# Combining economics and psychology: Does CO2 framing strengthen pro-environmental behaviors?

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**Abstract**

This paper considers valence-based framing, i.e. a description of equivalent outcomes in either a positive or negative light, in order to reduce transport-related $CO_2$ emissions. This nudge is easier to implement than more traditional tools, such as taxation, and does not rely on the stringent assumption that individuals are fully rational. The findings from a discrete choice experiment focusing on long-distance travel choice are reported herein. Results indicate that a loss framing on $CO_2$ emissions significantly increases the respondents' pro-environmental behaviors. Moreover, it is shown that the magnitude of the framing effect depends on individuals' motivational orientation, and that preferences are sensitive to individuals' psychological factors (i.e. preference for the future and environmental self-identity).

***Keywords:*** Framing effect, Discrete choice experiment, Pro-environmental behavior, Psychological factors

# 1 Introduction

The European Union is aiming to achieve climate neutrality by 2050 (i.e. net-zero greenhouse gas emissions). However, in the meantime, global transport $CO_2$ emissions are still rising and constitute one of the main contributors, accounting for a quarter of total emissions (IEA, 2020). Several incentive measures have already been proposed by economists to mitigate these emissions. Responses based solely on technological improvements or price signal changes (e.g. carbon tax) appear to be insufficient given the climate emergency.

This article investigates the following question: How can environmental considerations be better included in travel decisions through nudges? The literature has increasingly advocated new approaches involving neither technological changes nor price interventions to limit climate change (Stiglitz, 2019). It has been shown that although the effect of information and the way it is presented typically only exert a marginal direct effect, both can help raise public awareness and gain acceptance of other public policy instruments as part of a larger set of measures (Givoni et al., 2013). The introduction of such a nudge has a significant impact on pro-environmental behavior by increasing environmental sensibilities. A nudge can be defined as "any aspect of the choice architecture that alters individuals' behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler and Sunstein, 2008, p. 6). The most well-known type of nudge is likely to be the framing effect (Homar and Cvelbar, 2021). This effect is the measurable outcome of selecting of one frame vs. another regarding decision-making. Tversky and Kahneman (1981) postulated that formalizing of a communication message accompanied by a recommendation suggesting a particular behavior could modify the effectiveness of this communication by altering the perception of certain aspects of the considered problem. For instance, the consequences of this modification could be presented in terms of either expected gains when adopting the change (gain framing) or losses incurred when not adopting

the change (loss framing). As a departure from rational decision theory (Von Neumann and Morgenstern, 1947), the framing effect suggests, on the contrary, that the way information is presented does have an impact on subsequent behavior. As such, this notion relies on the prospect theory framework proposed by Kahneman and Tversky (1979): preferences are no longer assumed to preexist; they are not fixed but rather constructed in the context of the decision-making process.

Here, we consider whether attribute valence framing, i.e. a description of the same object (or characteristics) positively or negatively, is capable of promoting pro-environmental transport behavior. Attribute valence framing is one the three distinct types of valence framing effects – along with goal framing and risky choice framing – "in which some characteristic of an object or event serves as the focus of the framing" (Levin et al., 1998). In the context of attribute valence framing, Rozin and Royzman (2001) demonstrated that a negatively (framed) piece of information – denoted "negativity bias" by these authors – has more weight on decision-making than objectively equivalent positively framed information. Given the magnitude of $CO_2$ emissions originating from the transport sector, it is essential to determine all types of framing that could encourage individuals to better integrate environmental consequences into their travel behavior. In this context, it is important to be able to estimate the effect of each framing, thus allowing public authorities to choose the best policies to implement. The findings from a discrete choice experiment focusing on travel choice are reported herein. The framing of a choice with supplementary information on a climate-related topic (i.e. goal framing) has already been examined in transportation economics through discrete choice experiments (Hilton et al., 2014; Raux et al., 2021). However, the framing effects proposed by these authors relied on information and descriptive norms delivered before the choices were made, not within the choice exercise by directly

framing certain choice attributes (so-called attribute valence framing), as is the case here.[1] For policymakers, such a framing would be quite simple and inexpensive to mandate in the context of drawing a comparison between different travel options (e.g. online comparators or travel agencies).

In addition to proposing a particular design of discrete choice experiments (DCE) to test the potential effect of attribute valence framing on respondents' preferences, this article also seeks to understand the underlying preference heterogeneity, in response to both distinct attributes and their valence framing. To investigate this second objective, we are proposing an original approach by examining psychological constructs from social psychology theory. First, based on regulatory focus theory (Higgins, 1997), we test whether the magnitude of the framing effect depends on an individual's motivational orientation. Second, based on results indicating that consideration of future consequences (Strathman et al., 1994) and environmental self-identity (Van der Werff et al., 2013a) were found to be a key determinant of a more sustainable behavior, we test for the first time in DCE if these two factors are indeed able to explain preference heterogeneity in response to certain attributes. Since social psychological factors may play an important role in the evolution of individual preferences, we feel that the proper use of these in DCE could greatly contribute to the field of environmental economics. Our contribution constitutes a true interdisciplinary work by testing, within the framework of DCE, a number of results stemming from environmental psychology theory to promote pro-environmental transport behavior.

A DCE survey was conducted in June 2020 on a sample representative of the French population, with a manipulation of the framing of two considered attributes. A hypothetical scenario was presented to participants, asking them to travel for a private purpose using

[1]To the best of our knowledge, the only two discrete choice experiment studies that tested valence-based framing of attribute levels in the environment economics literature are Kragt and Bennett (2012) and Faccioli and Glenk (2021) who respectively focused on the environmental outcomes of alternative catchment management programs in Australia and peatland restoration programs in Scotland.

public transit (domestic haul). The origin and destination of the trip were assigned, and two travel alternatives by means of public transit were proposed. Each participant had to make ten choices, between two travel alternatives with various combinations of: travel time, cost, $CO_2$ emissions and sanitary measures (i.e. ensuring an empty seat between passengers). The main framing effects studied were the gains and losses on two distinct attributes, namely travel time and $CO_2$ emissions. Since the initial goal of this study consisted of analyzing the framing effect on these specific attributes, the total sample was divided into five treatments (each composed of approximately 200 respondents): the control group (T1), a gain in travel time (T2), a gain in $CO_2$ emissions (T3), a loss in travel time (T4) and a loss in $CO_2$ emissions (T5). The questionnaire was structured as follows: (i) basic socio-demographic information, (ii) choice experiment between travel alternatives and (iii) a series of follow-up questions on psychological considerations. These questions sought to evaluate respondents' psychological factors, namely individuals' motivational orientation (Higgins, 1997), temporal preference for consequences (Strathman et al., 1994) and environmental self-identity (Van der Werff et al., 2013a).

To analyze the impact of the framing on the respondents' preferences for each choice attribute, a Random Parameter Logit (RPL) model in willingness to pay space was used. First, the relevance of the coefficients was checked by analyzing their signs and relative values. In all estimated models, the signs of attributes were consistent and statistically significant. Respondents sought to minimize the price and duration of their travel while maximizing the sanitary measures available for their benefit. A negative coefficient for the $CO_2$ attribute could be observed, meaning that in general transit users do care about their emissions and seek to minimize them. Second, results indicated that a loss framing on travel duration or $CO_2$ emissions was significant and increased the weight of the framed attribute in the individual's decision. On the contrary, this effect was not observed for gain

framing. The loss framing effect is larger when applied to $CO_2$ than to duration, which is a more familiar attribute. Third, the magnitude of the framing effect on $CO_2$ emissions depended on individuals' motivational orientation: those with a low promotion focus score (Higgins, 1997) and a high environmental self-identity score (Van der Werff et al., 2013a) were even more heavily affected by loss framing on the $CO_2$ emissions attribute.

The remainder of this paper is organized as follows. Section 2 provides a brief literature review and hypothesis formulation. Section 3 then describes data collection, the sample's socioeconomic characteristics and the construction of psychological factors. Section 4 is devoted to presenting the descriptive statistics of respondents' characteristics, along with the validation process of the psychological factors. Section 5 details the econometric specification of the models used in this study and moreover displays results. Section 6 discusses the results of our analysis, followed by a conclusion that considers the potential applications of these results.

## 2 Relevant literature and hypothesis formulation

This section presents the main concepts borrowed from environmental psychology theory, which will then be used in the DCE survey outlined in Section 3. Four hypotheses will be formulated hereafter, regarding: the intuitive reaction of respondents to a framing effect (Hypothesis 1); and how specific psychological factors/constructs are able to explain the heterogeneity not only in preferences in the reactions to attribute valence framing (Hypothesis 2), but also in a given type of attribute (Hypothesis 3 and 4). These hypotheses will be tested in Sections 4 and 5 and then discussed in Section 6.

