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Abstract

The potential of psychological and fiscal incentives in motivating environmentally responsible behavior in a context of long distance leisure travel is explored thanks to a series of controlled experiments on 900 participants. Framing effects like information on CO_2 emissions, injunctive and descriptive norms, in combination with fiscal incentives such as a carbon tax, a bonus-malus or a carbon trading scheme are tested. Providing CO_2 information on emissions is highly effective and the injunctive norm reinforces this effect in the case of air and train. A quota scheme reinforces the injunctive norm effect in the case of these two modes. More strikingly, the amount of the financial sanction or reward has no effect on the probability of using the various travel modes, unlike the presence of the fiscal framing itself. These results reinforce the case for using psychologically framing effects, in association or not with fiscal instruments, in promoting effective pro-environmental behavior in transport choices.

Keywords: transport CO_2 emissions; individual choices; psychological incentives; fiscal incentives; discrete choice experiments

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1 INTRODUCTION

Transport generated 22 per cent of anthropogenic CO_2 emissions in the world in 2011 with three-quarters due to road transport and a continuous increase at least since 1990 (IEA, 2013). There is a majority consensus among climate scientists and economists on a need for a sharp reduction of anthropogenic greenhouse gas emissions in the next few decades (see e.g. Stern 2006). This consensus has extended to the policy side and some industrialized countries have set their own ambitious targets of mitigation, e.g. a reduction of their emissions by four by 2050. Regarding transport it is recognized that improvements undertaken in vehicle energy efficiency will not be sufficient in the coming decades and that behavioral changes are also needed, such as shifting from individual to public transportation or lower-emission modes per passenger-km or even reducing kilometers travelled.

Regarding behavioral changes, carbon taxes and vehicle taxes are advocated by economists as the most cost-effective instruments (Parry et al., 2007). A carbon tax system has already been adopted in a number of countries (Finland, Sweden, Italy, Germany and Switzerland). It was considered in France in 2009-2010 before being withdrawn due to legal difficulties and political opposition. Recently Australia withdrew a controversial carbon tax project. Indeed public opinion is very sensitive if not resistant to fuel tax increases.

Variants of economic incentives like personal carbon trading have also been proposed. Their roots can be found in the economic literature initially as a combination of economic incentive and quantity control, namely marketable or Tradable Permits (Baumol and Oates, 1988). In its variant named “cap-and-trade”, this consists in setting a cap (for instance the amount of CO_2 emitted in the transport sector, and hence fossil fuel consumed by vehicles); allocating permits (or rights or credits) to agents to emit CO_2, the allowance being generally free; making agents liable to return permits in proportion of their emissions; authorizing agents to sell unused permits or to buy additional permits in excess of their free allowance to emit more, hence the “tradable” attribute (for a discussion of pros and cons of TPs schemes in transportation see Raux, 2004, 2011).

Due to the specific nature of tradable permits applied to personal consumption of fuel, potential supplementary outcomes when compared to a carbon tax are expected on psychological grounds rather than economic ones (Fawcett, 2010). One effect might come from making carbon visible at the end-user level, with a carbon account delivering frequent feedback on travel behavior (i.e. “carbon budgeting”, see Capstick and Lewis, 2009; Lejoux and Raux, 2011). Another effect could come from the social norm associated with a personal allowance fixed within the frame of a public policy. However, the evidence regarding the compared effectiveness of a carbon tax and personal carbon trading is mixed (Harwatt et al, 2011; Parag et al, 2011; Zanni et al, 2013).

Another hybrid instrument named “bonus-malus” (similar to feebates, see Greene et al, 2005) has been applied in France since 2008 to new car sales based on their CO_2 emissions per km has shown unexpected success regarding consumer behavior. This fiscal system administered by the government was set up to be self-financed, with the money earned from the maluses being used to finance the bonuses, but the strength of the reaction of French consumers which provoked a shift from large-engined cars to small-engined ones, forced the government to subsidize the scheme and to subsequently modify it in order to reduce this deficit. Moreover, an econometric analysis (d’Haultfoeuille et al, 2011) shows that the consumer reaction cannot be attributed solely to price change and is more complex than expected.

