prefer options that have a high impact on productivity (positive coefficient), the installation of a sign (positive coefficient), but prefer to pay less for wood ash (negative coefficient). Moreover, respondents seem to have a preference for the status quo (positive and significant coefficient for the three models). However, this coefficient should be evaluated together with the coefficients of the interaction terms. For example preferences for the status quo situation for a median respondent, with respect to their answers to the sensitivity (*sensitivity* = 38) and fairness questions (*fairness* = 6), treated with positive framing is calculated as follows (accounting only for significant coefficients): 3.54 + 38*(-0.059) + 6*(-0.378) + 1*(-1.094) + 1*0.089*6 = -1.48. Nevertheless, the positive framing treatment and the productive wording treatment seem to induce the respondents to choose an alternative that is different from the status quo because the coefficient associated with the variable *Treat*SQ* is negative and significant in both cases. The recycling wording treatment does not seem to induce any significant change in comparison to the control group.

[8] We obtain $\rho_{acc,sensi} = 0.104$ (p-value = 0.001), $\rho_{supp,sensi} = 0.102$ (p-value = 0.001) and $\rho_{eff,sensi} = 0.072$ (p-value = 0.022).

This effect of the treatment on the choice of the status quo is less important for the individuals that are the most sensitive to environmental matters because the coefficient associated with the variable *Treat* SQ*fairness* is positive and significant in both cases (positive framing and productive wording). The interpretation may be that those sensitive individuals are less impacted by the nudge. This makes sense because respondents considering fairness of the policy and the environment as important characteristics are less impacted because they already have strong positive opinions in these areas. In the productive wording treatment, this effect is also reduced by the sensitivity parameter because the coefficient associated with the variable *Treat* SQ*sensitivity* is positive and significant (whereas it is not in the positive framing treatment).

Therefore, we cannot reject hypothesis **H1** for the positive framing and the productive wording treatments, *i.e.*, treatments increase the social acceptability of ash recycling. Moreover, we show that the effect of the treatment depends on the type of individuals a regulator wants to nudge. Consequently, depending on the issue under consideration, a nudge can be effective for one subgroup with given characteristics, while it may have no, or adverse impact, on other subgroups with other characteristics. For example, our results indicate that nudge implementation should target groups of individuals who are not environmentally sensitive and do not consider the fairness of the measures in order to be effective.

We also estimated a conditional logit model separately for each treatment and a latent class model with class membership functions to assess the determinants of the respondents' choices in the control group and in each treatment. The results are reported in Appendix F. Environmental sensitivity does not seem to have an effect on the decision to depart from the status quo in the productive wording treatment as the coefficient of the variable *SQ*sensitivity* is not significant). This corresponds to the results in Table 5 where we find a significant negative parameter of the *SQ*sensitivity* parameter but a significant positive parameter of the interaction term *treat*SQ*sensitivity*. We also find that effect of *SQ*fairness* is less pronounced in the positive framing and in the productive wording treatment than found in Table 5, as the treatment reduces the impact of the fairness attitude on the choice of the status quo.

Finally, also with the objective to validate the robustness of the results, we estimated a hybrid mixed logit model (HMXL) where environmental sensitivity and perceived fairness were modelled as latent variables. HMXL models have increasingly been used during the last decade to account for attitudes and the decision-making processes in choice models (Abou-Zeid and Ben-Akiva 2014; Grilli, Notaro, and Campbell 2018b; Vij and Walker 2016). The advantage of such models is that it is possible to model unobserved heterogeneity explicitly as a function of underlying, latent, attitude variables, *i.e.*, in our case perceived fairness and environmental sensitivity. We estimated three models, one for each treatment where we also included the control group. This allowed testing explicitly the effect of the treatments by including the treatment as dummies corresponding to the results of the conditional logit

model reported in table 5. Compared to this model we also allowed for preference heterogeneity with respect to scenario attributes. The estimated model and the results are outlined in detail in Appendix G. Basically, the results of the HMXL confirmed the previous results with respect to preferences for attributes (in the HMXL model the "period" attribute is also statistically significant in all three models) and the importance of perceived fairness and environmental sensitivity for the choice of an ash-recycling policy. Furthermore, we also confirm that the productive framing and productivity wording treatments influence choices, and this effect is dependent on the environmental sensitivity and perceived fairness. However, the direct effect of productive wording was not significant in interaction with the status quo (*Treat*SQ*), but the treatment increased the environmental sensitivity latent variable significantly and, therefore, indirectly increased the probability of choosing ash-recycling. We also find that the perceived fairness decreased with the positive framing treatment corresponding to the t-test reported in Table 4. Therefore, the positive direct effect of positive framing on the choice of ash-recycling is reduced by the negative impact of perceived fairness latent variable. However, one difference was that the significant effect of perceived fairness in interaction with the productive wording treatment and status quo (*Treat*SQ$*fairness*) in the conditional logit model was not significant in the HMXL model. We also simulate the effect of treatment and the environmental sensitivity and perceived fairness and find that all treatments increased the probability of choosing a ash-recycling policy, but also that the effect of environmental sensitivity and perceived fairness are more important determinants of choice than the treatments. Therefore, we conclude that the results of the much more complex model (HMXL) does support the results of the more simple conditional logit model. It should also be noted that the few differences we find concerning statistical significance of parameters may be due to the large number of parameters to be estimated in the HMXL model, although having around 12*250 = 3000 choices per treatment.

i) *Willingness-to-pay*

We now estimate the WTP space for each treatment. We also account for potential heterogeneity in preferences in our sample by applying a mixed logit model and assuming normal distributed attribute coefficients.[9] The results are reported in Table 6.

[Table 6 here]

Overall, it appears that the respondents seem to have a preference for the status quo alternative (the coefficient associated with this variable is always significant at the 1% level in each treatment), but this preference is the least important in the productive wording treatment (and the most important in the recycling wording treatment). However, the interpretation of the SQ variables has to be moderated

[9] Estimations are carried out by simulation (750 Halton draws) in STATA using the GMNL command.

by the fact that we have to take the environmental sensitivity and perceived fairness into account since the interaction terms are always significant. If a respondent gave very low scores on the fairness questions (see Appendix D) and revealed a low environmental sensitivity (represented by the total score of the questions presented in Appendix A), then they had a willingness-to-accept (negative WTP). However, for an average respondent (sensitivity = 38 and fairness = 6) the WTP for the status quo (SQ + SQ*sensitivity + SQ *fairness) is negative. Therefore, respondents stating that it is not fair that households pay forest owners to recycle ash and are not sensitive to the environment will not pay to such a policy. On the other hand, respondents considering this a fair policy (the majority) are willing to pay for such a policy even without ash recycling being signaled or without a high productivity impact.

Therefore, when considering, this option, it seems that policymakers should study the efficiency of this treatment, *ex ante*, to verify whether the WTP is larger than what would be obtained in a neutral situation. This point is discussed in the next section.

6. Public policy perspectives and conclusion

We now discuss the different results obtained and, in particular, their implication in terms of a public policy perspective. First, we focus on the WTP with different treatments and for different groups of populations differing by their environmental sensitivity and perceived fairness.

Based on the results of the WTP space model (Table 6), we conducted different computations, taking into account all the attributes with a significant coefficient, and considering 5% and 15% increases in soil productivity. We also vary the respondents' characteristics regarding their environmental sensitivity and the way they perceive that contributing to wood ash application is fair, considering the median scores obtained on these questionnaires, the scores of the first decile (lowest scores) and the ones of the last decile (highest scores). The results are reported in Table 7 and correspond to euros paid once for 30 years. For instance, the WTP obtained in the control group for a median total score in environmental sensitivity (*i.e.*, a median total score equal to 38) and in fairness (*i.e.*, a median total score equal to 6) is given by the sum of all the significant coefficients obtained in Table 6. Note that in this estimation a dummy was used for *Fertility* (equal to 1 if a 15% increase is observed). The coefficient therefore captures a 10 points increase in soils' fertility (a 1-point increase is evaluated at €1.3795). The WTP is given by: -85.512 + 1.3795*5 + 2.023 + 1.661*38 + 10.341*6 = €48.57.