Two recent works indicate that when travelers are aware of the amount of $CO_2$ emitted by each mode of transport during long-distance leisure trips, they are willing to spend more money or time for their journey in order to reduce $CO_2$ emissions (Raux et al., 2021;

Bökman et al., 2021). It can be assumed that the framing effect (Tversky and Kahneman, 1981) boosts the impact of the attribute framed on individual preferences. Framing communication corresponds to the selection of "some aspects of a perceived reality and makes them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (Entman, 1993, p. 53). More specifically, the framing effect is the measurable impact of the selection of one frame or another on decision-making. There are three distinct types of valence-based framing effects, namely goal framing, risky choice framing and attribute valence framing (Levin et al., 1998, p. 150). First, goal framing consists of presenting an identical outcome, by emphasizing either the potential gain of performing a particular act or the loss resulting from not performing said act. Second, risky choice framing consists of proposing discrete choices between a risky and a riskless option of equal expected value. Under the first condition, the options are described as realizing gains, while options under the second condition are presented as avoiding losses. Individuals prefer avoiding losses to acquiring equivalent gains, which is termed "loss aversion". This phenomenon is explained by the prospect function of prospect theory, which states that losses outweigh gains (Kahneman and Tversky, 1979). In this seminal article, the authors argued that loss framing is more effective in stimulating behavior that leads to risk-taking or uncertainty, while gain framing helps stimulate behavior promoting risk avoidance. Third, attribute framing consists of selecting just a single characteristic and presenting it in either a positive or negative light. According to "negativity bias" (Rozin and Royzman, 2001), negatively framed information has more weight on decision-making than objectively equivalent positively framed information. As such, valence-based framing of $CO_2$ emissions influences the perceived difference in environmental impact, either between two unspecified modes of transport (Avineri and Waygood, 2013) or between two neighborhoods (Waygood and Avineri, 2018). Under

their experimental condition denoted "positive framing", the quantities of $CO_2$ emitted by the other mode or the other neighborhood are displayed as lower. Under the experimental condition denoted "negative framing", the quantities of $CO_2$ emitted by the other mode or the other neighborhood are perceived to be higher. In line with "negativity bias" (Rozin and Royzman, 2001), which states that "negative information has a systematically stronger impact on judgment than objectively equivalent positive information" (Levin et al., 1998, p. 176), these results indicate that the perceived difference between the quantities of $CO_2$ emitted through transportation is greater for the "negative framing" condition than for either "positive framing" (Avineri and Waygood, 2013) or "neutral framing" (i.e. absence of valence framing) (Waygood and Avineri, 2018). In accordance with "negativity bias" (Rozin and Royzman, 2001) and with respect to the existing literature (Avineri and Waygood, 2013; Waygood and Avineri, 2018), we have adopted the following hypothesis:

**Hypothesis 1** *Loss framing has a positive effect on individuals' preference for the framed attribute, whereas gain framing exerts no significant effect. Therefore, individuals exposed to loss framing are expected to have an increased willingness to pay (WTP) compared to the average, whereas those exposed to gain framing are expected to have a lower WTP.*

Let's suppose that the magnitude of negativity bias is not fixed but, on the contrary, can be moderated by psychological factors, especially the individual's regulatory focus (Higgins, 1997). Regulatory focus theory (1997), distinguishes two motivational strategies regulating goal-directed behavior, namely Promotion and Prevention. On the one hand, a Promotion focus emphasizes the pursuit of gain (or avoidance of non-gain), along with aspirations toward ideals using eager means, by adopting additive tactics. On the other hand, a Prevention focus is driven by safety and responsibility considerations. This individual motivational orientation emphasizes the avoidance of loss (or the pursuit of non-loss), through adopting subtractive tactics. In other words, this theory states the existence of two dis-

tinct motivational strategies that lead to a different sensitivity to positive and negative information. In the context of the framing effect, a regulatory fit effect (Higgins, 2000) is encountered. Valence-based framing is more effective when it fits individuals' regulatory focus, a phenomenon defined as regulatory fit (Cesario et al., 2008). Thus, a Promotion-oriented individual is more readily convinced by a gain-framed message than a loss-framed message. In contrast, a Prevention-oriented individual is more readily convinced by a loss-framed message than a gain-framed one (Bosone et al., 2015). According to regulatory fit theory (Higgins, 2000) and with respect to the existing literature (Bosone et al., 2015; Cesario et al., 2008), we have adopted the following hypothesis:

**Hypothesis 2** *A strong Promotion focus (resp. Prevention focus) leads to a higher (resp. lower) sensitivity to gain framing, and a lower (resp. higher) sensitivity to loss framing. Therefore, among individuals with a strong Promotion focus, those exposed to gain framing are expected to have an increased WTP compared to the average (in Promotion and in framing), whereas those exposed to loss framing are expected to have a lower WTP. The opposite is expected with a Prevention focus.*

Along these same lines of reasoning, we have therefore investigated how the heterogeneity of preferences for an attribute could be explained by some psychological factors. More precisely, we assume that the WTP for each attribute depends on both the temporal preference of consequence (Strathman et al., 1994) and environmental self-identity (Van der Werff et al., 2013a). First, the relationship between preference for future and behavior is explained by the temporal dilemma between short-term and long-term costs and benefits (Van Lange and Joireman, 2008). When considering the future beyond the present, it becomes possible to accept constraints as well as the efforts needed to achieve future benefits. Typically, sustainable behavior, e.g. health-related behavior, is costly for the present but beneficial in the future. Empirical results confirm that consideration for future consequences is viewed as

an important determinant of: further sustainable behavior (Milfont and Demarque, 2015), lower health risk-taking, and higher rates of preventive behavior (Strathman and Joireman, 2005). In the domain of mode choice, results have indicated that preference for the future is correlated with a preference to commute to work by means of public transit rather than private car (Joireman et al., 2004). It seems reasonable to assume that individuals with a strong preference for the future are more willing to pay for a decrease in their travel $CO_2$ and for sanitary measures by favoring the long-term over the short-term consequences of their behavior.

In sum, we have adopted the following hypothesis:

**Hypothesis 3** *Individuals with a high preference for the future are more willing to pay for a decrease in $CO_2$ emitted during trip-making as well as for sanitary measures.*

Lastly, social identity is defined as the "part of an individual's self-concept, which derives from his knowledge of his membership in a social group (or groups), together with the value and emotional significance attached to that membership" (Tajfel, 1978, p. 63). When individuals identify and view a social group they belong to as psychologically meaningful, they internalize the norms, values and beliefs that define the group, which will guide them toward making specific decisions and adopting specific behaviors (Turner et al., 1987). Environmental self-identity is defined as "the extent to which one sees oneself as a type of person who acts in an environmentally-friendly manner" (Van der Werff et al., 2013a, p. 1258). This concept pertains to a broad range of environmental behaviors (Van der Werff et al., 2013b). The particular link is explained by the fact that people with a strong environmental self-identity feel compelled to make environmentally motivated choices by personal norm without any financial reward. It seems reasonable to assume that individuals with a strong preference for the future are more willing to pay for a decrease in their travel $CO_2$. We have adopted the following hypothesis:

**Hypothesis 4** *Individuals with a high environmental self-identity are more willing to pay for a decrease in $CO_2$ emitted during trip-making.*

# 3 The survey methodology

A web survey was administered at the end of June 2020 by a professional research firm, to a representative sample from the French population with respect to age, gender and professional status. A total of 1,032 individuals residing in metropolitan France and aged between 18 and 75 years completed the survey. Administration of the questionnaire lasted less than 15 minutes.

The questionnaire was structured as follows: (i) basic socio-demographic information, (ii) choice experiment between travel alternatives and (iii) questions regarding psychological factors. The questions about socioeconomic background and psychological factors were similar for all respondents. In contrast, for the stated preference scenarios, respondents were randomly assigned to one of the five treatments (see Section 3.2).

## 3.1 Choice experiment

Hypothetical scenarios were presented to participants, whereby they needed to travel for a private purpose using public transit. The travel origin and destination of the travel were fixed and not disclosed, and two public transit alternatives were proposed. Since the goal of this study was to analyze the framing effect on attributes, it was essential to avoid the question of transportation mode during the survey, as this would have led to misleading information. The selection of attributes was based on the literature and the specific context of the Covid-19 pandemic, which was a particularly important topic at the time the survey was administered.

To cope with the Covid-19 pandemic, the French government implemented a strict lock-

down between March 17$^{th}$ and May 10$^{th}$, 2020. During this period, virtually no travel was allowed in France in order to reduce social interactions and thus potential contagion. The rules were gradually eased beginning on May 11$^{th}$. During an initial phase (May 11$^{th}$ - June 1$^{st}$), travel was only allowed within a 100-km radius of one's residence. Traveling further than 100 km from home required a compelling reason (e.g. frontline work, urgent family reasons) and a specific permit. In public transit systems, non-pharmaceutical measures were implemented (e.g. routine deep cleaning, face masks). In addition, the french national rail company (SNCF)[2] ran on a extremely limited schedule at first, and tickets were restricted to half the seats on the train so as to allow users to comply with social distancing measures. These latter restrictions did not apply to airline companies. As of June 2$^{nd}$, the 100-km travel limit was lifted and seating restrictions on trains were discontinued; by June 15$^{th}$, the SNCF was selling tickets for all seats.

The attributes and their associated levels are listed in Table 1. For each quantitative attribute (price, duration, $CO_2$ emissions), the value can take one of four possible levels. Conversely, the sanitary measure is a binary variable notifying the presence or absence of a guaranteed one-seat gap between transportation users. More specifically:

1. The **price** of travel (expressed in €), which is the monetary attribute, and one of the main determinants in transportation choice modeling.