The research field of behavioral economics has only recently met the research field of travel behavior (for a review see Metcalfe and Dolan, 2012; Avineri, 2012). Regarding more specifically the environment, there is a growing interest in the psychological aspects of “nudges” (Thaler and Sunstein, 2009) considered as such or in combination with fiscal instruments as taxes and carbon trading, which may serve as social signals concerning their social acceptability and desirability. This is likely to be the case with environmentally responsible behavior where people may be intrinsically motivated to behave responsibly to the environment for moral reasons (Bénabou and Tirole, 2003). Economists have increasingly recognized that providing external incentives for behaviors may “crowd out” intrinsic motivation (Frey, 1997; Frey and Stutzer, 2008) and we need to know more about how such paradoxical effects may occur in environmental behavior. Hilton et al (2014) have recently tested a bonus-malus scheme on travel options on populations of students. They show that the bonus-malus has both a price effect and a social (environmental) norm effect plus a potential “crowding out” effect on travel intentions if the size of bonus-malus is large.

Although advocates of personal trading schemes claim that one of its advantages is that it encourages individuals to take responsibility for their personal carbon budget, we do not know of any systematic research which examines the psychological effect of private carbon schemes on behavior, and which is capable of isolating these aspects from their more purely economic effects.

The aim of this paper is, in a transport choice context, to evaluate and compare the impacts of economic and psychological incentives in motivating environmentally responsible mobility behavior. We will do so by the means of discrete choice experiments where we explore the trade-off between travel price and travel time, while introducing in a controlled setting various effects such as information on CO_2 emissions, injunctive and descriptive social norms, and fiscal incentives such as a carbon tax, a bonus-malus and a carbon trading scheme.

In this paper, by “framing” we mean the ways of presenting a choice based initially on objective economic properties (here the trade-off between travel price and travel time) that do change psychological aspects (information on CO_2 emissions, injunctive and descriptive social norms) and sometimes economic aspects by imposing fiscal incentives.

The remainder of the paper is structured as follows. Section 2 describes the methodology of data production. Section 3 presents the results and section 4 the discussion and conclusion.

2 METHODOLOGY

Firstly the experimental setting is described, followed by the design of the stated choice experiments to end by the design of the discrete choice models themselves.

2.1 Experimental setting

As the aim is to explore the tradeoff between price and duration of travel in various framing conditions, the field experiment is long distance leisure travel. Such casual travel choices are distinct from routine daily travel behavior and lead to specific decision at each time. Moreover, the quantity of CO_2 emissions for each such travel decision is sufficiently large to yield significant values of decision parameters and to lead the respondents to play into the assessment of the various alternatives.

Participants were presented with a fictitious scenario in which they had to travel to a destination at about 1,000km from their home location for a one week of holidays accompanied by a person of their choice. The one week holiday duration aims at making ground transportation a relevant choice given the necessary time to travel this distance. Travelling with somebody else aims at making private car a plausible alternative given its price. Participants had to choose between four different travel modes (air, car, coach, train) or renouncing travel altogether, in a series of choice situations with various combinations of travel price and duration and framing conditions.

The framing conditions refer to various psychological and economic incentives. As in a clinical trials a "baseline control group" was established where only the basic price-time tradeoff between travel modes had to be performed. The survey for this control condition was conducted in June 2013.

For each of the subsequent experimental conditions another group of individuals is selected randomly and assigned to one and only one condition. Because of this random selection, the assumption is made that the responses of any individual assigned to any given experimental condition can be compared to the responses of any other individual assigned to any other experimental condition. Moreover, because each group is assigned to one and only one condition the effect of each condition can be isolated. The differences in responses will allow measurement of the effects only due to differences in experimental conditions.

The next three experimental conditions were conducted in December 2013. The aim of the second condition was to see if providing basic information on CO_2 emissions was encouraging pro-environment behavior compared with control condition. In the screens showing the duration and price tradeoff between alternative transportation modes, the amount of CO_2 emissions associated with each travel mode was added. The same quantity applied for a given mode regardless of travel duration (which is a simplification): 180 Kg of CO_2 for train, 720 kg for air, 124 kg for coach – round trip for two persons for these three transport modes, 408 kg for car – roundtrip for the vehicle.

In the third experimental condition, an "injunctive norm" was added in order to assess the impact of such a psychological incentive. This injunctive norm was stated as follows: "The high level of greenhouse gas emissions in the atmosphere (such as CO_2) can cause dangerous climate change for the planet. Climatologists are already seeing many consequences such as melting glaciers or ice field. According to scientists, to limit these effects it is necessary that all humans reduce their emissions by half".

In the fourth condition, a potential reinforcing effect by a "descriptive norm" is tested. The following sentence is added to the previous injunctive norm: "60% of French people personally contribute through their daily actions to reduce their emissions".

Finally, the last three experimental conditions were conducted in June 2014 and involved fiscal incentives added to the CO_2 information and the injunctive norm. These two framing effects were kept as necessary to make the introduction of fiscal incentives plausible.

