Exploring the public's willingness to reduce air pollution and greenhouse gas emissions from private road transport in Catalonia.

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Abstract

Internalizing environmental externalities is a market-driven approach to correcting people's private costs and benefits. One way of quantifying these externalities is estimating the willingness to pay (WTP) of people to reduce them. To better understand the determinants of this WTP, we use the Theory of Planned Behavior (TPB), which is a commonly used approach for predicting behavioral intentions. Our study focuses on air pollution and greenhouse gas (GHG) emissions from private road transport. We gathered survey data from 406 residents of Catalonia to explore the relationships among the psychological factors determining willingness to pay to quantify the mentioned externalities. We expanded the TPB by adding as antecedent Environmental Concern (EC) prior to the theory's three main factors (Attitude, Subjective Norms and Perceived Behavioral Control). Next, we used Structural Equation Modeling (SEM) to calculate an estimate of these externalities. The results of our study show that environmental concern is positively related to the three main factors of TPB. Our model accounts for most of the variation of WTP (R-squared is 94.7%). Our results also reveal that a majority of the respondents in Catalonia are willing to pay to reduce air pollution and GHG emissions from private road transport.

Keywords: Theory of Planned Behavior, Willingness to pay, Air pollution, GHG emissions, Structural Equation Model

1. Introduction

Among all transport externalities, especially those from road transport, greenhouse gases (GHG) and air pollution are the most challenging externalities to deal with (van Essen et al., 2011). Transport emissions are projected to double between 2010 and 2050 (OECD, 2012). In 2010, all modes of transport produced 24.3% of total greenhouse gases emissions (GHG) of EU-27. Road transport accounts for 72.1% of these emissions (European Commission, 2013a). From the society point of view,

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these externalities are costs that are not taken into account by transport users. Having an estimate of these costs facilitates the planning and implementation of corrective policies (e.g. "polluter pays" policy) (Layton and Brown, 2000; van Essen et al., 2012). These externalities are estimated as representing 40% of total external costs of transport in EU-27, which was around 641€/inhabitant—excluding congestion—in 2008 (van Essen et al., 2011). Many studies endeavor to quantify the environmental external costs of transport; some cover all negative externalities of transport (e.g. Kumar Sen et al., 2010) and others try to quantify specific external costs related to transport such as accident (Martin, 2005), noise (Arsenio et al., 2006), climate change (Lemp and Kockelman, 2008) air pollution and GHG emissions (Creutzig and He, 2009; Desaigues et al., 2011; Guo et al., 2010). These studies use various methods and conceptual frameworks to quantify externalities.

To design tools and implement plans to mitigate negative externalities, behavioral and technological changes are required. The cost of these changes should be estimated in order to assess the difficulty of implementing a corrective policy in terms of social acceptance of the policy, cost of technological change implied by the policy, and the like. For example, initially the public may approve a mitigation policy, but it is necessary to evaluate the degree of support for this policy as it will imply concrete changes that the public may not have been aware of (Bamberg et al., 2011; Layton and Brown, 2000). To address this, different surveying techniques can assess the public benefits of clean air and a stable climate. Nevertheless, the stated preferences methods approach is the only technique capable of estimating total economic value of these benefits in monetary terms (Bateman et al., 2004).

In the case of evaluating individual preferences and estimating the price of non-marketed goods such as air quality, one of the most popular, practical and recommended tools is the willingness-to-pay (WTP) approach (Bateman et al., 2002; Maibach et al., 2008; U.S. Environmental Protection Agency, 2011). Eliciting WTP from hypothetical situations can be done by any of several varieties of the Contingent Valuation (CV) methods (Bateman et al., 2004). Contingent Valuation, as a stated preference method, is a survey-based economic valuation approach that makes it possible to estimate the total economic value of a public good with no previous market value (Mitchell and Carson, 1989). It has been widely used by researchers to determine values of various environmental amenities and environmental damage, nature conservation and restoration, reduction of health risk and improvement of health indices, as well as public policy, cultural goods and other fields of study (Baranzini et al., 2010; Longo et al., 2012; Santagata and Signorello, 2000; Spash et al., 2009; Wang and Mullahy, 2006; Wang et al., 2015).

On the one hand, there is a growing interest in understanding public perceptions about air pollution and GHG emissions and how these perceptions influence the public's behavior regarding the environment (Dunlap et al., 2000). Some studies have focused on age, education, gender, income and marital status as socio-economic factors to analyze the essence of behavior towards the environment (Olofsson and Ohman, 2006; Torgler and García-Valiñas, 2007). Due to the limited power of previous studies to explain the variance of environmental behavior, researchers have recently shifted their

attention to other psychosocial constructs such as values, beliefs and attitudes. These variables seem to have been useful factors for predicting pro-environmental behavior (Hoyos et al., 2009; Oskamp, 1995; Sauer and Fischer, 2010; Spash et al., 2009; Steg and de Groot, 2010; Vlek, 2000).

On the other hand, based on the findings in social psychology, attitude is the most commonly used predictor of economic value of a good (Ajzen and Peterson, 1988). WTP as an environmental attitude can be evaluated by using psychological concepts of behavioral theories (Ajzen, 1991; Ajzen and Madden, 1986; Gifford et al., 2011; Pouta and Rekola, 2001). In other words, analysis of psychological factors is needed to understand the behavioral intentions of individuals, such as their intention to pay or stated WTP (e.g. Ajzen et al., 1996; Spash et al., 2009). There are plenty of studies that have analyzed intentions and attitudes by estimating people's WTP for using and conserving environmental goods (Hoyos et al., 2009; López-Mosquera et al., 2014) or reducing negative environmental impacts (Lera-lópez et al., 2013; Pouta and Rekola, 2001), as well as many studies on WTP estimation for air pollution and GHG emissions reduction. Some studies consider public and households' WTP for CO_2 emission reductions and mitigation (Adaman et al., 2011; Yang et al., 2014) or try to estimate households' WTP for improving air quality (Carlsson and Johansson-Stenman, 2000) and for reducing CO_2 emissions among different countries (Carlsson et al., 2012). Still other studies focus on air travelers' WTP for CO_2 mitigation (Brouwer et al., 2008) or their voluntary carbon offsets in an aviation context (MacKerron et al., 2009); and one discusses car buyers' consideration of a car's CO_2 emission performance in making car choices (Achtnicht, 2011).