2. The travel **duration** (expressed in hours), which is the second unavoidable attribute in transportation choice.[3]

3. **$CO_2$** emissions (expressed in kg), as the main variable of interest to study the framing effect. It was voluntarily decided not to provide any information on the meaning

[2] *Société nationale des chemins de fer français.*

[3] These orders of magnitude are realistic when we consider, for example, the differences in travel time between high-speed trains and interregional trains.

and/or consequences of a 1-kg emission of $CO_2$, in order to avoid any unwanted supplementary information framing the effect on this attribute. Moreover, use of the kg unit without offering any further information corresponds to the current practice of the public transit companies.

4. The **sanitary** measure, a binary attribute representing the fact that the transportation operator guarantees a one-seat gap between each passenger. At first, other non-pharmaceutical measures were considered, like the provision of hand sanitizer or face masks. However, the face mask use had already been made mandatory in public transit vehicles, and gel sanitize could be easily obtained for passengers; hence, provision was already considered as the user's responsibility. Therefore, the most differentiating sanitary measure between two trips was the guarantee of a one-seat gap between riders.[4]

Table 1: Levels of the attributes values of the alternatives.

| Attribute | Levels | | | |
|---|---|---|---|---|
| Price (€) | 50 | 75 | 125 | 175 |
| Duration (hours) | 3h | 3h55 | 5h05 | 6h35 |
| $CO_2$ (kg) | 30 | 39 | 51 | 66 |
| Sanitary (One-seat gap) | Yes | No | _ | _ |

## 3.2 Experimental design

The aim of the experimental design is to construct the choice sets (i.e. combinations of attribute levels) presented to respondents. With four attributes with two to four levels each, the questionnaire would be far too cumbersome if all possible attribute level combinations were given to respondents.

[4]This attribute was introduced to take into account the specific sanitary context at the time of the survey. Its detailed analysis will be discussed in a companion paper.

To obtain a choice dataset that yields accurate estimates of the model parameters, one common solution among experimental design techniques consists of using D-efficient designs.[5] As recommended by Crabbe and Vandebroek (2012), in order to avoid any choice set with a dominant alternative, we used prior information to compute D-efficient designs. In accordance with this principle, a pretest was conducted on a non-representative sample of 48 respondents. An initial D-efficient design was computed for this pretest, which was not subject to any framing effect. A conditional logit model was then estimated in order to obtain prior attribute estimates. These prior values were used to generate the final D-efficient design used for the survey.[6] Our final experimental design provided 20 different choice sets, with each set being divided into two blocks. Inside each treatment sample, respondents were randomly assigned to one of the two blocks.

The main framing effects studied were the gain and loss on two distinct attributes, i.e. travel time and quantity of $CO_2$ emitted. The total sample was therefore divided into five treatments: the control group (T1), gain in travel time (T2), gain in $CO_2$ emissions (T3), loss in travel time (T4), and loss in $CO_2$ emissions (T5). This same experimental design with 2 blocks of 10 choice sets was used for each of the five sub-samples. The only additional manipulation made to the choice sets was that for the two treatments with gain framing (in duration and $CO_2$). The alternatives with the highest value of the framed attribute were always placed in the first position, whereas they were positioned second for loss framing. An example of a choice set for each treatment is shown in Figure 1.

### 3.3 Psychological factors

The respondents were also asked to express their agreement or disagreement with a series

[5] In order to obtain these designs, the D-optimality criterion, i.e. the determinant of the Fisher information matrix, is maximized. Further details can be found in Louviere et al. (2000).

[6] Whereas the first D-efficient design computed for the pretest had two choice sets with a dominant alternative, the one generated with prior values had none.

T1 : Control

| | Option 1 | Option 2 |
|---|---|---|
| **Time** | 6h35 | 3h00 |
| **Cost** | €50 | €175 |
| **One-seat gap** | Yes | No |
| **$CO_2$** | 39 kg | 51 kg |

T2 : Gain in travel time

| | Option 1 | Option 2 |
|---|---|---|
| **Time** | 6h35 | 3h00 (3h35 less) |
| **Cost** | €50 | €175 |
| **One-seat gap** | Yes | No |
| **$CO_2$** | 39 kg | 51 kg |

T3 : Gain in $CO_2$ emissions

| | Option 1 | Option 2 |
|---|---|---|
| **Time** | 3h00 | 6h35 |
| **Cost** | €175 | €50 |
| **One-seat gap** | No | Yes |
| **$CO_2$** | 51 kg | 39 kg (12 kg less) |

T4 : Loss in travel time

| | Option 1 | Option 2 |
|---|---|---|
| **Time** | 3h00 | 6h35 (3h35 more) |
| **Cost** | €175 | €50 |
| **One-seat gap** | No | Yes |
| **$CO_2$** | 51 kg | 39 kg |

T5 : Loss in $CO_2$ emissions

| | Option 1 | Option 2 |
|---|---|---|
| **Time** | 6h35 | 3h00 |
| **Cost** | €50 | €175 |
| **One-seat gap** | Yes | No |
| **$CO_2$** | 39 kg | 51 kg (12 kg more) |

Figure 1: Example of the same travel choice set for each of the five treatments.

of statements. A five-point Likert scale was used to measure the agreement-disagreement level, with "strongly disagree" coded as 1, "disagree" as 2, "neither agree nor disagree" as 3, "agree" as 4, and "strongly agree" as 5. These statements, used to build psychological factors, were drawn from the environmental and social psychology literature. A total of four factors were calculated as the mean of their corresponding question scores. All statements used for these factors are presented in Appendix A. The four psychological factors are defined as follows.

The first and the second factor we considered is the the concept of **regulatory focus**, introduced by Higgins (1997), which distinguishes two motivational strategies regulating

goal-directed behavior, namely promotion and prevention. We used a French translation of a composite measure of five regulatory focus measures (Haws et al., 2010). This composite chronic regulatory focus scale comprises ten items (five each for promotion and prevention focus). According to the authors, we not collapse promotion and prevention focus into a single bipolar dimension. On the contrary, we calculated a score for each sub-scale.

The third factor is the **Consideration of Future Consequences** (CFC), proposed and validated by Strathman et al. (1994). We used a French adaptation and validation of the Consideration of Future Consequences scale (Demarque et al., 2010). This score yields a measure of *"the extent to which people consider distant versus immediate consequences of potential behaviors"* (Strathman et al., 1994, p. 742).The high scores indicate the high priority of the future benefits of the behaviors while participants with low scores prioritize the immediate implications of their current actions.

Fourthly, in order to evaluate the **Environmental self-identity** score (hereafter denoted Identity); we utilised a French translation of three items used in previous research (Van der Werff et al., 2013a). The higher the score, the higher the environmental social identity.

# 4 Descriptive statistics and validation of the psychological factors

This section will present the descriptive statistics of the respondents' characteristics along with the validation process of the psychological factors.

## 4.1 Socioeconomic characteristics of the sample

Table 2 reports the descriptive statistics of respondents' characteristics. The total sample size of 1,032 is quite representative of the French population of 18 to 75-year-olds in terms of age, gender ratio and professional activity (see Appendix B for a comparison of the five sub-samples).

Table 2: Selected characteristics of study sample.

| Description | French population* | Sample |
|---|---|---|
| *Gender* | | |
| Female | 51.1 | 50.5 |
| Male | 48.9 | 49.5 |
| *Age* | | |
| Young (18-29) | 19.8 | 21.3 |
| Young adult (30-44) | 26.8 | 27.7 |
| Adult (45-59) | 28.6 | 27.6 |
| Old (60-75) | 24.8 | 23.4 |
| *Professional activity* | | |
| Top socio-professional category | 15.7 | 18.5 |
| Middle socio-professional category | 16.4 | 14.5 |
| Low socio-professional category | 33.7 | 32.0 |
| Retired | 20.0 | 19.6 |
| Inactive | 14.2 | 15.4 |
| N (ind.) | - | 1,032 |

* Based on census data provided by The National Institute of Statistics and Economic Studies (INSEE).

## 4.2 Psychometric variables

In order to validate the internal consistency of the psychological factors, Cronbach's $\alpha$

coefficients were computed (Cronbach, 1951). The typical minimum threshold of 0.7 was used to validate the internal coherence of the questions contributing to the score. The values, shown in Table 3, indicate that three scales (i.e. CFC, Promotion (without Q13) and Identity) are indeed internally consistent and reach acceptable Cronbach's alpha levels, whereas Prevention is insufficiently reliable. Consequently, in the following dicussion, we will use these three psychological factors to describe the individuals' psychological features.[7] Thus, we were not able to test the effect of Prevention described in Hypothesis 2. For the remainder of this paper, only Promotion is tested in Hypothesis 2.

Table 3: Factors validity (Cronbach's alpha coefficient).

| Score | Question numbers | Cronbach's $\alpha$ |
|---|---|---|
| CFC | Q1 to Q12 | 0.70 |
| Promotion | Q13 to Q17 | 0.63 |
| Promotion (without Q13) | Q14 to Q17 | 0.72 |
| Prevention | Q18 to Q22 | 0.62 |
| Identity | Q23 to Q25 | 0.91 |

Table 4 reports the mean and standard deviation of the three remaining psychological factors for each sub-sample (i.e. each round of treatment). Welch's tests were performed between all sub-samples' psychological factors in order to identify potential significant selection bias with psychological features. For each of the four framed samples and each constructed psychological factor, the null hypothesis of mean equality with the control group was tested. No significant mean difference was found between each sub-sample and the control group (see Table 5). For the remainder of this article, the three psychologi-

[7] We dropped Q13 from the calculation of the Promotion score in order to improve Cronbach's $\alpha$ from 0.63 to 0.72.

cal factors were standardized to facilitate the estimation of their effect using econometric models.