In the fifth experimental condition a carbon tax is applied starting from the first unit of fuel consumed and thus of CO_2 emissions. The aim of this experimental condition is to see if an economic sanction increases or not the use of the least emitter modes of transportation when compared with previous Condition 3 (injunctive norm).

In the sixth condition, a first kind of "social normalization" was tested with a bonus-malus scheme. In this scheme a malus increasing the initial price applies when the CO_2 emissions exceed a given threshold and a bonus decreasing the initial price applies when the emissions are under this threshold (an example is given in the appendix).

The last economic instrument, in the seventh condition, is that of quotas (or carbon allowances) allocated to each individual and corresponding to an authorization to emit CO_2. Following her travel choices, the individual account is debited from the allowances in proportion of emissions of the travel mode chosen. If the account balance is in the red the individual must buy allowances as needed, but if it is in credit she may sell her allowances unused. This experimental condition is similar to the bonus-malus one since it combines an economic sanction with a social norm effect. The only difference is in the framing of the policy.

The seven experimental conditions were conducted via an Internet panel on seven different samples, totaling 900 participants in eight French urban areas (Paris, Lyon, Marseille, Toulouse, Lille, Bordeaux, Nice, Nantes). These eight areas were selected as they host an airport connected to the world airline network. Each of the seven samples was representative of the French population according to the quota method (gender x age, job status household, urban area) with individuals aged from 25 to 70.

The experimental design is described in Table 1.

Table 1: Description of the experimental design

Experimental conditions	Description	When	N	N included in analysis
1 (control)	Price and duration combination	June 2013	300	293
2	Price and duration combination + CO_2 emissions information	December 2013	100	100
3	Price and duration combination + CO_2 emissions information + injunctive norm	December 2013	100	96
4	Price and duration combination + CO_2 emissions information + injunctive norm+ descriptive norm	December 2013	100	99
5	Price and duration combination + CO_2 emissions information + injunctive norm + tax	June 2014	100	99
6	Price and duration combination + CO_2 emissions information + injunctive norm + bonus/malus	June 2014	100	99
7	Price and duration combination + CO_2 emissions information + injunctive norm + quotas	June 2014	100	99

2.2 Stated choices design

Stated choice experiments involve various design issues which are linked, including the sample size, the number of choice situations submitted to the respondent, and the number of attributes and levels including their ranges. We follow on this the methodology indicated by Rose and Bliemer (2005, 2013) as summed up below.

We draw on the fact that orthogonal fractional designs allow submitting only a subset of choice situations to the respondent and hence reducing her cognitive burden. However orthogonal designs are suited to linear regression models but not to discrete choice models, which are at stake here. This is why "efficient designs" are looked for here. They aim at generating model parameters with standard errors that are as small as possible. The building of such a design involves determining the asymptotic variance-covariance matrix of parameters based on the underlying experiment and model and some prior information on parameters. The measures of efficiency are based on the roots of the diagonal of the matrix (asymptotic standard errors). These designs allow reducing both the number of choices presented to the individual and the sample size. The efficiency is also increased when the less attribute levels and the wider the level range. The NGENE software (http://www.choice-metrics.com/) has been used to generate the designs.

Regarding the levels of duration and price attributes a compromise was made between presenting realistic values and the need for a large range of levels. An informal survey of travel prices proposed by travel agencies on the Internet helped to design four levels for the price of a round trip for two people, that is 400, 500, 600 and 700 Euros, applicable to the four modes. Regarding one-way trip duration different levels were applied depending on the mode: air: 3h (direct flight), 5h, 10h (with connections); car and coach: 10h, 17h; train: 5h (high speed train), 10h, 17h.

The first experimental condition was conducted on an orthogonal design in order to find prior values for the duration and price parameters to be used in subsequent experimental conditions. An orthogonal design with 36 choice situations was found and an orthogonal blocking of 6 choice situations to be presented to the respondent was set up in order to reduce the burden. The sample size was 300 individuals in order to get accurate priors.

The prior values obtained in the first experimental condition were input in the following experimental conditions. Experiments 2, 3 and 4 involved adding only one framing effect each time (respectively, CO_2 information, injunctive norm and descriptive norm).