[Table 7 here]

A main policy relevant results is that our results highlight and confirm that a regulator should adapt the communication strategy to the population segment targeted. With people who are not environmentally sensitive, or with agents not considering wood ash application as an equitable

measure, the productive wording may help to obtain the strongest preferences for wood ash application. Indeed, the productive wording always results in a higher WTP, or close to it, for the median scores and the lowest 10% environmental sensitivity and perceived fairness. In other words, using a productive framing of the policy will make the preferences depend less on the characteristics of the population (e.g., environmentally sensitive or not).

Overall, considering median values for environmental sensitivity and perception of fairness, the positive framing induces the highest WTP, while the productive wording induces the second highest WTP. Still, the difference between the positive framing and productive wording is not really significant (€50.00 compared to €49.55) for median values of environmental sensitivity and perceived fairness.

On the other hand, the productive wording induces a (bit) higher WTP for wood ash than under the control when considering median scores and induces twice the highest WTP in the other situations with different values for environmental sensitivity and perceived fairness. Moreover, considering the result on the fairness dimension (beginning of Section 4), it seems to allow for a higher social acceptability than the one obtained under the positive framing treatment.

We obtained similar results when considering a 15% increase in soil productivity (into parentheses), except that the positive framing treatment no longer induces the highest WTP when considering the median scores of the ES and the perception of fairness.

Note that, on average, households paid an average yearly electricity bill of €1683 in 2017.[10] Therefore, the maximum increase in electricity price to allow for ash recycling in forests (corresponding to an increase of €83.05 in Table 7) would correspond to a 4.93% increase in price.

On the basis of the results concerning social acceptability, we can conclude that the positive framing option should be avoided from a public policy point of view in the sense that it will induce the least support for a policy based on acceptability scores. However, based on these simulations, we obtained the lowest WTP in most cases with the recycling wording treatment.

Regarding the difference in social acceptability that we detected among the different treatments, a possible interpretation can be found in Jung and Mellers (2016) and Reisch and Sunstein (2016): as emphasized in Section 2, the positive framing is based on a reaction of *System 1*, while the wording treatments are based on a reaction of *System 2*. In these two studies, the authors found that the nudges based on a reaction of *System 1* are generally less well accepted by the public because agents have the impression of losing their freedom of choice.

In a sense, although the general population is not directly evaluating the different nudges we introduced, their evaluation of the social acceptability of wood ash spreading may be considered as an indirect evaluation of the nudge they faced. The main objective of the focus groups was to make sure

[10] See http://www.lesechos.fr/25/01/2018/lesechos.fr/0301204816754_chauffage---la-facture-moyenne-a-augmente-en-2017.htm. Note that a large share of French households use electricity for heating purposes.

that the questionnaire was understandable and the attributes of the choice experiment were relevant, while the nudges were not tested.

In this paper, the objective of our nudges was to make a new environmental measure socially accepted by the French general population, therefore conducting them to subsidize it. The objective of our nudges is thus different from traditional applications considered to correct agents' behavior in order to protect environmental quality (Allcott, 2011; Costa and Kahn, 2013; Ferraro and Price, 2013). Indeed, we considered nudge implementation as a communication tool. One could ask if the impact of using nudges as a communication tool only would be temporal as it may not change underlying preferences and motivations. However, this applies also to other types of incentives which are only effective as long they are maintained.

Our results indicate that the productive wording may be an efficient way to induce a higher social acceptability of wood ash recycling, as long as we consider the expressed WTP as a secondary measure of this acceptability. Moreover, our results also indicate that some individuals are more sensitive to this type of communication than others: this is the case of the least sensitive to environmental matters. This result is not totally surprising in the sense that the productive wording was emphasizing the productive gains in terms of forest exploitation for the forest owners. This result may also suggest that the least environmentally sensitive people had less knowledge and understanding of the issue and the productive wording, through the provision of new information that wasn't evident previously, help to enhance acceptability.

In the introduction, we acknowledged that our usage of a choice experiment was made in a different context than a pure cost-benefit analysis one, even if we followed the recommendations formulated by Jonhston *et al*. (2017). This usage was made on purpose to assess the effect of nudges on social acceptability, that we consider as the sum of four dimension (acceptance, support, perceived fairness and perceived effectiveness), and completed by the respondents' expressed WTP. One advantage of using the choice experiment is that we are able to quantify the impact of different policy attributes on the acceptability. In this way, our application could complement the assessment of other measures of acceptability. Moreover, it is worth emphasizing that our objective was not to manipulate the respondents with the nudges to obtain the highest WTP as possible. In our case, a higher WTP is simply interpreted as a higher expressed social acceptability.

From a public policy point of view, a real application of the wording we considered in this survey could simply be to use specific words in communications from the regulator, in line with hypothesis H1 (at least with the productive wording). Continuing with the example of electricity (the electricity bill was the payment vehicle chosen in the choice experiment), one possibility could be to present a contract that considers a special fee for wood ash emphasizing the "productive" role of wood ash, for those having to choose a new electricity supplier. Indeed, in our survey, this nudge induced the respondents to significantly choose less often the status quo compared to the baseline (following hypothesis H1), without reducing the social acceptability of the measure contrary to the positive

framing (following hypothesis H3). Regarding the positive framing, it could consist of emphasizing the electricity contracts that include such a fee. More generally, our results emphasize the importance of considering the heterogeneity of attitudes in the population when considering new policies and communicating new policies. Precisely, our results show that applying nudges will only has an important positive impact on respondent who are not sensitive to the environment. One potential use of our results is that new regulation concerning ash-recycling should be presented as a measure to ensure future fertility of soils and not as a recycling measure. Another use of our results could be by energy producers using biomass. They could include an energy supply option in their product mix which guarantees that produced ash will be returned to forest to insure future fertility of forest soils. Our results show that there is a potential positive willingness to pay for such an option.

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Appendix A – Environmental sensitivity questionnaire

• I could not be bothered to save water or other natural resources.

- □ This behavior does not describe me at all
- □ This behavior describes me a little
- □ Neutral
- □ This behavior generally describes me
- □ This behavior totally describes me

• I make sure that during the winter, the heating system in my room is not switched on too high.

- □ This behavior does not describe me at all
- □ This behavior describes me a little
- □ Neutral
- □ This behavior generally describes me
- □ This behavior totally describes me

• In my daily life I'm just not interested in trying to conserve water and/or power.

- □ This behavior does not describe me at all
- □ This behavior describes me a little
- □ Neutral
- □ This behavior generally describes me
- □ This behavior totally describes me

• Whenever possible, I take a short shower in order to conserve water.

- □ This behavior does not describe me at all
- □ This behavior describes me a little
- □ Neutral
- □ This behavior generally describes me
- □ This behavior totally describes me

• I always switch the light off when I don't need it on any more.

- □ This behavior does not describe me at all
- □ This behavior describes me a little
- □ Neutral
- □ This behavior generally describes me
- □ This behavior totally describes me

• I drive whenever it suits me, even if it pollutes the atmosphere.

- □ This behavior does not describe me at all
- □ This behavior describes me a little
- □ Neutral
- □ This behavior generally describes me
- □ This behavior totally describes me

• In my daily life, I try to find ways to conserve water or power.

- □ This behavior does not describe me at all
- □ This behavior describes me a little

□ Neutral
□ This behavior generally describes me
□ This behavior totally describes me

• I am not the kind of person who makes efforts to conserve natural resources.