Table 4: Psychological factor means and standard deviations by treatment.

| | T1 | | T2 | | T3 | | T4 | | T5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Score | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd |
| CFC | 3.39 | 0.50 | 3.35 | 0.50 | 3.34 | 0.47 | 3.35 | 0.48 | 3.37 | 0.49 |
| Promotion | 3.58 | 0.68 | 3.54 | 0.73 | 3.55 | 0.65 | 3.54 | 0.73 | 3.54 | 0.64 |
| Identity | 3.89 | 0.79 | 3.83 | 0.79 | 3.72 | 0.78 | 3.81 | 0.76 | 3.90 | 0.75 |
| N (ind.) | 209 | | 207 | | 205 | | 207 | | 204 | |

Table 5: Welch test p-values between psychological factors' framed samples and the control group (T1).

| | Welch test p-values | | | |
|---|---|---|---|---|
| Score | T1:T2 | T1:T3 | T1:T4 | T1:T5 |
| CFC | 0.38 | 0.40 | 0.40 | 0.68 |
| Promotion | 0.50 | 0.57 | 0.57 | 0.54 |
| Identity | 0.46 | 0.30 | 0.30 | 0.91 |

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

It is thus possible to analyze the general effect of psychological factors on the full sample (i.e. aggregation of the five sub-samples). In this case, the absolute value of the estimated coefficients differs from the one stemming from a non-framed sample, although this is not a problem. The objective herein is to have a large enough sample size to obtain robust values of the general effect of psychological factors on respondents' WTP for the various attributes.

# 5 Econometric framework and empirical results

This section presents the econometric specifications of the models used and displays their main results.

## 5.1 Econometric framework

In this article, the WTP-space approach has been employed to analyze the responses to the discrete choice experiment (DCE) survey proposed. We are in fact more interested in estimating the marginal rate of substitution between the change in an attribute and the marginal utility of income[8] than merely estimating the coefficient of this attribute. According to the WTP-space approach, marginal WTP estimates are directly obtained, unlike with the preference-space approach, wherein a ratio is to be computed between the non-cost attribute and the cost attribute.[9] Before specifying the modeling framework of the WTP-space, let's briefly recall the Random Utility Model in the preference-space for an unlabeled DCE (our case).

According to the discrete choice experiment approach, an alternative $i \in [\![1; I]\!]$ can be described by a set of $K$ observable characteristics, called attributes, as denoted by $X_i = (x_{i,1}, ..., x_{i,k}, ..., x_{i,K})'$. An individual $n \in [\![1; N]\!]$ is described by $A$ economic and attitudinal characteristics, called socioeconomic variables and denoted $Z_n = (z_{n,1}, ..., z_{n,a}, ..., z_{n,A})'$. The (indirect) utility $V_{n,i}$ is thus given by:

$$V_{n,i} = V(X_i, Z_n) \text{ for } n \in [\![1; N]\!] \text{ and } i \in [\![1; I]\!] \tag{1}$$

[8] This marginal utility is represented by the coefficient of the cost attribute, see below.
[9] A more detailed description of this framework can be found in Chèze et al. (2021).

McFadden (1974) considered that individuals make choices according to a deterministic component based on both their measured characteristics Z and attribute alternatives X, along with some degree of randomness $\epsilon$. The random utility $U_{n,i}$ of an alternative $i \in [\![1; I]\!]$ for respondent $n \in [\![1; N]\!]$ is therefore composed of a deterministic part, i.e. the (indirect) utility $V_{n,i} = V(X_i, Z_n)$, and the stochastic component, $\epsilon_{n,i}$, thereby capturing the unsystematic and unobserved random elements of respondent $n$'s choice (Louviere et al., 2000).

$$U_{n,i} = V(X_i, Z_n) + \epsilon_{n,i} \tag{2}$$

In the preference-space, a column vector of parameters $\beta_n = (\beta_{1,n}, ...\beta_{K,n})$ is introduced, corresponding to the coefficients quantifying the linear influence of the $K$ attributes on the utility that individual $n$ associates with the $I$ available alternatives, i.e.:

$$U_{n,i} = \beta_n X_i + (X_i)' \Lambda_n Z_n + \epsilon_{n,i} \tag{3}$$

The matrix $\Lambda_n$ of size $(K \times A)$, is composed of coefficients $\lambda_{n,k:a}$, which represent the effect of individuals' variables $z_{n,a}$ on attribute $x_{i,k}$.[10]

Equation (3) corresponds to the preference-space model. In their seminal paper, Train and Weeks (2005) found that the WTP distributions they derived from preference-space models had an "unreasonably" large variance in comparison with WTP distributions derived from utility models in the WTP-space. Their result has been confirmed in subsequent studies (Mabit et al., 2006; Scarpa et al., 2008; Rose and Masiero, 2010).

[10]No *Alternative Specific Constant* (ASC) has been introduced in Equation (3) as both alternatives proposed in choice cards are unlabeled: The choice options 1 and 2 (recall Figure 1) are symmetrical, differing only in the attributes assigned $X_i$, and none of them corresponds to a *statu quo* alternative.

The random utility expressed in Equation (3) can be rewritten in the WTP-space as follows:

$$U_{n,i} = \beta_{p,n} x_{p,i} + \beta_{p,n} \sum_{k=1}^{K-1} WTP_{k,n} x_{k,i} + \sum_{k=1}^{K-1} \sum_{a=1}^{A} \lambda_{k:a,n} z_{a,n} x_{k,i} + \epsilon_{n,i} \tag{4}$$

where $WTP_{k,n}$ is the willingness to pay for the attribute $k \in [\![1; K-1]\!]$ defined as:[11]

$$WTP_{k,n} = \frac{\beta_{k,n}}{\beta_{p,n}}$$

When analyzing the effects of psychological features or socioeconomic characteristics, it is more convenient for all $\lambda_{n,k:a}$ (which serve to measure the effects of individuals' characteristics on attribute preferences) to be divided by the price coefficient $\beta_{p,n}$ in order to generate their estimation in the WTP-space. This step directly yields an estimation of the effect of the individuals' characteristics on the average WTP.[12] The newly formed $\gamma_{k:a,n}$ therefore measures the effect of the psychological variables $z_{a,n}$ on the WTP for attribute $k$. It is thus possible to consider these effects as directly included in a newly formed individuals' $\widetilde{WTP}_{k,n}$, as follows:

$$\widetilde{WTP}_{k,n} = WTP_{k,n} + \sum_{a=1}^{A} \gamma_{k:a,n} z_{a,n} \quad \text{with} \quad WTP_{k,n} = \frac{\beta_{k,n}}{\beta_{p,n}} \quad \text{and} \quad \gamma_{k:a,n} = \frac{\lambda_{k:a,n}}{\beta_{p,n}} \tag{5}$$

As pointed out by Revelt and Train (2000), the number of choices per individual influences the estimation of both the mean and variance of the conditional distributions. To

[11] The price is considered to be the last attribute, for purpose of consistency with previous notations. Moreover, the coefficients $\lambda_{n,p:a}$ that represent the effect of individuals' characteristics on the price attribute can be considered as equal to zero because what matters to the choice model is the relative preferences between attributes, which can be fully taken into account with $K-1$ attributes.

[12] It is therefore necessary to use standardized individuals' characteristics.

avoid an overfitting of individual conditional estimates, given the limited number of choice sets per individual, we have opted to evaluate only the average effect $\gamma_{k:a}$ of individuals' characteristics on attributes. Equation (4) then becomes:

$$U_{n,i} = \beta_{p,n} x_{p,i} + \beta_{p,n} \sum_{k=1}^{K-1} \left( WTP_{k,n} + \sum_{a=1}^{A} \gamma_{k:a} z_{a,n} \right) x_{k,i} + \epsilon_{n,i} \tag{6}$$

## 5.2 Empirical results

This section is organized as follows. We will first analyze how respondents' psychological factors (Consideration of Future Consequences and Environmental Self-identity) may impact their preferences (Hypotheses 3 and 4), yet without considering any framing effects. This analysis is achieved with a Random Parameter Logit (RPL) model including cross-effects. When estimating the RPL models presented in Table 6, the mixed effect component for the price coefficient is specified as a normal distribution ($\beta_{p,n} \sim \mathcal{N}(\mu_p, \sigma_p)$). The $WTP_{k,n}$ are also specified with a normal distribution ($WTP_{k,n} \sim \mathcal{N}(v_k, \sigma_k)$ for the $k \in \{duration, co_2, sanitary\}$). Next, framing effects will be analyzed through an RPL model with a dummy variable for each treatment (Hypothesis 1). Last, the Promotion score will be used to identify individual heterogeneity within the magnitude of framing effects (Hypothesis 2).