The three next experimental conditions involved another framing effect each time (tax, bonus-malus, quota) with quantitative attributes depending on the scheme. In the carbon tax scheme the tax levels was given three values 3, 5 and 10 Euro-cents per kg of CO_2. This corresponds to respectively 30, 50 and 100 Euros per ton of CO_2. 30 and 100 Euros are values advocated by economists respectively for present time and for 2030 in order to give the right economic signal for optimal CO_2 reductions. These three same levels are used in the bonus-malus scheme (level of bonus-malus per kg of CO_2) and the quota scheme (unit price of kg of CO_2 to be bought or sold). Moreover, in the bonus-malus and quota schemes an additional attribute was respectively the threshold and the amount of quotas available which was given three levels: 50, 300 or 500 kg of CO_2. Overall the design of the experimental conditions involved four attributes (travel, duration, price, tax) in the tax scheme and five attributes (adding the threshold) in the bonus-malus and quota schemes.

$U_{nj} = V_{nj} + \varepsilon_{nj} \; \forall j$

Finally, S-efficient designs were elaborated for each of the six experimental conditions following the first one, with a sample size of N=100 individuals in each condition, each individual being submitted to 6 choice situations.

2.3 Model design

Two kinds of discrete choice models are best candidates: multinomial logit model (MNL) or nested logit model (NL). We therefore study a choice including an option that is renouncing to the trip. According to Dhar (1997), this option can be selected if no other alternative is attractive for the respondent or if he or she does not know the range of choice, continues to seek the best option, and then eventually choose this option. These observations show that choosing the no choice option may have different determinants than other options and can therefore not been considered as any choice, potentially leading to a questioning of the IIA assumption. Haaijer et al. (2001) discuss many modelling methods and show that MNL (including a no-choice dummy variable or not) and NL allow taking this option into account.

We thus seek to estimate the modal choice where the individual *i* compares the different levels of utility associated with different travel alternatives and chooses the one that maximizes his utility. For individual *i*, the utility of the alternative *j* is:

$$U_{ij} = f(\beta X_{ij}) + \varepsilon_{ij}$$

Where β is a vector of unknown parameters, X_{ij} is a vector of determinants and ε_{ij} a random error term identically and independently extreme value distributed. The vector of determinants X_{ij} includes the price and travel duration for each alternative, the different framing effects that are tested and when relevant the amount of the tax (or the subsidy).

3 RESULTS

Among the initial 900 respondents who participated in one of the seven experimental conditions, 15 persons chose systematically the no-travel option, which represents only 1.67% of the sample. This is an indication of the quality of the experimental design and we removed these respondents from the analysis.

Firstly, we estimate a model on the control condition to take into account only the trade-off between travel price and travel time. In a second step, we include the different effects described in the previous section in order to compare their effectiveness on encouraging pro-environmental behaviour in modal choices.

As mentioned earlier, there are many possibilities to model a set of choices including a "no-choice" option when it is offered to the respondent (here renouncing travel). We estimate a multinomial logit model (MNL) and a nested logit model (NL) taking into account the "no-choice" as the reference variable. The nested model is a tree with two levels: the higher level is a partition between choosing to travel or renouncing travel and the lower level is, when choosing to travel, a partition between the four travel modes.

Table 2 shows the results of both estimations (N = 293 x 6 = 1758 choice situations). The NL model fits a little bit better than the MNL regarding ρ^2 McFadden and Estrella indicators. The first one has been defined by McFadden (1973) but is not equivalent to the coefficient of determination R^2 insofar as it lacks some properties and remains low. Estrella (1998) therefore proposed another indicator with the statistical properties of R^2.

In the case of the nested logit model, λ_1 and λ_2 parameters measure the correlation within each nest. λ_1=1 because there is only one branch. λ_2 is positive but not significantly different from 1 showing that the NL model reduces to a standard MNL.

Table 2: Estimation results Condition 1 (control)

Model	**MNL**	**NL**
Variables		
Air constant	6.9581*** (0.2639)	8.1373*** (1.0004)
Car constant	5.8668*** (0.3380)	7.0150*** (1.0072)
Coach constant	4.4862*** (0.6489)	5.5767*** (1.1280)
Train constant	7.0324*** (0.2739)	8.1863*** (0.9901)
Price	-0.0059*** (0.0004)	-0.0061*** (0.0004)
Air duration	-0.2435*** (0.0192)	-0.2514*** (0.0201)
Car duration	-0.1400*** (0.0219)	-0.1422*** (0.0222)
Coach duration	-0.1781*** (0.0538)	-0.1764*** (0.0539)
Train duration	-0.2631*** (0.0175)	-0.2664*** (0.0178)
λ1		1
λ2		0.7122*** (0.1717)
N	1758	1758
Log-likelihood	-1724	-1722
ρ^2 McFadden	0.3908	0.3913
Estrella indicator	0.7937	0.7942
Values of time		
Air	41 €	41 €
Car	24 €	23 €
Coach	30 €	29 €
Train	45 €	44 €