□ This behavior does not describe me at all
□ This behavior describes me a little
□ Neutral
□ This behavior generally describes me
□ This behavior totally describes me

• Whenever possible, I try to save natural resources.

□ This behavior does not describe me at all
□ This behavior describes me a little
□ Neutral
□ This behavior generally describes me
□ This behavior totally describes me

• Even if public transportation was more efficient than it is, I would prefer to drive my car.

□ This behavior does not describe me at all
□ This behavior describes me a little
□ Neutral
□ This behavior generally describes me
□ This behavior totally describes me

Appendix B – Social acceptability questionnaire

Partly adapted from Dreyer *et al*. (2015)

Acceptance

• To what extent are you in favor of/against wood ash recycling in forests?

□ Totally against
□ Against
□ Neutral
□ In favor
□ Totally in favor

• Do you prefer wood ash recycling in forests instead of nothing?

□ Not preferable at all
□ Few preferable
□ Neutral
□ Preferable
□ Totally preferable

Support

• To what extent would you support wood ash recycling in forests (in the sense of writing a positive comment, for instance)?

□ I would not support at all
□ I would not support
□ Neutral
□ I would support
□ I would totally support

• How willing are you to bear some of the costs resulting from wood ash application in forests?

□ Not willing at all
□ Not really willing
□ Neutral
□ Willing to
□ Totally willing to

• How willing are you to take action to voice a positive opinion about wood ash recycling, such as writing a letter or calling a representative?

□ Not willing at all
□ Not really willing
□ Neutral
□ Willing to
□ Totally willing to

• Regarding wood ash recycling, how likely are you to:

- Voice a positive opinion to a family member?

□ Not willing at all
□ Not really willing
□ Neutral
□ Willing to
□ Totally willing to

- Express a positive opinion on social media, such as Facebook?

□ Not willing at all
□ Not really willing
□ Neutral
□ Willing to
□ Totally willing to

- Voice a positive opinion to a co-worker?

□ Not willing at all
□ Not really willing
□ Neutral
□ Willing to
□ Totally willing to

- Write a positive opinion letter to a newspaper?

□ Not willing at all
□ Not really willing
□ Neutral
□ Willing to
□ Totally willing to

Perceived fairness

• How fair do you think it is that all French households pay the same for wood ash application in forests?

□ Totally unfair
□ Not really fair
□ Neutral
□ Fair
□ Totally fair

• How fair do you think it is that the forest owners have the opportunity to implement such a recycling measure in their forests thanks to the monetary contributions of households?

□ Totally unfair
□ Not really fair
□ Neutral
□ Fair
□ Totally fair

Perceived effectiveness

• How effective do you think wood ash recycling will be to improve the quality of forest soils (and avoid soil depletion in the future)?

□ Totally inefficient
□ Not really efficient
□ Neutral
□ Efficient
□ Totally efficient

• Do you think that wood ash recycling is an efficient measure to reduce the monetary impacts due to soil depletion?

□ Totally inefficient
□ Not really efficient
□ Neutral
□ Efficient
□ Totally efficient

Appendix C – Comparison of the total score of the environmental sensitivity questionnaire between treatments

Table C1 - *P-values* of the t-tests (mean comparison).

	Control	Positive framing	Recycling wording
Positive framing	0.432	-	-
Recycling wording	0.847	0.331	-
Productive wording	0.633	0.755	0.504

Appendix D – Results of the social acceptability questionnaire

Table D1 - Mean scores and standard deviation of the social acceptability questionnaire (all treatments).

Dimension measured	Mean total score	Standard deviation
Acceptance (2 questions)	7.18	1.19
Support (7 questions)	21.63	5.51
Perceived fairness (2 questions)	5.83	2.07
Perceived effectiveness (2 questions)	6.98	1.70

Table D2 - Coefficient of correlation and p-values of the Spearman correlation test of the dimensions measured by the social acceptability questionnaire.

	Acceptance	Support	Perceived fairness
Support	0.580 ($p < 0.01$)	-	-
Perceived fairness	0.240 ($p < 0.01$)	0.450 ($p < 0.01$)	-
Perceived effectiveness	0.581 ($p < 0.01$)	0.559 ($p < 0.01$)	0.395 ($p < 0.01$)

Appendix E – T-test comparison of the total score of the social acceptability questionnaire (per dimension) between treatments

Acceptance

Table E1 - *P-values* of the t-tests (mean comparison).

	Control	Positive framing	Recycling wording
Positive framing	0.577	-	-
Recycling wording	0.879	0.456	-
Productive wording	0.540	0.958	0.421

Support

Table E2 - *P-values* of the t-tests (mean comparison).

	Control	Positive framing	Recycling wording
Positive framing	0.252	-	-
Recycling wording	0.686	0.475	-
Productive wording	0.773	0.384	0.899

Perceived effectiveness

Table E3 - *P-values* of the t-tests (mean comparison).

	Control	Positive framing	Recycling wording
Positive framing	0.522	-	-
Recycling wording	0.674	0.809	-
Productive wording	0.564	0.218	0.302

Appendix F –Additional estimations (Conditional logit and latent class with class membership functions)

Table F1 - Conditional logit estimation per treatment.

	Control	Positive framing	Recycling wording	Productive wording
Variable	Coefficient (St. Err.)	Coefficient (St. Err.)	Coefficient (St. Err.)	Coefficient (St. Err.)
Period	0.072	0.056	0.084*	0.033
	(0.047)	(0.046)	(0.047)	(0.045)
Fertility	0.604***	0.517***	0.628***	0.559***
	(0.048)	(0.047)	(0.048)	(0.047)
Signal	0.115**	0.153***	0.049	0.181***
	(0.047)	(0.046)	(0.047)	(0.045)
Cost	-0.037***	-0.044***	-0.045***	-0.037***
	(0.002)	(0.002)	(0.002)	(0.002)
SQ	3.574***	2.405***	3.362***	1.391***
	(0.300)	(0.308)	(0.297)	(0.287)
SQ*sensitivity	-0.059***	-0.046***	-0.062***	-0.011
	(0.007)	(0.007)	(0.940)	(0.007)
SQ*fairness	-0.376***	-0.292***	-0.337***	-0.290***
	(0.025)	(0.023)	(0.025)	(0.023)
Log-Likelihood	-2693.7	-2812.1	-2690	-2925.3
Adjusted R^2	0.166	0.170	0.187	0.137
N	245 (2940 choices)	257 (3084 choices)	251 (3012 choices)	257 (3084 choices)

Significance levels: * p < 0.10; ** p < 0.05; *** p < 0.01

Table F2 - Latent class estimations with class membership functions.