### 5.2.1 Psychological effects

A Random Parameter Logit in the WTP-space is first estimated on the total sample of 1,032 individuals, yet without including any framing effect or psychological factors. The random utility model used is the one described by Equation 4. The mixed effect of the RPL model is specified with a normal distribution for the price coefficient ($\beta_{p,n} \sim \mathcal{N}(\mu_p, \sigma_p)$), duration, $CO_2$ emissions and sanitary measure, i.e. WTPs ($WTP_{k,n} \sim \mathcal{N}(v_k, \sigma_k)$ for the $k \in$

$\{duration, co_2, sanitary\}$). This set-up serves as a reference estimation for WTP and price coefficients in order to verify the robustness of the subsequent models with psychological factors and framing effects. As shown in Table 6 (model (1)), all coefficients are significant, with a 1% p-value threshold, indicating that all attributes have been taken into account in the average of individuals. The signs of the four attributes are consistent: a positive sign for the mean WTP for duration, $CO_2$ emissions and sanitary measure offers consistency. As expected, the price coefficient is negative. Individuals are willing to pay, on average, €0.26 to decrease their travel time by 1 minute, and €0.54 to decrease the emissions of their trip by 1 kg of $CO_2$. Moreover, they are willing to pay €24.10 to benefit from a guaranteed one-seat gap.

The effect of psychological factors on each WTP can be estimated through cross-effects. We have therefore introduced into the WTP equation for each attribute (duration, $CO_2$ and sanitary measure) the effect of the individual psychological factors (CFC, Identity and Promotion) by means of Equation 6:

$$U_{n,i} = \beta_{p,n} x_{p,i} + \beta_{p,n} \sum_{k=1}^{K-1} \left( WTP_{k,n} + \sum_{c \in C} \gamma_{k:c} z_{c,n} \right) x_{k,i} + \epsilon_{n,i} \quad \text{with} \quad C = \{CFC, Identity, Promotion\} \tag{7}$$

with $\gamma_{k:c}$ denoting the effect of the individual's psychological factor $c \in \{CFC, Identity, Promotion\}$ on the WTP for attribute $k \in \{duration, co2, sanitary\}$.

The results of the corresponding model are presented in Table 6 ((2) for the full model and (3) for the reduced model); they show that all three psychological features have a significant effect on travel attributes. Individuals with a high preference for the future (CFC) generally ascribe more importance to the *co2* attribute.[13] Individuals with a high

[13]More precisely, when looking at the effect of CFC in model (3), an increase by 1 standard deviation of

environmental self-identity score exhibit a higher preference for the $CO_2$ emissions attribute, a lower preference for travel *duration* and a higher preference for the *sanitary* attribute. Like for individuals with a high Promotion score, this population tends to exhibit a greater preference for the *duration* attribute, and a lower preference for travel *emissions*.

### 5.2.2 Framing effects

We have shown herein that psychological features exert an effect on travel choice. Let's now analyze how attribute framing can modify preferences. The average effect of the four treatments will first be estimated. It will then be investigated how a psychological factors specifically designed to measure gain or loss sensitivity can impact these average preferences.

**Average framing effect on attributes**

To estimate the framing effect directly on the WTP-space, dummies of the framed attributes were introduced. The model remains the same as in Equation 6, in considering framing as an individual characteristic. The dummy variables $z_{T2,n}$ and $z_{T4,n}$ were introduced to estimate the effect of the duration framing on the mean of the baseline distribution of $WTP_{duration}$. The same step was carried out for $CO_2$ framing, by introducing $z_{T3,n}$ and $z_{T5,n}$, thus yielding the following equation:

$$U_{n,i} = \beta_{p,n} x_{p,i} + \beta_{p,n} \sum_{k=1}^{K-1} \left( WTP_{k,n} + \sum_{t \in T} \gamma_{k:t} z_{t,n} \right) x_{k,i} + \epsilon_{n,i} \quad \text{for} \quad T = \{T2, T3, T4, T5\} \tag{8}$$

The results of the RPL model are reported in Table 7 (models (4) and (5)). It can be observed that only $\gamma_{duration:T4}$ and $\gamma_{co_2:T5}$ are significant at the 10% level, as opposed to

CFC serves to increase, on average, by €0.090 the WTP to decrease the travel emissions by 1 kg of $CO_2$.

Table 6: RPL models with psychological features

| **Variable** | **(1)** | **(2)** | **(3)** |
|---|---|---|---|
| **Attributes' mean and variance WTP** | | | |
| $\mu_{duration}$ | 0.258*** | 0.260*** | 0.253*** |
| | (0.017) | (0.017) | (0.018) |
| $\mu_{co2}$ | 0.537*** | 0.564*** | 0.571*** |
| | (0.064) | (0.063) | (0.062) |
| $\mu_{sanitary}$ | 24.096*** | 24.135*** | 24.142*** |
| | (2.101) | (2.090) | (2.059) |
| $\mu_{price}$ | -0.051*** | -0.049*** | -0.050*** |
| | (0.003) | (0.003) | (0.003) |
| $\sigma_{duration}$ | 0.394*** | 0.396*** | 0.397*** |
| | (0.019) | (0.019) | (0.019) |
| $\sigma_{co2}$ | 1.093*** | 1.075*** | 1.085*** |
| | (0.071) | (0.072) | (0.072) |
| $\sigma_{sanitary}$ | 51.803*** | 51.906*** | 51.892*** |
| | (2.292) | (2.311) | (2.268) |
| $\sigma_{price}$ | 0.034*** | 0.032*** | 0.032*** |
| | (0.004) | (0.003) | (0.003) |
| **Psychological features' effects** | | | |
| $\gamma_{duration:CFC}$ | _ | 0.004 | _ |
| | | (0.019) | |
| $\gamma_{duration:Identity}$ | _ | -0.027* | -0.038** |
| | | (0.018) | (0.018) |
| $\gamma_{duration:Promotion}$ | _ | 0.044** | 0.046*** |
| | | (0.020) | (0.019) |
| $\gamma_{co2:CFC}$ | _ | 0.096* | 0.090* |
| | | (0.070) | (0.068) |
| $\gamma_{co2:Identity}$ | _ | 0.242*** | 0.228*** |
| | | (0.067) | (0.066) |
| $\gamma_{co2:Promotion}$ | _ | -0.147** | -0.141** |
| | | (0.071) | (0.074) |
| $\gamma_{sanitary:CFC}$ | _ | -2.031 | _ |
| | | (2.380) | |
| $\gamma_{sanitary:Identity}$ | _ | 7.385*** | 7.456*** |
| | | (2.355) | (2.022) |
| $\gamma_{sanitary:Promotion}$ | _ | 1.605 | _ |
| | | (2.414) | |
| Log Likelihood | -5,334.34 | -5,315.7 | -5,315.36 |
| AIC | 10,684.7 | 10,665.3 | 10,658.7 |
| BIC | 10,742.6 | 10,788.4 | 10,760.1 |
| Number of respondents | 1,032 | 1,032 | 1,032 |
| Number of observations | 10,320 | 10,320 | 10,320 |

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

$\gamma_{duration:T2}$ and $\gamma_{co_2:T3}$, which are not significant (Table 7, model (4)). This finding indicates that the loss framing in duration (resp. in $CO_2$ emissions) is significant and moreover increases the average preference for a shorter trip duration (resp. lower $CO_2$ emissions). Table 7 (model (5)) thus presents the reduced model, i.e. without $\gamma_{duration:T2}$ and $\gamma_{co_2:T3}$. When examining loss framing T4 and T5 in model (5), the relative WTP increase for the framed attributes can be calculated. The baseline WTP for travel duration equals to €0.241/min, while the loss framing on duration increases this baseline by €0.075/min, corresponding to a $0.075/0.241 = 31\%$ increase. Next, the baseline WTP for $CO_2$ equals to €0.486/kg and the loss framing on $CO_2$ adds €0.257/kg to this value, corresponding to a $0.257/0.486 = 53\%$ increase. This result demonstrates that loss framing on $CO_2$ produces a larger effect than loss framing on duration, relative to their average baseline values.

Table 7: RPL models with framing effects.

| **Variable** | **(4)** | **(5)** |
|---|---|---|
| **Attributes' mean and variance WTP** | | |
| $v_{duration}$ | 0.243*** | 0.241*** |
| | (0.022) | (0.020) |
| $v_{co_2}$ | 0.47*** | 0.486*** |
| | (0.080) | (0.071) |
| $v_{sanitary}$ | 23.741*** | 23.776*** |
| | (2.099) | (2.099) |
| $\mu_{price}$ | -0.051*** | -0.051*** |
| | (0.003) | (0.003) |
| $\sigma_{duration}$ | 0.391*** | 0.392*** |
| | (0.019) | (0.019) |
| $\sigma_{co_2}$ | 1.079*** | 1.081*** |
| | (0.070) | (0.070) |
| $\sigma_{sanitary}$ | 51.864*** | 51.901*** |
| | (2.291) | (2.294) |
| $\sigma_{price}$ | 0.035*** | 0.034*** |
| | (0.004) | (0.004) |
| **Treatment effects** | | |
| $\gamma_{duration:T2}$ | -0.011 | _ |
| | (0.044) | |
| $\gamma_{duration:T4}$ | 0.075* | 0.078** |
| | (0.041) | (0.039) |
| $\gamma_{co_2:T3}$ | 0.066 | _ |
| | (0.163) | |
| $\gamma_{co_2:T5}$ | 0.273* | 0.257* |
| | (0.159) | (0.154) |
| Log Likelihood | -5,330.927 | -5,331.042 |
| AIC | 10,685.85 | 10,682.08 |
| BIC | 10,772.76 | 10,754.5 |
| Number of respondents | 1,032 | 1,032 |
| Number of observations | 10,320 | 10,320 |

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

**Psychological influence on the framing effect**

The following objective is to determine if the framing effect is influenced by an individual's psychological factors. For this purpose, we have assessed whether or not the framing can vary according to the heterogeneity of the three psychological factors: CFC, Identity,

and Promotion score. The working hypothesis is that a strong Promotion focus would lead to greater sensitivity for gain framing and lower sensitivity for loss framing. As previously noted, gain framing for both duration and $CO_2$ is not significant, thus rendering irrelevant the need to explore the heterogeneity of preferences within treatments T2 and T3. Consequently, our focus here is limited to the loss framing applied to travel duration (T4) and $CO_2$ emissions (T5).