The "renouncing travel" alternative is the reference
Standard deviation in parenthesis
****: significant at 1%; **: significant at 5%; *: significant at 10%*

The transport modes constants are significant and positive which means that people prefer travelling over renouncing travel. The price and duration coefficients are significant and, as expected, negative: the larger the price or the duration the lower is the probability of travelling. Various specifications regarding the generic or specific character of these coefficients have been tested and the best specification is when the price coefficient is generic and duration coefficient is mode specific (i.e. the duration of travel is valued differently according to travel mode, as expected). This allows computation of values of travel time differentiated according to travel modes.

We therefore found a value of travel time of 23€ per hour for the car, 29-30€ for the coach, 41€ for the air and 44-45€ for the train. These values are a little higher than empirical revealed preferences values for leisure travel reported in the literature for car, coach and train but in line with those for air travel (Shires and de Jong, 2006; Wardman, 2011). However, this is not an issue since our purpose is not to provide accurate measures of value of time but rather to see, within our experimental context, how these values are altered when introducing various framing effects.

The estimated coefficients of the MNL and NL models are quite similar, those of the NL model being overall a little higher, and the resulting values of travel time are very close between the two models. The MNL structure is a good candidate for our estimation.

The "renouncing travel" alternative is chosen by very few respondents across all experimental conditions: from 3% to 8% of all responses (choice situations) according to the seven experimental conditions. This is why we exclude them in the following analyses. We then concentrate on the framing effects on travel mode choices for those having effectively chosen to travel. Therefore in the following MNL models of the choice among the four travel modes are estimated. The coach alternative is set as the reference because it is the less chosen and the less CO_2 emitting travel mode.

We first pool all the experimental conditions in one sample (N=5010) in order to give an overall estimate of the various framing effects (cf. Table 3). The travel mode constants are significant and positive meaning that people prefer travelling by air, train or then car rather than coach. The price and duration coefficients are significant and negative as expected. All the framing effects are significant and negative: they decrease the probability of using air, car and train when compared to coach.

Table 3: Estimation results: Conditions 1 to 7

Variables	**Coefficients**
Air constant	2.1475*** (0.2806)
Car constant	1.6075*** (0.3141)
Train constant	2.0954*** (0.2868)
Price	-0.0052*** (0.0002)
Air duration	-0.2103*** (0.0112)
Car duration	-0.1640*** (0.0123)
Coach duration	-0.1844*** (0.0201)
Train duration	-0.2224*** (0.0085)
Air-CO2	-1.4720*** (0.2086)
Car-CO2	-1.6591*** (0.2471)
Train-CO2	-0.7244*** (0.2199)
Air- CO2+ IN	-1.6922*** (0.2096)
Car- CO2+IN	-1.2077*** (0.2328)
Train- CO2+IN	-0.8163*** (0.2200)
Air- CO2+ IN +DN	-1.0749*** (0.2157)
Car- CO2+ IN +DN	-1.0618*** (0.2453)
Train- CO2+ IN +DN	-0.4218* (0.2278)
Air- CO2+ IN +Tax	-1.2101*** (0.2398)
Car- CO2+ IN +Tax	-0.7487*** (0.2567)
Train-CO2+IN+Tax	-0.7524*** (0.2491)
Air- CO2+ IN +BM	-1.4853*** (0.2364)
Car- CO2+ IN +BM	-0.8005*** (0.2566)
Train- CO2+ IN +BM	-0.6117*** (0.2468)
Air- CO2+ IN +Quota	-1.9396*** (0.2250)
Car- CO2+ IN +Quota	-0.8576*** (0.2414)
Train- CO2+ IN +Quota	-0.9780*** (0.2352)
N	5010
Log-likelihood	-4963
ρ^2 McFadden	0.2854
Estrella indicator	0.6003

The coach alternative is the reference
IN: Injunctive norm, DN: Descriptive norm, BM: Bonus/Malus
Standard deviation in parenthesis
****: significant at 1%; **: significant at 5%; *: significant at 10%*

Figure 1 shows the variation of these effects according to the travel modes. Overall these effects are stronger on air than on car and then train. Providing CO_2 information on mode emissions is much highly effective for reducing the preference for air and car when compared to train. This effect is reinforced by the injunctive norm in the case of air and train but not in the case of car. Adding the descriptive norm decreases the cumulated effect of CO_2 information and injunctive norm in reducing the preference for the three modes. Adding one of the fiscal incentives (tax, bonus-malus or quota) to the combination of CO_2 information and injunctive norm generally decreases the previous effects. However, bonus-malus and then quota schemes appear to have a stronger effect than a tax scheme. Moreover, the effect of the quota scheme is stronger than the effect of the sole injunctive norm in reducing the preferences for the air or train.