	Baseline		Positive framing		Recycling wording		Productive wording	
	Class 1 – Low sensitivity and perceived fairness	Class 2 – High sensitivity and perceived fairness	Class 1 – Low sensitivity and perceived fairness	Class 2 – High sensitivity and perceived fairness	Class 1 – Low sensitivity and perceived fairness	Class 2 – High sensitivity and perceived fairness	Class 1 – Low perceived fairness	Class 2 – High perceived fairness
Variables	Coef. (St. Err.)	Coef. (St. Err.)	Coef. (St. Err.)	Coef. (St. Err.)	Coef. (St. Err.)	Coef. (St. Err.)	Coef. (St. Err.)	Coef. (St. Err.)
Period	0.091*** (0.021)	0.234*** (0.011)	0.088*** (0.022)	0.246*** (0.011)	0.075*** (0.022)	0.258*** (0.011)	0.089*** (0.020)	0.222*** (0.011)
Fertility	***0.027 (0.022)***	0.434*** (0.012)	***0.034 (0.023)***	0.401*** (0.012)	0.062*** (0.023)	0.433*** (0.012)	***0.035 (0.022)***	0.415*** (0.012)
Signal	0.151*** (0.021)	0.219*** (0.011)	0.173*** (0.022)	0.243*** (0.011)	0.133*** (0.022)	0.212*** (0.011)	0.156*** (0.021)	0.245*** (0.011)
Cost	-0.003*** (0.001)	-0.005*** (<0.001)	-0.003*** (0.001)	-0.006*** (<0.001)	-0.003*** (<0.001)	-0.006*** (<0.001)	-0.003*** (<0.001)	-0.005*** (<0.001)
SQ	0.742*** (0.018)	0.083*** (0.009)	0.743*** (0.020)	0.093*** (0.009)	0.775*** (0.019)	0.089*** (0.009)	0.736*** (0.018)	0.083*** (0.009)
Class membership function parameters								
Constant	5.214*** (1.262)		4.084*** (1.231)		3.983*** (1.091)		***1.345 (0.995)***	
Sensitivity	-0.097*** (0.029)		-0.081*** (0.029)		-0.084*** (0.025)		***-0.011 (0.023)***	
Fairness	-0.536*** (0.101)		-0.489*** (0.094)		-0.408*** (0.0923)		-0.377*** (0.083)	
Log-Likelihood	-5166.14		-5563.04		-5316.24		-5469.45	
AIC	10360.28		11154.08		10660.47		10966.90	
BIC	10409.29		11203.77		10709.83		11016.58	
N	245 (8820 choices)		257 (9252 choices)		251 (9036 choices)		257 (9252 choices)	

Appendix G – Hybrid mixed logit model

In this appendix we describe the estimation of the hybrid mixed logit model (HMXL) which is a structural model where environmental sensitivity and perceived fairness are modelled as latent variables.[11] The HMXL consists of a choice model, structural equations, and measurement model. Our choice model differs from the conditional logit model (eq. 1) by including two latent variables in the status quo alternative and stochastic preference heterogeneity for scenario attributes. Below the utility functions U_{njt} for the choice set t, t={1,…,T=12} is written for individual n, and j ={1, 2, SQ} represents the choice alternative:

$$\boldsymbol{U_{njt}} = \boldsymbol{V_{njt}} + \boldsymbol{\varepsilon_{n1t}} =$$

$$\begin{cases} \boldsymbol{\alpha_n p_{1t}} + \boldsymbol{\beta'_n x_{1t}} + \boldsymbol{\varepsilon_{n1t}} \\ \boldsymbol{\alpha_n p_{2t}} + \boldsymbol{\beta'_n x_{2t}} + \boldsymbol{\varepsilon_{n2t}} \\ \boldsymbol{SQ} + \boldsymbol{SQ_l \varphi_l} + \boldsymbol{\lambda_{es}\, LV_{sensi\,n}} + \boldsymbol{\lambda_{fair}\, LV_{fair\,n}} + \boldsymbol{\lambda_{sensi_{\varphi_l}}\, LV_{sensi\,n}\, \varphi_l} + \boldsymbol{\lambda_{fair_{\varphi_l}}\, LV_{fair\,n}\, \varphi_l} + \boldsymbol{\varepsilon_{nsqt}} \end{cases}$$

$$\boldsymbol{\varepsilon} \sim \boldsymbol{D}(\mathbf{0}, \boldsymbol{\Sigma_\varepsilon})$$

Where V_{njt} is the deterministic part of the utility function, $\boldsymbol{\beta}_n$ and α_n are parameters assumed $N(\boldsymbol{\mu}, \Omega)$, SQ is the utility associated with the status quo, SQ_l is the effect on utility of a treatment φ_l, l=*{Positive framing, Recycling wording, Productive wording},* on not choosing a policy, $LV_{sensi\,n}$ *and* $LV_{fair\,n}$ are latent variables representing environmental sensitivity and perceived fairness considerations, respectively. Therefore, we get that the likelihood of the observed sequence of T choices for person n, conditional on individual preference parameters, $\boldsymbol{\beta}_n$ and α_n, is given by :

$$\mathrm{L}_{C_n}\left(\boldsymbol{\beta}_n, \alpha_n, \boldsymbol{SQ}, \boldsymbol{SQ_l}, \boldsymbol{\lambda_{es}}, \boldsymbol{\lambda_{fair}}, \boldsymbol{\lambda_{sensi_{\varphi_l}}}, \boldsymbol{\lambda_{fair_{\varphi_l}}}\right) = \prod_{t=1}^{T} \frac{e^{\boldsymbol{V_{nj^*t}}}}{\sum_{j=1}^{3} e^{\boldsymbol{V_{njt}}}}$$

Where j^* is the chosen alternative. The latent variables are modelled in the structural equations as a function of sociodemographic variables (see Table G2). As in the article, we decided to focus on environmental sensitivity and perceived fairness attitudes, and therefore defined two equations, one for each latent variable, as a function of a vector of socio-demographic variables $\boldsymbol{z}_{sensi\_n}$ and $\boldsymbol{z}_{fair\_n}$:

$$LV_{sensi\,n} = \boldsymbol{\gamma'_{sensi}} \boldsymbol{z}_{sensi\_n} + \gamma_{sensi\_\varphi_l}\, \varphi_l + \vartheta_{sensi\_n}$$

$$LV_{fair\_n} = \boldsymbol{\gamma'_{fair}} \boldsymbol{z}_{fair\_n} + \gamma_{fair\_\varphi_l}\, \varphi_l + \vartheta_{fair\_n}$$

Where $\boldsymbol{\gamma}_{sensi}$, $\boldsymbol{\gamma}_{fair}$, $\gamma_{sensi\_\boldsymbol{\varphi_l}}$, and $\gamma_{fair\_\boldsymbol{\varphi_l}}$ are (vector of) parameters to be estimated and ϑ_{sensi_n} *and* ϑ_{fair_n} *are* assumed N(0,1) and independent.

The estimation of the HMXL was proposed by an anonymous reviewer.

The third model component, the measurement equations, are modelled as ordered logit models following, for example, Daly et al. (2012), Grilli et al. (2018) and Hess et al. (2013) where the latent index functions are defined first for the 10 questions on environmental sensitivity, $k=\{sensi_1,\ldots,sensi_{10}\}$:

$$I^*_{k\,n} = f(\theta_k, LV_{sensi\,n}) + \epsilon_{k\,n}$$

and for the two perceived fairness questions, $f=\{fair_1, fair_2\}$:

$$I^*_{f\,n} = f(\theta_f, LV_{fair\,n}) + \epsilon_{f\,n}$$

where $\epsilon_{k\,n}$ and $\epsilon_{f\,n}$, are zero-mean errors with a logistic distribution and for given individual assumed to be mutual independent. θ_k, and θ_f are parameters to be estimated.

The responses to the attitudinal statements are collected using a likert type response scale with five levels. The measurement equations are therefore given by threshold functions. For the discrete indicators, $I_{k\,n}$ and $I_{f\,n}$ with five levels i_s, $s=\{1,\ldots S=5\}$, such that $i_1 \prec i_2 \prec i_3 \prec i_4 \prec i_5$, the measurement equation for individual n is modelled as an ordered logit as a function of the latent variable, where $\tau_{k\,h}$, and $\tau_{f\,h}$ are thresholds that need to be estimated where $h=\{1, \ldots, 4\}$ are indicators of thresholds. Below is an example of the definition of indicator $I_{k\,n}$ for the environmental sensitivity measurement equations:

$$I_{k\,n} = \begin{cases} i_1 \;\; if \; -\infty < I^*_{k\,n} < \tau_{k,1} \\ i_2 \;\; if \;\; \tau_{k,1} < I^*_{k\,n} < \tau_{k,2} \\ \qquad\qquad \ldots \\ i_5 \;\; if \;\; \tau_{k,4} < I^*_{k\,n} < \infty \end{cases}$$