In seeking to determine whether the impact of the framing effect on coefficient attributes varies for individuals with different psychological features, three types of variables (attributes, treatments, psychological factors) must be cross-analyzed. For an unlabeled choice experiment, this requirement can be incorporated into the Random Utility Model (RUM) through interaction terms, while still using the framework described in Equation 6. The utility equation is similar to Equation 5, but the difference lies in CFC, Identity and Promotion heterogeneity $\omega_{k:t:c}$, which get added to the average framing effects $\gamma_{duration:T4}$ and $\gamma_{co_2:T5}$ (the steps to derive Equation 9 from the general framework are presented in Appendix A).

$$U_{n,i} = \beta_{p,n} x_{p,i} + \beta_{p,n} \sum_{k=1}^{K-1} \left( WTP_{k,n} + \sum_{c \in C} \gamma_{k:c} z_{c,n} + \sum_{t \in T} (\gamma_{k:t} + \sum_{c \in C} \omega_{k:t:c} z_{c,n}) z_{t,n} \right) x_{k,i} + \epsilon_{n,i}$$
$$\text{for} \quad T = \{T4, T5\} \quad \text{and} \quad C = \{CFC, Promotion, Identity\} \tag{9}$$

Table 8: Influence of psychological features on framing effect

| Variable | (2) | (5) | (6) |
|---|---|---|---|
| **Attributes' mean and variance WTP** | | | |
| $v_{duration}$ | 0.260*** | 0.241*** | 0.244*** |
| | (0.017) | (0.020) | (0.019) |
| $v_{co2}$ | 0.564*** | 0.486*** | 0.517*** |
| | (0.063) | (0.071) | (0.070) |
| $v_{sanitary}$ | -24.135*** | -23.776*** | -24.042*** |
| | (2.090) | (2.099) | (2.087) |
| $\mu_{price}$ | -0.049*** | -0.051*** | -0.050*** |
| | (0.003) | (0.003) | (0.003) |
| $\sigma_{duration}$ | -0.396*** | -0.392*** | -0.394*** |
| | (0.019) | (0.019) | (0.019) |
| $\sigma_{co2}$ | 1.075*** | 1.081*** | 1.057*** |
| | (0.072) | (0.070) | (0.072) |
| $\sigma_{sanitary}$ | 51.906*** | 51.901*** | 51.909*** |
| | (2.311) | (2.294) | (2.306) |
| $\sigma_{price}$ | -0.032*** | -0.034*** | -0.032*** |
| | (0.003) | (0.004) | (0.003) |
| **Psychological features' effects** | | | |
| $\gamma_{duration:CFC}$ | 0.004 | _ | -0.008 |
| | (0.019) | | (0.022) |
| $\gamma_{duration:Identity}$ | -0.027* | _ | -0.034** |
| | (0.018) | | (0.020) |
| $\gamma_{duration:Promotion}$ | 0.044** | _ | 0.042** |
| | (0.020) | | (0.022) |
| $\gamma_{co2:CFC}$ | 0.096* | _ | 0.098* |
| | (0.070) | | (0.076) |
| $\gamma_{co2:Identity}$ | 0.242*** | _ | 0.171** |
| | (0.067) | | (0.074) |
| $\gamma_{co2:Promotion}$ | -0.147** | _ | -0.069 |
| | (0.071) | | (0.078) |
| $\gamma_{sanitary:CFC}$ | -2.031 | _ | -2.148 |
| | (2.380) | | (2.318) |
| $\gamma_{sanitary:Identity}$ | 7.385*** | _ | 7.495*** |
| | (2.355) | | (2.331) |
| $\gamma_{sanitary:Promotion}$ | 1.605 | _ | 1.213 |
| | (2.414) | | (2.356) |
| **Treatment effects** | | | |
| $\gamma_{duration:T4}$ | _ | 0.078** | 0.079** |
| | | (0.039) | (0.040) |
| $\gamma_{co2:T5}$ | _ | 0.257** | 0.196* |
| | | (0.154) | (0.152) |
| **Treatment heterogeneity** | | | |
| $\omega_{duration:T4:CFC}$ | _ | _ | 0.045 |
| | | | (0.043) |
| $\omega_{duration:T4:Identity}$ | _ | _ | 0.049 |
| | | | (0.045) |
| $\omega_{duration:T4:Promotion}$ | _ | _ | -0.010 |
| | | | (0.046) |
| $\omega_{co2:T5:CFC}$ | _ | _ | 0.032 |
| | | | (0.176) |
| $\omega_{co2:T5:Identity}$ | _ | _ | 0.323** |
| | | | (0.169) |
| $\omega_{co2:T5:Promotion}$ | _ | _ | -0.402** |
| | | | (0.189) |
| Log Likelihood | -5,315.66 | -5,331.04 | -5,307.78 |
| AIC | 10,665.31 | 106,82.08 | 10,665.52 |
| BIC | 107,88.43 | 107,54.5 | 108,46.56 |
| Number of respondents | 1,032 | 1,032 | 1,032 |
| Number of observations | 10,320 | 10,320 | 10,320 |

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

First, the results in Table 8 show that coefficients are definitely stable between models (2), (5) and (6). The introduction of heterogeneity within framing effects does not modify the average treatment effect. Second, in Table 8 (model 6) a significant effect for $\omega_{co_2:T5:Identity}$ and $\omega_{co_2:T5:Promotion}$, but not for the other sources of treatment heterogeneity. Individuals with strong environmental self-identity are more sensitive to loss framing on $CO_2$. In contrast, individuals with a strong Promotion focus are less sensitive to a loss framing on the $CO_2$ emissions attribute. More precisely, $\omega_{co_2:T5:Identity}$ equals -0.323, which can be interpreted as follows: with all other things being equal, an individual with an environmental self-identity of 1 standard deviation higher than average is affected by $CO_2$ loss framing with a total effect on the WTP equal to 0.196 + 0.323 = €0.519/kg $CO_2$ (this amount corresponds to an approximate 0.519/0.517 = 100% increase in the base WTP for $CO_2$ without framing).[14] An individual with a Promotion focus of 1 standard deviation higher than average is affected by $CO_2$ loss framing with a total effect on the WTP equal to 0.196 - 0.402 = €-0.206/kg $CO_2$, which suggests that individuals with a high Promotion focus are negatively affected by loss framing on $CO_2$. Conversely, individuals with a low Promotion score are even more strongly affected by loss framing on $CO_2$. The magnitude of these framing effects is therefore dependent on an individuals' self-environmental identity and motivational strategies.

# 6 Discussion

The primary aim of this research has been to determine how environmental considerations can be better incorporated into travel decisions through nudges. For this purpose, we conducted a DCE with both gain and loss framing on two attributes: travel duration and

[14]This interpretation constitutes a simplification in line with our model, in assuming a linear effect of the score on the framing effect, which would need further research to be tested.

$CO_2$ emitted during trip-making.

As an initial result, we determined whether any individual psychological feature affected transportation choice behavior. Thus, the CFC (Consideration of Future Consequences) factor positively influences the preferences for the reduction of $CO_2$ emissions. These results confirm that consideration for future consequences or a future time perspective is a key determinant of more sustainable behavior and higher rates of preventive behavior (Strathman and Joireman, 2005). This relation is typically explained by the temporal dilemma, as embedded in many of our daily choices and behaviors, between short-term and long-term costs and benefits (Van Lange and Joireman, 2008). More precisely, a future time perspective leads participants to accept to pay more for temporally distant benefits. In addition, the effect of environmental self-identity on the $CO_2$ coefficient follows the expected trend, i.e. individuals with a high environmental self-identity are more willing to pay for a decrease in $CO_2$ emitted during trip-making. This effect is quite significant when comparing the $CO_2$ coefficient for the baseline, $v_{co2}$, with that for the effect, $\gamma_{Identity:co2}$. Identity also has a negative effect on the duration attribute. These results are in line with past results showing that those with a strong environmental self-identity feel compelled to make environmentally-friendly choices by personal norm without any financial reward (Van der Werff et al., 2013b). In other words, when this identity is salient, people are more likely to change their behavior in favor of the collective interests. Future research should test whether situational cues can trigger this social environmental-identity.