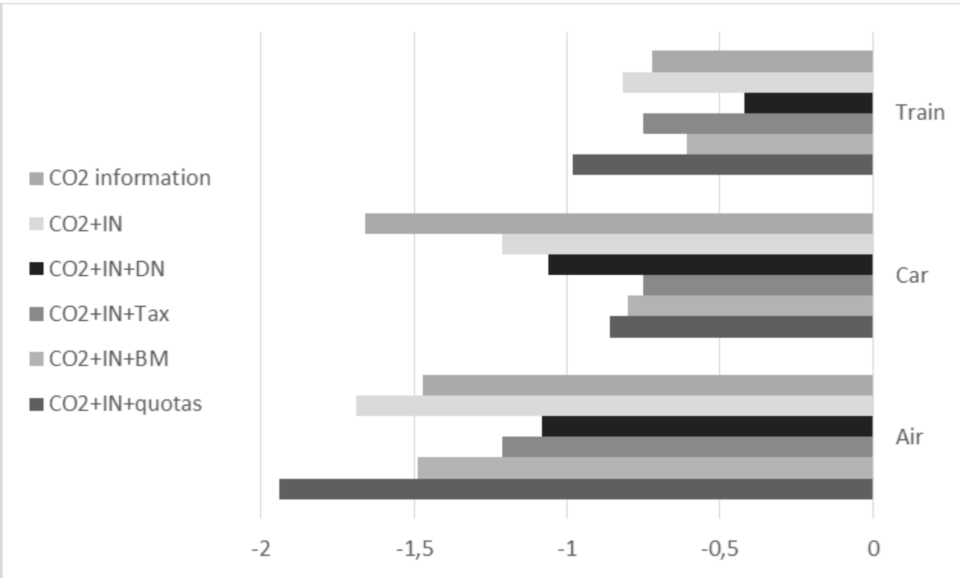

Figure 1: Comparison of framing effects according to travel modes

However, for the three last conditions the price effect has been considered as a whole, aggregating the initial (baseline) price and the tax amount, either positive in the case of the carbon tax, a malus or quotas to be bought when exceeding some emissions threshold, or negative in the case of a bonus or quotas available to be sold when under the threshold. In the following analyses the tax amount is set apart from the baseline price and separated into two distinct variables when relevant, one regarding the positive tax, the other the subsidy ("negative" tax).

The estimation of the carbon tax effect is presented in Table 4 selecting the samples of conditions 1, 2, 3 and 5 (tax).

Table 4: Estimation results: effect of carbon tax (Conditions 1, 2, 3, 5)

Variables	Including tax framing effect	Excluding tax framing effect
Air constant	2.6309*** (0.3543)	2.6614*** (0.3475)
Car constant	2.0877*** (0.3962)	2.1523*** (0.3894)
Train constant	2.6265*** (0.3586)	2.6857*** (0.3505)
Baseline price	-0.0055*** (0.0002)	-0.0055*** (0.0002)
Amount of carbon tax	-0.0014 (0.0062)	-0.0187*** (0.0031)
Air duration	-0.2302*** (0.0139)	-0.2293*** (0.0139)
Car duration	-0.1748*** (0.0155)	-0.1729*** (0.0154)
Coach duration	-0.1548*** (0.0264)	-0.1329*** (0.0251)
Train duration	-0.2429*** (0.0110)	-0.2440*** (0.0109)
Air-CO_2	-1.4519*** (0.2092)	-1.2417*** (0.1891)
Car-CO_2	-1.6304*** (0.2480)	-1.4769*** (0.2271)
Train-CO_2	-0.6648*** (0.2221)	-0.4671** (0.1983)
Air- CO_{2+}IN	-1.6737*** (0.2101)	-1.4626*** (0.1900)
Car- CO_{2+}IN	-1.1739*** (0.2338)	-1.0200*** (0.2113)
Train- CO_{2+}IN	-0.7549*** (0.2222)	-0.5565*** (0.1984)
Air- CO_{2+}IN+Tax	-1.3077*** (0.3358)	
Car- CO_{2+}IN+Tax	-0.7860*** (0.2849)	
Train-CO_{2+}IN+Tax	-0.6883*** (0.2552)	
N	3313	3313
Log-likelihood	-3166	-3174
ρ^2 McFadden	0.3106	0.3088
Estrella indicator	0.6378	0.6362