We consider the thresholds to be common across all respondents (n) within one measurement equation, while we allow the thresholds to vary across measurement questions (k). The likelihood of the observed $I_{k\,n}$ is calculated as follows:

$$\mathrm{L}_{sensi}(\tau_k, \theta_k, LV_{sensi\;n},) = \sum_{s=1}^{5} I_{k\,n,s=i_n} \left[\frac{e^{\tau_{k,s} - \theta_k LV_{sensi\,n}}}{1 + e^{\tau_{k,s} - \theta_k LV_{sensi\,n}}} - \frac{e^{\tau_{k,s-1} - \theta_k LV_{sensi\,n}}}{1 + e^{\tau_{k,s-1} - \theta_k LV_{sensi\,n}}} \right]$$

where $I_{k\,n,s=i_n}=1$ if $s=i_n$ and for $I_{f\,n}$:

$$\mathrm{L}_{fair}(\tau_f, \theta_f, LV_{fair\;n}) = \sum_{s=1}^{5} I_{f\,n,s=i_s} \left[\frac{e^{\tau_{f,s} - \theta_f LV_{fair\,n}}}{1 + e^{\tau_{f,s} - \theta_f LV_{fair\,n}}} - \frac{e^{\tau_{f,s-1} - \theta_f LV_{fair\,n}}}{1 + e^{\tau_{f,s-1} - \theta_f LV_{fair\,n}}} \right]$$

Where $I_{f\,n,s=i_n}=1$ if $s=i_n$

The model is finally estimated by maximum simulated likelihood. The estimation involves maximizing the joint likelihood of the observed sequence of choices and the observed answers to the environmental sensitivity and perceived fairness questions. The first part is conditional on the

individual specific preferences for scenario attribute ($\boldsymbol{\beta}_n$, α_n) and the later part conditional on the two latent variables. Accordingly, the likelihood function of the model is given by integrating over $\boldsymbol{\beta}_n$, α_n and $LV_{sensi\,n}$ and $LV_{fair\,n}$.The combined log-likelihood for the model is then given by:

$$LL = \sum_{n=1}^{N} \log[\int_{a_n \boldsymbol{\beta}_n} \int_{LV_{sensi}} \int_{LV_{fair}} \mathrm{L}_{C_n}(\Xi)\, \mathrm{L}_{sensi}(\tau_k\ , \theta_k, LV_{sensi\ n},)\, \mathrm{L}_{fair}(\tau_f\ , \theta_f, LV_{fair\ n}\ )$$

$$\mathrm{f}(\boldsymbol{\beta}_n\ , \alpha_n)\mathrm{f}_{LVsensi}(LV_{sensi})\mathrm{f}_{LVfair}(LV_{fair})\mathrm{d}LV_{fair}\mathrm{d}LV_{sensi}\mathrm{d}\boldsymbol{\beta}_n\ \mathrm{d}\alpha_n]$$

Where $\Xi = \{\boldsymbol{\beta}_n\ , \alpha_n, \boldsymbol{SQ}, \boldsymbol{SQ_l}, \boldsymbol{\lambda_{es}}, \boldsymbol{\lambda_{fair}}, \boldsymbol{\lambda_{sensi_{\varphi_l}}}, \boldsymbol{\lambda_{fair_{\varphi_l}}}\}$

It has been estimated using the Apollo package in *R* (Hess and Palma 2019) and the final model was estimated with the random start procedure in the Apollo package. This was important, in particular due to the high number of parameters of the model and therefore risk of model convergence to local maxima.

Results

The same approach as in the estimation of conditional logit reported in Table 5 was applied, *i.e.*, we estimated a model for each treatment group and in each model we included also the control group. First, we show the results of the choice model in Table G1. All the scenario attributes are statistically significant at the 1% level and have the same signs as in Table 5. Compared to the estimation of the conditional model, we find that now the restrictions on the period where ash-recycling can be applied (Period) is significant in all models while this was only the case for Control-versus-Recycling in Table 5. We also find that the constant for the status quo (SQ) is highly significantly negative. Furthermore, the interactions between the status quo constant and the latent variables are highly statistically significant and confirm that the respondents who are sensitive to the environment and consider a policy supporting ash recycling to be fair are more likely to choose an ash-recycling scenario. Note that the interaction term is positive for LV_{sensi} and negative for LV_{fair}. In table G4 we see that LV_{sensi} has a positive effect on choosing responses indicating high environmental sensitivity in the measurement equations of environmental sensitivity. We did always code the responses to the environmental sensitivity questions in a way that the highest index corresponds to the most environmental sensitive answer option, although the order of responses was for some questions inversed. From Table G4, we conclude that the latent variable considering perceived fairness, LV_{fair}, is high when low consideration and low if high consideration of perceived fairness. In other words, the LV_{fair} should in the present model be considered as a variable of unfairness. We can therefore conclude that respondents thinking the policy is not fair are more likely to choose the status quo (no policy) and this, therefore, confirms results from Table 5.

Concerning the treatment effects, we find again that the positive framing has a direct effect on the choice of the policy, *i.e.*, with positive framing respondents are more likely to choose a policy. However, compared to Table 5, the productive wording does not have a direct significant effect on choosing a policy relatively to the control. Notwithstanding, the full effect of the treatments also include the interaction of the treatment dummy with the status quo and the latent variables as well as the indirect effect that a treatment may have through the structural equations, *i.e.*, the interaction between the treatment dummy on the latent variables LV_{sensi} and LV_{fair} First, we consider the *Treat*SQ* LV_{sensi}* interaction which is statistically significant and negative (10% level) for the positive framing treatment but positive and significant (1% level) for the productive wording treatment. This implies that, for an environmental sensitive respondent, the positive framing has an even higher positive impact on choosing one of the suggested policies than for the respondents with low sensitivity to the environment. In Table 5, the interaction between environmental sensitivity score and the treatment and status quo was not significant for the positive framing treatment while we confirm the effect of productive wording, *i.e.*, for environmental sensitive respondents the treatment increases the probability of choosing the status quo relative to the effect of treatment on less environmental sensitive respondents. In table G1, we see that the productive wording treatment has a statistically significant influence on the environmental sensitivity (at a 5% level) and, therefore, indirectly on the effect of choosing a policy through the latent variable LV_{sensi} in the choice model. Note that we did not find a significant effect of treatment on the environmental sensitivity score when comparing treatment using simple t-tests. To evaluate the total effect of the treatment we have, in Table G5, simulated the aggregate value of the status quo with and without treatment.

Regarding the interaction term *Treat*SQ* LV_{fair}* which represents the potential dependence of the treatment effect on the perceived fairness considerations of the respondent, we find that in none of the treatments this term was significant, though in Table 5 we find that the higher score of perceived fairness the lower treatment effect of positive framing and productive wording. However, from Table G3 we see that the positive framing has a negative impact on the fairness consideration (this was confirmed by the t-test, see Tables 3 and 4). Therefore, the positive framing has an indirect negative effect on choosing an ash-recycling policy as it increases the latent variable LV_{fair} (*i.e.*, less perceived fairness) and therefore through the term $SQ*LV_{fair}$ increases the likelihood of choosing the status quo. In other words, as positive framing treatment has a direct positive effect on choosing ash-recycling, it is counteracted by the indirect effect through the impact on the fairness latent variable.