The second result reveals that loss framing treatments have a significant impact on preferences for both $CO_2$ and travel time, whereas gain framing does not exert any significant effect. This furthermore underscores the importance of the way information about a choice is actually delivered, with the focus on loss being able to modify an individual's choice. The weakness of gain framing compared to loss framing can be tied to prospect theory

(Kahneman and Tversky, 1979), whereby the value function is steeper for losses than for gains. Moreover, the effect of the loss framing on the $CO_2$ attribute is stronger than on the duration attribute. This result could be explained by the complexity of the $CO_2$ attribute compared to that of duration. Individuals with less attribute knowledge are more likely to construct preferences, thereby enhancing the loss framing effect (see also Mrkva et al. (2020) for a similar intuition).

The last result extends the scope of previous findings in the field of transportation (Avineri and Waygood, 2013; Waygood and Avineri, 2018) by showing that the effect of loss framing differs across respondents. Respondents do not react the same way to a loss framing, depending on their psychological characteristics, namely individuals' motivational strategies (Higgins, 1997) and environmental self-identity (Van der Werff et al., 2013a). Individuals with a low Promotion score and individuals with high environmental self-identity score are more heavily affected by loss framing on the $CO_2$ emissions attribute. This result may call into question the hypothesis forwarded earlier about the impact of the lack of knowledge of the $CO_2$ attribute. It seems plausible to assume that this effect must not be attributed to a misinterpretation of the attribute, but rather to the perceived importance of the loss depending on the participants' psychological characteristics. Future research will need to distinguish between these two options by comparing, for example, the effect of framing $CO_2$ emissions with a more concrete framing of the consequences of transport pollution, e.g. the immediate impact on air quality and its health consequences.

# 7 Conclusion

The main contribution of our work to the existing literature is threefold: (i) explore whether a simple way of implementing a framing could increase pro-environmental behavior, (ii) estimate the effect of this framing on transport choices, and (iii) analyze if the framing

effect could vary according to an individual's psychological heterogeneity.

Our main results confirm and extend the previous literature (Avineri and Waygood, 2013; Waygood and Avineri, 2018; Homar and Cvelbar, 2021). We first demonstrated that a loss framing on $CO_2$ emissions significantly increases the respondents' choice of pro-environmental behavior, while a loss framing on duration increases the average preference for shorter trip duration; gain framing has no significant effect. In addition, the basic observation that loss aversion or negativity bias is simply a general trend does seem to be challenged by our results; it would be influenced in a predictable way by other elements of the decision-making context.

Our work has raised some issues that require further investigation. First, the fact that framing effects depend on individuals' motivational strategies is a powerful result that should be analyzed and validated with respect to psychological theory. Here, the internal consistency of the scale of prevention is insufficiently reliable, which in turn limits the scope of the investigation into the effects of individuals' motivational orientation on the magnitude of the framing effect on $CO_2$ emissions. Second, we showed that the effect of loss framing was greater for $CO_2$ than for duration. One possible explanation for this finding is that framing on a more distant or complex attribute (e.g. kg of $CO_2$ emissions) has a greater effect than framing on an already well-known and typical attribute (e.g. duration). Another possible explanation lies in the perceived magnitude of the loss with respect to the participants' psychological characteristics. This point needs to be closely investigated in order to ascertain whether or not the magnitude of the framing effect is caused by the fact that $CO_2$ emissions remains an abstract indicator. If so, it would be beneficial to find a way to communicate on $CO_2$ emissions with a more understandable unit of measurement.

# A Questions used for psychological factors

| Factors | Statements |
|---|---|
| **Consideration of Future Consequences** | |
| Q1 | I consider how things might be in the future, and try to influence those things with my day to day behavior. |
| Q2 | Often I engage in a particular behavior in order to achieve outcomes that may not result for many years. |
| Q3* | I only act to satisfy immediate concerns, figuring the future will take care of itself. |
| Q4* | My behavior is only influenced by the immediate (i.e. a matter of days or weeks) outcomes of my actions. |
| Q5 | My convenience is a big factor in the decisions I make or the actions I take. |
| Q6 | I am willing to sacrifice my immediate happiness or well-being in order to achieve future outcomes. |
| Q7 | I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years. |
| Q8 | I think it is more important to perform a behavior with important distant consequences than a behavior with less-important immediate consequences. |
| Q9* | I generally ignore warnings about possible future problems because I think the problems will be resolved before they reach crisis level. |
| Q10* | I think that sacrificing now is usually unnecessary since future outcomes can be dealt with at a later time. |
| Q11* | I only act to satisfy immediate concerns, figuring that I will take care of future problems that may occur at a later date. |
| Q12* | Since my day to day work has specific outcomes, it is more important to me than behavior that has distant outcomes. |
| **Promotion** | |
| Q13 | When it comes to achieving things that are important to me, I find that I don't perform as well as I ideally would like to do. |
| Q14 | I feel like I have made progress toward being successful in my life. |
| Q15 | When I see an opportunity for something I like, I get excited right away. |
| Q16 | I frequently imagine how I will achieve my hopes and aspirations. |
| Q17 | I see my self as someone who is primarily striving to reach my "ideal self" - to fulfill my hopes, wishes, and aspirations. |
| **Prevention** | |
| Q18 | I usually obeyed rules and regulations that were established by my parents. |
| Q19 | Not being careful enough has gotten me into trouble at times. |
| Q20 | I worry about making mistakes. |
| Q21 | I frequently think about how I can prevent failures in my life. |
| Q22 | I see myself as someone who is primarily striving to become the self I "ought" to be - fulfill my duties, responsibilities and obligations. |
| **Identity** | |
| Q23 | Acting environmental friendly is an important part of who I am. |
| Q24 | I am the type of person who acts environmental friendly. |
| Q25 | I see myself as an environmental-friendly person. |

* Questions 3, 4, 9, 10, 11 and 12 were asked in reverse order compared to their respective score, as performed in the reference studies. The Likert-scale of the pertinent questions was thus inverted before coding.

The original statements in French are available upon request submitted to the authors.

# B Comparison of the five sub-samples

The differences between the five sub-samples were tested with a Chi-squared homogeneity test (see Table 9). The p-values below the 5% threshold were considered significant to reject the null hypothesis of no difference between distributions. The five sub-samples can thus be considered as not significantly different for the *Gender*, *Age*, *Net monthly household income (€)* and *Aggravating risk of Covid-19* characteristics. However, a significant difference is observed between the sample 2 (T2) and the control group (T1) for the *Working situation* and *Education level* variables, as well as between the sample 5 (T5) and the control group (T1) for the *Education level*.

Table 9: Socio-economic characteristics of the five sub-samples.

| Description | T1 | T2 | T3 | T4 | T5 | Chi2 pvalue T1:T2 | Chi2 pvalue T1:T3 | Chi2 pvalue T1:T4 | Chi2 pvalue T1:T5 |
|---|---|---|---|---|---|---|---|---|---|
| *Gender* | | | | | | | | | |
| Female | 49 | 49 | 50 | 49 | 55 | 1.00 | 0.92 | 1.00 | 0.21 |
| Male | 51 | 51 | 50 | 51 | 45 | | | | |
| *Working situation* | | | | | | | | | |
| Active | 68 | 58 | 68 | 65 | 59 | 0.04** | 1.00 | 0.63 | 0.09* |
| Non active | 32 | 42 | 32 | 35 | 41 | | | | |
| *Age* | | | | | | | | | |
| 18-29 | 22 | 23 | 23 | 18 | 21 | 0.22 | 0.75 | 0.64 | 0.96 |
| 30-44 | 26 | 29 | 26 | 31 | 26 | | | | |
| 45-59 | 28 | 20 | 32 | 28 | 30 | | | | |
| 60-75 | 23 | 29 | 20 | 22 | 23 | | | | |
| *Education level* [a] | | | | | | | | | |
| $E_1$ | 16 | 25 | 19 | 22 | 21 | 0.03** | 0.11 | 0.03** | 0.04** |
| $E_2$ | 42 | 43 | 49 | 48 | 49 | | | | |
| $E_3$ | 42 | 31 | 32 | 30 | 30 | | | | |
| *Net monthly household income (€)* | | | | | | | | | |
| $< 1500$ | 22 | 19 | 17 | 22 | 20 | 0.73 | 0.38 | 0.88 | 0.66 |
| 1500 - 3500 | 53 | 56 | 58 | 51 | 57 | | | | |
| $> 3500$ | 24 | 25 | 25 | 27 | 23 | | | | |
| *Aggravating risk of Covid-19* [b] | | | | | | | | | |
| Yes | 76 | 76 | 72 | 76 | 80 | 1.00 | 0.43 | 1.00 | 0.35 |
| No | 24 | 24 | 28 | 24 | 20 | | | | |
| N (ind.) | 209 | 207 | 205 | 207 | 204 | | | | |

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

[a] $E_1$: No vocational degree, Basic vocational degree; $E_2$: Intermediate qualification, Lower tertiary; $E_3$: Upper tertiary.

[b] The *Aggravating risk of Covid-19* corresponds to the answer (yes or no) to the following question: "Do you think you have any of the risk factors (heart problems, high blood pressure, diabetes, chronic respiratory problems, obesity, cancer, etc.) for severe forms of Covid-19?"