The coach alternative is the reference
IN: Injunctive norm
Standard deviation in parenthesis
****: significant at 1%; **: significant at 5%; *: significant at 10%*

Table 5 shows the estimations for bonus/malus and quotas effects selecting the samples of respectively conditions 1, 2, 3 and 6 (bonus-malus), and conditions 1, 2, 3 and 7 (quotas). In each of these three cases, when looking at the second column of the tables, the amount of financial (dis)incentive whether a tax or a subsidy is not significant (unlike the baseline price) whereas the coefficients of the framing effects are. This result is confirmed when looking at the third column where the framing effects at stake are not included in the specification and the amount of tax then becomes significant. This means that only the framing of respectively carbon tax, bonus-malus and quotas has an effect while the tax (or subsidy) amount itself has no effect on the probability of using travel modes.

Table 5: Estimation results: effect of bonus/malus and quotas

Bonus-malus scheme. Conditions 1, 2, 3, 6		
Variables	Including framing effect	Excluding framing effect
Air constant	2. 2845 *** (0.3591)	2.1162*** (0.3540)
Car constant	1.5773*** (0.4006)	1.4658*** (0.3970)
Train constant	2.2869*** (0.3664)	2.1454*** (0.3604)
Baseline price	-0.0054*** (0.0002)	-0.0054*** (0.0002)
Bonus	0.0037 (0.0106)	0.0256*** (0.0088)
Malus	-0.0073 (0.0073)	-0.0304*** (0.0046)
Air duration	-0.2392*** (0.0140)	-0.2367*** (0.0139)
Car duration	-0.1659*** (0.0156)	-0.1642*** (0.0154)
Coach duration	-0.1897*** (0.0277)	-0.1816*** (0.0271)
Train duration	-0.2504*** (0.0112)	-0.2487*** (0.0112)
Air-CO_2	-1.4239*** (0.2100)	-1.1917*** (0.1898)
Car-CO_2	-1.6037*** (0.2483)	-1.4309*** (0.2280)
Train-CO_2	-0.6262*** (0.2230)	-0.4240** (0.1999)
Air- CO_{2+}IN	-1.6500*** (0.2110)	-1.4170*** (0.1908)
Car- CO_{2+}IN	-1.1546*** (0.2341)	-0.9827*** (0.2124)
Train- CO_{2+}IN	-0.7197*** (0.2232)	-0.5173*** (0.2000)
Air- CO_{2+}IN+Bonus/Malus	-1.5059*** (0.3311)	
Car- CO_{2+}IN+ Bonus/Malus	-0.8408*** (0.2858)	
Train-CO_{2+}IN+ Bonus/Malus	-0.6427*** (0.2517)	
N	3332	3332
Log-likelihood	-3086	-3097
ρ^2 McFadden	0.3318	0.3295
Estrella indicator	0.6675	0.6652
Quota scheme. Conditions 1, 2, 3, 7		
Variables		
Air constant	2.2274*** (0.3481)	1.9337*** (0.3392)
Car constant	1.3187*** (0.3877)	1.1279*** (0.3816)
Train constant	2.1218*** (0.3548)	1.8505*** (0.3451)
Baseline price	-0.0051*** (0.0002)	-0.0051*** (0.0002)
Quotas to sell	0.0095 (0.0105)	0.0337*** (0.0088)
Quotas to buy	-0.0008 (0.0075)	-0.0319*** (0.0047)
Air duration	-0.2306*** (0.0139)	-0.2243*** (0.0138)
Car duration	-0.1441*** (0.0152)	-0.1374*** (0.0149)
Coach duration	-0.1878*** (0.0265)	-0.1785*** (0.0259)
Train duration	-0.2307*** (0.0109)	-0.2285*** (0.0108)
Air-CO_2	-1.4547*** (0.2093)	-1.1104*** (0.1855)
Car-CO_2	-1.6459*** (0.2468)	-1.4509*** (0.2232)
Train-CO_2	-0.6961*** (0.2213)	-0.3597** (0.1947)
Air- CO_{2+}IN	-1.6809*** (0.2103)	-1.3357*** (0.1865)
Car- CO_{2+}IN	-1.2066*** (0.2326)	-1.0137*** (0.2073)
Train- CO_{2+}IN	-0.7925*** (0.2214)	-0.4572*** (0.1948)
Air- CO_{2+}IN+Quotas	-2.0526*** (0.3264)	
Car- CO_{2+}IN+ Quotas	-0.8809*** (0.2712)	
Train-CO_{2+}IN+ Quotas	-0.9630*** (0.2384)	
N	3305	3305
Log-likelihood	-3155	-3180
ρ^2 McFadden	0.3114	0.3058
Estrella indicator	0.6386	0.6315