Table G1 - Estimation results for choice model

	Control vs Positive framing		Control vs Recycling wording		Control vs Productive wording	
	N	: 502	N	: 496	N	: 502
	Choices	: 6024	Choices	: 5952	Choices	: 6024
	LL	: -12003.42	LL	: -11771.05	LL	: -12078.23
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Period	0.134	0.002	0.174	0.000	0.116	0.003
Fertility	0.643	0.000	0.679	0.000	0.682	0.000
Signal	0.270	0.000	0.170	0.000	0.233	0.000
Cost	-1.079	0.000	-1.056	0.000	-0.834	0.000
SQ	-2.395	0.000	-2.604	0.000	-1.941	0.000
$SQ*LV_{sensi}$	-0.814	0.000	-0.524	0.000	-0.643	0.000
$SQ*LV_{fair}$	3.036	0.000	2.957	0.000	3.300	0.000
Treat*SQ	-1.536	0.015	-0.226	0.736	0.605	0.385
Treat*SQ* LV_{sensi}	-0.391	0.060	0.067	0.751	0.789	0.000
Treat*SQ* LV_{fair}	-0.052	0.866	0.508	0.174	-0.339	0.295
			Standard deviation			
Period	0.277	0.001	0.379	0.000	0.057	0.520
Fertility	0.799	0.000	0.779	0.000	0.847	0.000
Signal	0.058	0.496	0.276	0.000	0.424	0.000
Cost	1.063	0.000	1.056	0.000	0.848	0.000

In Table G2 we define and show the descriptive statistics of the socio-demographic variables used for the structural equation. The structural equations are reported in Table G3, where we see that female respondents are more environmental sensitive while young respondents are less sensitive. Respondents who had visited a forest during the last 12 months are more environmental sensitive. We also find that only the productive wording treatment had an effect on the latent variable for environmental sensitivity. For the perceived fairness equation, we have that old and rural respondents have lower perceived fairness (note that high LV_{fair} is indicating a low perceived fairness) while being a female respondent increased the perceived fairness (it was excluded from the last two treatments due to convergence problems in the estimation when this variable was included).

Table G2 - Descriptive statistics

	Control	Positive framing	Recycling wording	Productive wording
z_{sensi_n} , z_{fair_n}				
Young age (<35 years old)	0.22	0.21	0.24	0.20
Old age (>55 years old)	0.16	0.30	0.25	0.21
Female	0.47	0.52	0.55	0.48
Rural residence (town < 20,000 inhabitants	0.58	0.58	0.59	0.59
Visit forest	0.78	0.72	0.79	0.79

Table G3 - Estimation results for structural equations

	Control vs Positive framing		Control vs Recycling wording		Control vs Productive wording	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
LV_{sensi}						
Forest visitor	0.464	0.000	0.408	0.000	0.308	0.000
Young age	-0.467	0.000	-0.495	0.000	-0.675	0.000
Female	0.358	0.000	0.419	0.000	0.266	0.000
Treatment	0.078	0.328	0.086	0.316	0.154	0.031
LV_{fair}						
Old age	0.086	0.321	0.035	0.723	-0.051	0.552
Female	-0.202	0.005				
Rural residence	0.291	0.000	0.443	0.000	-0.078	0.288
Treatment	0.429	0.028	-0.150	0.420	-0.327	0.160

In Table G4, we see that the latent variable was significant in explaining all the measurement questions and all parameters having the expected sign.

153 **Table G4 - Results measurement equations**

	Control vs Positive framing		Control vs Recycling wording		Control vs Productive wording	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
	Environmental sensitivity questions					
$\theta_{k=sensi_1}$	1.624	0.000	1.599	0.000	1.922	0.000
$\tau_{k=sensi_1,1}$	-3.635	0.000	-3.299	0.000	-3.975	0.000
$\tau_{k=sensi_1,2}$	-2.122	0.000	-1.931	0.000	-2.502	0.000
$\tau_{k=sensi_1,3}$	-0.652	0.001	-0.524	0.018	-0.973	0.000
$\tau_{k=sensi_1,4}$	1.566	0.000	1.593	0.000	1.427	0.000
$\theta_{k=sensi_2}$	1.306	0.000	1.324	0.000	1.254	0.000
$\tau_{k=sensi_2,1}$	-2.985	0.000	-3.373	0.000	-3.242	0.000
$\tau_{k=sensi_2,2}$	-1.751	0.000	-1.769	0.000	-1.702	0.000
$\tau_{k=sensi_2,3}$	-0.600	0.000	-0.642	0.001	-0.638	0.000
$\tau_{k=sensi_2,4}$	0.960	0.000	1.074	0.000	0.850	0.000
$\theta_{k=sensi_3}$	1.362	0.000	1.697	0.000	1.626	0.000
$\tau_{k=sensi_3,1}$	-2.970	0.000	-3.649	0.000	-3.411	0.000
$\tau_{k=sensi_3,2}$	-1.803	0.000	-2.357	0.000	-2.243	0.000
$\tau_{k=sensi_3,3}$	-0.725	0.000	-0.889	0.000	-1.090	0.000
$\tau_{k=sensi_3,4}$	0.670	0.000	0.827	0.000	0.503	0.007
$\theta_{k=sensi_4}$	1.685	0.000	1.696	0.000	1.829	0.000
$\tau_{k=sensi_4,1}$	-3.087	0.000	-3.091	0.000	-3.592	0.000
$\tau_{k=sensi_4,2}$	-1.912	0.000	-1.767	0.000	-2.160	0.000
$\tau_{k=sensi_4,3}$	-0.242	0.236	-0.076	0.744	-0.360	0.076
$\tau_{k=sensi_4,4}$	1.735	0.000	1.863	0.000	1.624	0.000
$\theta_{k=sensi_5}$	1.750	0.000	1.808	0.000	2.183	0.000
$\tau_{k=sensi_5,1}$	-4.348	0.000	-4.668	0.000	-4.765	0.000
$\tau_{k=sensi_5,2}$	-2.780	0.000	-2.944	0.000	-3.303	0.000
$\tau_{k=sensi_5,3}$	-1.484	0.000	-1.593	0.000	-1.858	0.000
$\tau_{k=sensi_5,4}$	0.309	0.144	0.296	0.226	0.216	0.358
$\theta_{k=sensi_6}$	0.435	0.000	0.507	0.000	0.456	0.000
$\tau_{k=sensi_6,1}$	-1.923	0.000	-1.726	0.000	-2.074	0.000

$\tau_{k=sensi_6,2}$	-0.631	0.000	-0.570	0.000	-0.684	0.000
$\tau_{k=sensi_6,3}$	0.741	0.000	0.837	0.000	0.900	0.000
$\tau_{k=sensi_6,4}$	1.695	0.000	1.883	0.000	1.981	0.000
$\theta_{k=sensi_7}$	2.064	0.000	2.407	0.000	2.150	0.000
$\tau_{k=sensi_7,1}$	-3.990	0.000	-4.162	0.000	-4.338	0.000
$\tau_{k=sensi_7,2}$	-2.279	0.000	-2.170	0.000	-2.460	0.000
$\tau_{k=sensi_7,3}$	-0.022	0.926	0.119	0.707	-0.152	0.509
$\tau_{k=sensi_7,4}$	2.723	0.000	3.109	0.000	2.706	0.000
$\theta_{k=sensi_8}$	1.601	0.000	1.506	0.000	1.545	0.000
$\tau_{k=sensi_8,1}$	-3.516	0.000	-3.476	0.000	-3.463	0.000
$\tau_{k=sensi_8,2}$	-2.031	0.000	-1.895	0.000	-2.196	0.000
$\tau_{k=sensi_8,3}$	-0.633	0.001	-0.594	0.005	-0.812	0.000
$\tau_{k=sensi_8,4}$	1.039	0.000	1.137	0.000	0.973	0.000
$\theta_{k=sensi_9}$	2.748	0.000	2.963	0.000	2.771	0.000
$\tau_{k=sensi_9,1}$	-4.970	0.000	-5.980	0.000	-5.492	0.000
$\tau_{k=sensi_9,2}$	-2.885	0.000	-2.906	0.000	-3.141	0.000
$\tau_{k=sensi_9,3}$	-0.177	0.568	-0.170	0.652	-0.458	0.111
$\tau_{k=sensi_9,4}$	3.340	0.000	3.893	0.000	3.091	0.000
$\theta_{k=sensi_{10}}$	0.235	0.007	0.383	0.000	0.276	0.002
$\tau_{k=sensi_{10},1}$	-1.890	0.000	-1.923	0.000	-2.137	0.000
$\tau_{k=sensi_{10},2}$	-0.667	0.000	-0.607	0.000	-0.707	0.000
$\tau_{k=sensi_{10},3}$	0.527	0.000	0.567	0.000	0.506	0.000
$\tau_{k=sensi_{10},4}$	1.288	0.000	1.384	0.000	1.328	0.000
			Fairness questions			
$\theta_{f=fair_1}$	-0.543	0.000	-0.597	0.000	-0.464	0.000
$\tau_{f=fair_1,1}$	-1.705	0.000	-1.775	0.000	-1.551	0.000
$\tau_{f=fair_1,2}$	-0.508	0.000	-0.597	0.000	-0.394	0.000
$\tau_{f=fair_1,3}$	0.600	0.000	0.526	0.000	0.689	0.000
$\tau_{f=fair_1,4}$	2.237	0.000	2.204	0.000	2.214	0.000
$\theta_{f=fair_2}$	-0.745	0.000	-0.723	0.000	-0.556	0.000
$\tau_{f=fair_2,1}$	-1.936	0.000	-2.076	0.000	-1.793	0.000
$\tau_{f=fair_2,2}$	-0.903	0.000	-0.999	0.000	-0.822	0.000