# C Model of framing effect with psychological heterogeneity

The model presented in Equation 9 can be written from the general framework presented in Equation 6, but allowing for heterogeneity between individuals for the $\gamma$ coefficients. The

new $\gamma_{k:a,n}$ that includes heterogeneity can be defined as follows:

$$\gamma_{k:a,n} = \gamma_{k:a} + \sum_{b \in B} \gamma_{k:a:b} z_{b,n} \tag{10}$$

Equation 10 is still in line with the general framework of equation 6. Using the notation $z_{t:c,n} = z_{t,n} z_{c,n}$ leads to:

$$\begin{aligned} \sum_{a \in T:C} \gamma_{k:a,n} z_{a,n} = \sum_{t \in T} \gamma_{k:t} z_{t,n} + \sum_{t \in C} \gamma_{k:c} z_{c,n} + \sum_{t \in T, c \in C} \gamma_{k:t:c} z_{c,n} z_{t,n} \\ \text{with } T{:}C = \{T4,\ T5,\ CFC,\ Identity,\ Promotion, \\ T4{:}CFC,\ T4{:}Identity,\ T4{:}Promotion, T5{:}CFC,\ T5{:}Identity,\ T5{:}Promotion\} \end{aligned} \tag{11}$$

We then choose to use notation $\omega_{k:t:c} = \gamma_{k:t:c}$ for a better understanding. Therefore $\gamma_{k:t}$ represents the average effect of the framing $t$ on the WTP for the attribute $k$, $\gamma_{k:c}$ represents the average effect of the psychological factor $c$ on the WTP for the attribute $k$, and $\omega_{k:t:c}$ accounts for the heterogeneity of the framing $t$ on the WTP for $k$ contributed by the psychological factor $c$. We recall that psychological factors $z_{t,n}$ are normalized so that the $\omega_{k:t:c}$ coefficients are easily analysable and comparable with $\gamma_{k:t}$.

## References

Avineri, E. and Waygood, E. O. D. (2013). Applying valence framing to enhance the effect of information on transport-related carbon dioxide emissions. *Transportation research part A: policy and practice*, 48:31–38.

Bökman, F., Andersson, H., Sörqvist, P., and Ahonen-Jonnarth, U. (2021). The psychology of balancing gains and losses for self and the environment: Evidence from a carbon emission versus travel time tradeoff task. *Journal of Environmental Psychology*, 74:101574.

Bosone, L., Martinez, F., and Kalampalikis, N. (2015). When the model fits the frame: The impact of regulatory fit on efficacy appraisal and persuasion in health communication. *Personality and Social Psychology Bulletin*, 41(4):526–539.

Cesario, J., Higgins, E. T., and Scholer, A. A. (2008). Regulatory fit and persuasion: Basic principles and remaining questions. *Social and Personality Psychology Compass*, 2(1):444–463.

Chèze, B., Collet, C., and Paris, A. (2021). Estimating discrete choice experiments : theoretical fundamentals. Les cahiers de l'économie n°142, IFP School-IFPEN.

Crabbe, M. and Vandebroek, M. (2012). Using appropriate prior information to eliminate choice sets with a dominant alternative from D-efficient designs. *Journal of Choice Modelling*, 5(1):22–45.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3):297–334.

Demarque, C., Apostolidis, T., Chagnard, A., and Dany, L. (2010). Adaptation et validation française de l'échelle de perspective temporelle "Consideration of future consequences" (CFC). *Bulletin de Pyschologie*, 5:351–360.

Entman, R. M. (1993). Framing: Towards clarification of a fractured paradigm. *McQuail's reader in mass communication theory*, pages 390–397.

Faccioli, M. and Glenk, K. (2021). More in good condition or less in bad condition? valence-based framing effects in environmental valuation. *Land Economics*, pages 051920–0067R1.

Givoni, M., Macmillen, J., Banister, D., and Feitelson, E. (2013). From Policy Measures to Policy Packages. *Transport Reviews*, 33(1):1–20.

Haws, K. L., Dholakia, U. M., and Bearden, W. O. (2010). An assessment of chronic regulatory focus measures. *Journal of Marketing Research*, 47(5):967–982.

Higgins, E. (1997). Beyond pleasure and pain. *The American psychologist*, 52(12):1280–300.

Higgins, E. T. (2000). Making a good decision: value from fit. *American psychologist*, 55(11):1217.

Hilton, D., Charalambides, L., Demarque, C., Waroquier, L., and Raux, C. (2014). A tax can nudge: The impact of an environmentally motivated bonus/malus fiscal system on transport preferences. *Journal of Economic Psychology*, 42:17–27.

Homar, A. R. and Cvelbar, L. K. (2021). The effects of framing on environmental decisions: A systematic literature review. *Ecological Economics*, 183:106950.

IEA (2020). $CO_2$ emissions from fuel combustion. International Energy Agency.

Joireman, J. A., Van Lange, P. A., and Van Vugt, M. (2004). Who cares about the environmental impact of cars? those with an eye toward the future. *Environment and behavior*, 36(2):187–206.

Kahneman, D. and Tversky, A. (1979). Prospect theory: An analysis of decisions under risk. *Econometrica*, 47(2):263–292.

Kragt, M. E. and Bennett, J. W. (2012). Attribute framing in choice experiments: how do attribute level descriptions affect value estimates? *Environmental and Resource Economics*, 51(1):43–59.

Levin, I. P., Schneider, S. L., and Gaeth, G. J. (1998). All Frames Are Not Created Equal: A Typology and Critical Analysis of Framing Effects. *Organizational Behavior and Human Decision Processes*, 76(2):149–188.

Louviere, J. J., Hensher, D. A., and Swait, J. D. (2000). *Stated Choice Methods, Analysis and Applications*. Cambridge University Press.

Mabit, S., Caussade, S., and Hess, S. (2006). Representation of taste heterogeneity in willingness to pay indicators using parameterization in willingness to pay space. *Proceedings ETC*.

Milfont, T. L. and Demarque, C. (2015). Understanding environmental issues with temporal lenses: Issues of temporality and individual differences. In *Time perspective theory; Review, research and application*, pages 371–383. Springer.

Mrkva, K., Johnson, E. J., Gächter, S., and Herrmann, A. (2020). Moderating Loss Aversion: Loss Aversion Has Moderators, But Reports of its Death are Greatly Exaggerated. *Journal of Consumer Psychology*, 30(3):407–428.

Raux, C., Chevalier, A., Bougna, E., and Hilton, D. (2021). Mobility choices and climate change: Assessing the effects of social norms, emissions information and economic incentives. *Research in Transportation Economics*, 90:101007.

Revelt, D. and Train, K. (2000). Customer-specific taste parameters and mixed logit: Households' choice of electricity supplier. department of economics. *University of California at Berkeley. Working paper no. E00-274*.

Rose, J. M. and Masiero, L. (2010). A comparison of the impacts of aspects of prospect theory on wtp/wtaestimated in preference and wtp/wta space. *European Journal of Transport and Infrastructure Research*, 10(4).

Rozin, P. and Royzman, E. B. (2001). Negativity bias, negativity dominance, and contagion. *Personality and social psychology review*, 5(4):296–320.

Scarpa, R., Thiene, M., and Train, K. (2008). Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the alps. *American Journal of Agricultural Economics*, 90(4):994–1010.

Stiglitz, J. E. (2019). Addressing climate change through price and non-price interventions. *European Economic Review*, 119:594–612.

Strathman, A., Gleicher, F., Boninger, D. S., and Edwards, C. S. (1994). The Consideration of Future Consequences: Weighing Immediate and Distant Outcomes of Behavior. *Journal of Personality and Environmental Psychology*, 66(4):11.

Strathman, A. and Joireman, J. (2005). *Theory, Research, and Application.* Lawrence Erlbaum Associates, Inc.

Tajfel, H. E. (1978). *Differentiation between social groups: Studies in the social psychology of intergroup relations.* Academic Press.

Thaler, R. H. and Sunstein, C. R. (2008). Nudge: improving decisions about health. *Wealth, and Happiness*, 6:14–38.

Train, K. and Weeks, M. (2005). Discrete choice models in preference space and willingness-to-pay space. In *Applications of simulation methods in environmental and resource economics*, pages 1–16. Springer.

Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., and Wetherell, M. S. (1987). *Rediscovering the social group: A self-categorization theory.* Basil Blackwell.

Tversky, A. and Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, 211(4481):453–458.

Van der Werff, E., Steg, L., and Keizer, K. (2013a). It is a moral issue: The relationship between environmental self-identity, obligation-based intrinsic motivation and pro-environmental behaviour. *Global Environmental Change*, 23(5):1258–1265.

Van der Werff, E., Steg, L., and Keizer, K. (2013b). The value of environmental self-identity: The relationship between biospheric values, environmental self-identity and environmental preferences, intentions and behaviour. *Journal of Environmental Psychology*, 34:55–63.

Van Lange, P. A. and Joireman, J. A. (2008). How we can promote behavior that serves all of us in the future. *Social Issues and Policy Review*, 2(1):127–157.

Von Neumann, J. and Morgenstern, O. (1947). *Theory of games and economic behavior*. Princeton University Press, 2nd ed. edition.

Waygood, E. O. D. and Avineri, E. (2018). $CO_2$ valence framing: Is it really any different from just giving the amounts? *Transportation Research Part D: Transport and Environment*, 63:718–732.