*The coach alternative is the reference. ***: significant at 1%; **: significant at 5%; *: significant at 10%*

4 DISCUSSION AND CONCLUSION

The potential of psychological incentives in motivating environmentally responsible behavior in a context of long distance leisure travel has been explored thanks to a series of controlled experimental conditions testing various framing effects: information on CO_2 emissions, injunctive and descriptive norms, in combination or not with a carbon tax, a bonus-malus or a carbon trading (quotas) scheme. The seven experimental conditions were conducted via an Internet panel, totaling 900 participants in the eight main French urban areas.

The experimental setting shows a good consistency since travel price and duration have the expected effects on travel choice and mode choice. The values of travel time inferred from the stated behavior of respondents are broadly in line with empirical revealed values detailed in the literature.

When it comes to the various framing effects tested, they all have a significant effect of reducing the intention to choose the most emitting modes. The first striking result is that providing CO_2 information on mode emissions is highly effective in reducing the preferences for the most emitting modes (train, air and car). The injunctive norm reinforces this effect in the case of air and train.

The second striking result is that adding a descriptive norm or fiscal framing like carbon tax or bonus-malus schemes looks overall counterproductive since the cumulated effect decreases when compared with the only CO_2 information + injunctive norm.

However, bonus-malus and even more quota schemes appear to have a higher effect than the tax scheme. Moreover, for the air and train modes the effect of the quota scheme is higher than the effect of the sole CO_2 information + injunctive norm.

The third striking result appears in the case of financial incentives schemes. The amount of the economic sanction (tax, malus or quota to buy) or reward (bonus or quota to sell) has no effect on the probability of choosing the various travel modes. Only the presence of the framing effect, through the presentation of the fiscal incentive scheme, would have an effect. This is quite surprising from an economic point of view. However, the range of tax tested in the experimental conditions could have been too limited to give evidence of its effect. This potential limit might also explain why a “crowding out” effect could not be evidenced like in Hilton et al (2014). A research perspective is to explore further this issue.

There are some policy implications of such results. First they confirm and reinforce the case for using psychologically positive framing effects in promoting effective pro-environmental behavior in transport choices. Providing basic CO_2 emissions information on each travel alternative is likely to yield actual behavior changes. Normative messages through benchmarking (bonus-malus) or carbon budgeting (quotas) may reinforce the incentive especially for larger emitting modes. The amount of the financial (dis)incentive in itself might not matter regarding the effect on behavior change.

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APPENDIX

Information displayed in the sixth experimental condition (bonus/malus)

CO_2 is a greenhouse gas emitted during the transport by the vehicle used (air, car, coach or train).
The high level of greenhouse gas emissions in the atmosphere (such as CO_2) can cause dangerous climate change for the planet. Climatologists are already seeing many consequences such as melting glaciers or ice field. According to scientists, to limit these effects it is necessary that all humans reduce their emissions by half.
To reduce these emissions, a bonus/malus is set up to reward those who pollute less (bonus) and penalize those who pollute more (malus), compared to a threshold set for each return trip. The bonus/malus is calculated on the basis of the quantity of CO_2 emitted beyond the threshold.

You travel with another person to a destination of your choice, located 1,000 km from home.

Here is a first transport situation that is offered to you:

	Air	**Coach**	**Car***	**Train**
Duration (one way) **	10h	17h	17h	10h
Price (return for two persons)	600 €	600 €	400 €	400 €
CO_2 emitted (return for two persons)	720 kg	124 kg	408 kg	180 kg
Threshold level (kg of CO_2)	150 kg	150 kg	150 kg	150 kg
Unit amount bonus/malus per kg of CO_2	0.05 €	0.05 €	0.05 €	0.05 €
Total bonus (price increase) or malus (price decrease)	29 €	-1 €	13 €	2 €
Total price (including bonus/malus)	629 €	599 €	413 €	402 €

* For the car, the price takes into account the fuel and road tolls
** For air, coach or train, travel time includes the waiting time during connections

Based on these informations, and not taking account of your previous answers, what means of transportation do you choose? You also have the choice of renouncing travel.

- Air
- Coach
- Car
- Train
- Renounce travel