$\tau_{f=fair_2,3}$	0.591	0.000	0.509	0.000	0.681	0.000
$\tau_{f=fair_2,4}$	2.562	0.000	2.731	0.000	2.633	0.000

In table G5, we have calculated the aggregate status quo value with and without treatment effects for the three treatments:

$$SQall = \boldsymbol{SQ} + \boldsymbol{SQ_l}\boldsymbol{\varphi_l} + \boldsymbol{\lambda_{es}}\, \boldsymbol{LV_{sensi\,n}} + \boldsymbol{\lambda_{fair}}\, \boldsymbol{LV_{fair\,n}} + \boldsymbol{\lambda_{sensi_{\varphi_l}}}\, \boldsymbol{LV_{sensi\,n}}\, \boldsymbol{\varphi_l} + \boldsymbol{\lambda_{fair_{\varphi_l}}}\, \boldsymbol{LV_{fair\,n}}\, \boldsymbol{\varphi_l}$$

Table G5 - Aggregated status quo values with and without treatment

Treatment		Treatment $\boldsymbol{\varphi_l} = 1$	No treatment $\boldsymbol{\varphi_l} = 0$
Control vs Positive framing	SQall =	-2.91	-2.41
Control vs Recycling wording	SQall =	-2.01	-1.47
Control vs Productive wording	SQall =	-2.58	-2.73

While we find that the likelihood of choosing an ash-recycling policy systematically increases for all treatments, independent of environmental sensitivity and perceived fairness of the respondent, the effect of treatment is relatively low, *i.e*., only between 1 to 3% (Table G6). We have also simulated for treatment and without treatment assuming that all the respondents are: a female, forest visitor, young, and who has a residence in rural areas which, according to the structural equations, corresponds to an individual with high environmental sensitivity and high perceived fairness. We compare these results to an individual who is male, not forest visitor, old and who has a residence outside rural areas (low environmental sensitivity and low perceived fairness). We see that the respondents' attitudes are more important than the treatments in explaining choices which confirm our results in Table 7, where we see that the WTP is highly sensitive to the type of respondent. Furthermore, the results in Table G6 support also one of our main conclusions that the effect of treatments (nudge) is highest for people with low sensitivity and perceived fairness.

Table G6 - Probability of choosing status quo (mean) based on sample used for estimation

Treatment	Treatment $\varphi_l = 1$			No treatment $\varphi_l = 0$		
	Sample	High sensitivity, high perceived fairness	Low sensitivity, low perceived fairness	Sample	High sensitivity, high perceived fairness	Low sensitivity, low perceived fairness
Control vs Positive framing	0.21	0.19	0.26	0.24	0.23	0.27
Control vs Recycling wording	0.24	0.28	0.21	0.27	0.30	0.24
Control vs Productive wording	0.24	0.21	0.22	0.25	0.22	0.31

Table 1 Attributes and their levels of the discrete choice experiment.

Attribute	Levels
Period: Application period	At any time of the year Outside gathering periods
Fertility: Increase in fertility	+5% +15%
Signal: Installation of a sign	Yes No
Cost: additional price they would have to pay on their electricity bill (only once in 2018)	€0 + €4 + €8 + €15 + €30 + €50

205 **Table 2 - Characteristics of the sample.**

Characteristic	Interval	%	French data, % (INSEE, 2017)*
Age	18 - 24	14.16	10.22
	25 - 34	21.68	15.15
	35 - 44	20.30	16.10
	45 - 54	20.59	17.25
	> 55	23.27	41.29
Gender	Male	49.70	47.70
	Female	50.30	52.30
Location	Ile-de-France	19.21	18.84
	Northeast	22.38	22.12
	Northwest	23.17	20.07
	Southeast	22.48	20.67
	Southwest	12.77	18.30
Net monthly income (in euros)	< 1500	19.01	
	1500 – 1999	15.54	
	2000 – 2499	15.74	Median net
	2500 – 3499	21.19	monthly income
	3500 – 4999	16.14	in 2013:
	5000 – 6999	5.46	€2461.67
	> 7000	1.58	
	Don't know/Don't want to answer	5.35	
Went to a forest during the last 12 months	Yes	77.03	
	No	22.97	

*Access to the source: http://www.insee.fr/fr/accueil

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213 **Table 3 - Mean total scores of the social acceptability questionnaire per dimension and treatment (standard errors in**
214 **parentheses).**

	Control	Positive framing	Recycling wording	Productive wording
Acceptance	7.143	7.230	**7.120**	*7.237*
	(0.114)	(0.106)	(0.103)	(0.104)
Support	*21.857*	**21.296**	21.657	21.720
	(0.338)	(0.354)	(0.361)	(0.334)
Perceived fairness	5.894	**5.498**	5.932	*5.996*
	(0.130)	(0.135)	(0.126)	(0.129)
Perceived effectiveness	6.996	**6.895**	6.932	*7.082*
	(0.110)	(0.113)	(0.104)	(0.100)

In bold, we report the minimum scores per dimension. The highest scores are indicated in italics.

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219 **Table 4 - P-values of the t-tests on the mean scores (Perceived fairness dimension).**

	Control	Positive framing	Recycling wording
Positive framing	**0.035**	-	-
Recycling wording	0.318	**0.019**	-
Productive wording	0.258	**0.008**	0.290

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Table 5 - Conditional logit estimation of the effect of the treatments.

	Control vs. Positive framing	Control vs. Recycling wording	Control vs. Productive wording
Variable	Coefficient (St. Err.)	Coefficient (St. Err.)	Coefficient (St. Err.)
Period	0.063*	0.078**	0.052
	(0.033)	(0.033)	(0.032)
Fertility	0.560***	0.616***	0.581***
	(0.034)	(0.034)	(0.033)
Signal	0.134***	0.082**	0.149***
	(0.033)	(0.033)	(0.033)
Cost	-0.041***	-0.041***	-0.037***
	(0.001)	(0.001)	(0.001)
SQ	3.536***	3.550***	3.567***
	(0.299)	(0.300)	(0.298)
SQ*sensitivity	-0.059***	-0.059***	-0.059***
	(0.007)	(0.007)	(0.007)
SQ*fairness	-0.378***	-0.379***	-0.375***
	(0.025)	(0.025)	(0.025)
Treat*SQ	-1.094**	-0.170	-2.172***
	(0.426)	(0.418)	(0.411)
Treat* SQ*sensitivity	0.014	-0.002	0.048***
	(0.010)	(0.998)	(0.010)
Treat* SQ*fairness	0.089*	0.046	0.085**
	(0.033)	(0.035)	(0.033)
Log-Likelihood	-5511.934	-5389.827	-5619.943
Adjusted R^2	0.167	0.176	0.151
Likelihood Ratio Test	0.006	0.599	<0.001
N	502 (6024 choices)	496 (5952 choices)	502 (6024 choices)

Significance levels: * p < 0.10; ** p < 0.05; *** p < 0.01

Table 6 – Estimation in the willingness-to-pay space per treatment (in euros).

	Control	Positive framing	Recycling wording	Productive wording
Variable	Coefficient (St. Err.)	Coefficient (St. Err.)	Coefficient (St. Err.)	Coefficient (St. Err.)
Period	0.802	-0.289	0.126	-0.374
	(0.652)	(0.343)	(0.381)	(0.591)
Fertility	13.795***	7.163***	9.869***	11.819***
	(1.028)	(0.390)	(0.516)	(0.823)
Signal	2.023***	1.353***	0.640*	4.501***
	(0.618)	(0.311)	(0.362)	(0.720)
SQ	85.512***	44.527***	94.377***	20.745***
	(12.075)	(3.024)	(4.524)	(4.041)
SQ*sensitivity	-1.661***	-1.036***	-1.716***	-0.432***
	(0.231)	(0.065)	(0.094)	(0.091)
SQ*fairness	-10.341***	-8.370***	-11.018***	-7.244***
	(1.492)	(0.529)	(0.407)	(0.463)
Het. constant	-1.521***	-0.597**	-0.691***	-1.564***
	(0.184)	(0.289)	(0.258)	(0.193)
SD				
Period	2.243***	0.365	0.528	1.087
	(0.793)	(0.428)	(0.519)	(0.882)
Fertility	18.204***	9.756***	14.747***	15.793***
	(0.934)	(0.332)	(0.557)	(0.836)
Signal	3.723***	0.967**	1.241***	11.291***
	(1.079)	(0.450)	(0.393)	(0.659)
SQ	22.644***	23.478***	28.073***	19.135***
	(3.011)	(1.525)	(1.169)	(1.146)
SQ*sensitivity	0.908***	0.649***	0.791***	0.719***
	(0.124)	(0.040)	(0.032)	(0.044)
SQ*fairness	0.395***	2.959***	3.144***	3.933***
	(0.102)	(0.177)	(0.102)	(0.222)
Tau	1.614***	2.063***	1.943***	1.564***
	(0.119)	(0.177)	(0.170)	(0.129)
LL	-2159.584	-2185.0.98	-2074.903	-2295.374
Prob > Chi2	0.000	0.000	0.000	0.000

Significance levels: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

Table 7 - Simulations of WTP for wood ash application for a 5% increase in soil productivity (for a 15% increase in soil productivity in parentheses).

	Median score for ES and fairness	Score of the 10% lowest ES scores and median for fairness	Score of the 10% highest ES scores and median for fairness	Median score for ES and score of the 10% lowest scores for fairness	Median score for ES and score of the 10% highest scores for fairness
Control	€48.57 (*€62.37)*	€33.62 (€47.42)	*€61.86* (*€75.66*)	€17.55 (€31.34)	*€69.25* (*€83.05*)
Positive framing	*€50.00* (€57.16)	€40.67 (€47.83)	€58.28 (€65.45)	€24.89€ (€32.05)	€66.74 **(€73.90)**
Recycling wording	**€42.51 (€52.38)**	**€27.07 (€36.94)**	€56.24 (€66.11)	**€9.46 (€19.33)**	€64.55 (€74.42)
Productive wording	€49.55 (€61.36)	*€45.66* (*€57.48*)	**€53.00 (€64.82)**	*€27.81 (€39.63)*	**€64.03** (€75.85)

The values in bold correspond to the lowest WTP, while those in italics correspond to the highest ones.

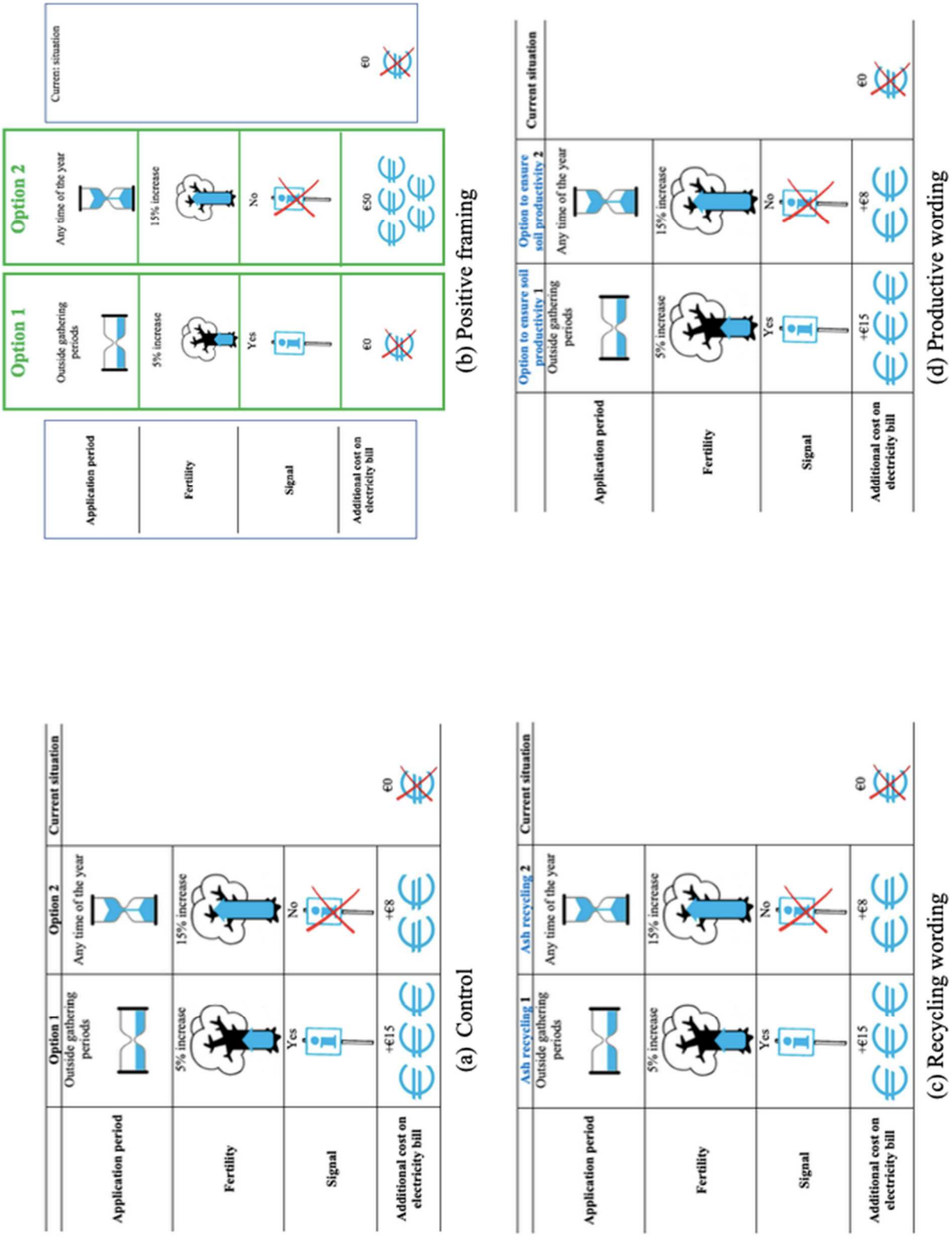

Figure 1 - Examples of choice cards (control and treatments)