In our study we use the Theory of Planned Behavior (TPB), one of the most commonly used approaches in the area of predicting behavioral intentions to estimate the value of non-marketed goods (e.g. Armitage and Conner, 2001; Bamberg et al., 2003; Bamberg and Schmidt, 2001; Collins and Carey, 2007; Fielding et al., 2008; Oreg and Katz-Gerro, 2006).

This paper aims to contribute to existing knowledge in the environmental economics literature by investigating how people feel and think about pollution reduction and how these factors can explain their intentions to engage in pro-environmental behavior. For this purpose, by using an extended model of TPB integrating environmental concern, we attempt to distinguish more clearly the psychosocial factors that play a role in determining individuals' WTP to reduce environmental externalities from private road transport.

In our study, we try to value air pollution and GHG emissions related to private car use according to the assessment of people in Catalonia (Spain). This study, in comparison with previous studies, has two elements which differentiate it from them. The first one refers to the model which is used. We extended the TPB model by adding environmental concern prior to the factors of the original model. The second one, is that we use this extended model to examine the intention to pay to reduce air pollution and GHG emissions in case of private road transport. Extended versions of TPB have been used in the literature to explain different types of pro-environmental intentions, such as willingness to pay for abatement of forest regeneration (Pouta and Rekola, 2001), willingness to reduce personal car use (Nordlund and

Garvill, 2003), willingness to pay for improving biodiversity (Spash et al., 2009) or for conserving a suburban park (López-Mosquera and Sánchez, 2012). However, to our knowledge there have been no studies that use the proposed extended model of TPB to examine WTP to reduce air pollution and GHG emissions in case of private road transport.

The paper is organized as follows. In the following sub-sections we lay out our theoretical framework, research hypotheses and theoretical model. In Section 2, the study methodology is presented. The results of analytical model are examined in Section 3. Section 4 contains the discussion and Section 5 summarizes the main conclusions.

1.1. Theoretical framework and research hypotheses

The Theory of Planned Behavior (TPB) assumes that attitudes, subjective norms and perceived behavioral control help us to better understand environment-related behaviors, such as "the behavior of paying money for a good" (Ajzen, 1991; Ajzen et al., 1996; Kaiser et al., 2005). Attitude refers to individuals' positive or negative evaluation of performing a behavior. Subjective norms represent the social pressure from the members of a reference group to act out a given behavior. Perceived behavioral control concerns the perceived ease or difficulty of performing a behavior. The majority of the studies using TPB have revealed that the individual's intention to engage in the behavior under investigation should be enhanced by a positive attitude, stronger subjective norms and higher perceived behavioral control (Ajzen, 1991; Liebe et al., 2011). Using this theory combined with the Contingent Valuation (CV) method from the stated preferences approach, we estimate the monetary value of the externalities. The Contingent Valuation (CV) method is a survey-based and direct value elicitation method that is commonly applied in hypothetical situations (Mitchell and Carson, 1989). Several CV studies use TPB as their theoretical underpinning (Ajzen et al., 1996; Liebe et al., 2011; Meyerhoff, 2006; Pouta and Rekola, 2001).

Many studies try to address CO_2 emissions and climate change effects from different transport modes (see MacKerron et al., 2009), but few use the WTP approach and the original and extended TPB model (to consider the role of behavioral motives) to analyze the public's intention to reduce air pollution and GHG emissions from transport. Abrahamse et al. (2009) studied the intention to reduce car use and its related emissions. Others have considered consumer purchase intentions towards environmentally friendly and less polluting vehicles (Afroz et al., 2015; Nayum et al., 2013). Some have sought to identify the motives behind the choice of travel mode (Bamberg et al., 2003; Donald et al., 2014) or behind the decision to use public transport (Bamberg et al., 2007; Heath and Gifford, 2002). Van Birgelen et al. (2011) considered TPB to estimate willingness to compensate CO_2 emissions of air travel. Our study uses an approach similar to that of Van Birgelen et al. (2011) but we apply it to private road transport.

1.2. The basic model of TPB

According to previous studies on TPB, we expect greater intention to pay to reduce pollution and GHG emissions from individuals who (1) have a positive evaluation of the proposed payment (attitude), (2) feel the support from family and friends to do this payment (subjective norms), and (3) rely on their own strength to perform this payment (perceived behavioral control). This intention to pay (where the amount of the payment is not mentioned to the respondents) should lead to higher stated WTP (where the amount of the payment is mentioned to the respondents) and, finally, higher payment (behavior) (see Fig. 1). To better document the relationship between behavioral motivation and WTP to reduce air pollution and GHG emissions from private road transport, this study makes the following hypotheses:

H1: There is a significant and positive relation between a person's intention to pay and his/her stated willingness to pay to reduce air pollution and GHG emissions.

H2: Attitude toward payment to reduce air pollution and GHG emissions will positively predict a person's intention to pay for these reductions.

H3: Subjective norms toward payment to reduce air pollution and GHG emissions will be positively related to a person's intention to pay for these reductions.

H4: Perceived behavioral control toward payment to reduce air pollution and GHG emissions will positively predict a person's intention to pay for these reductions.

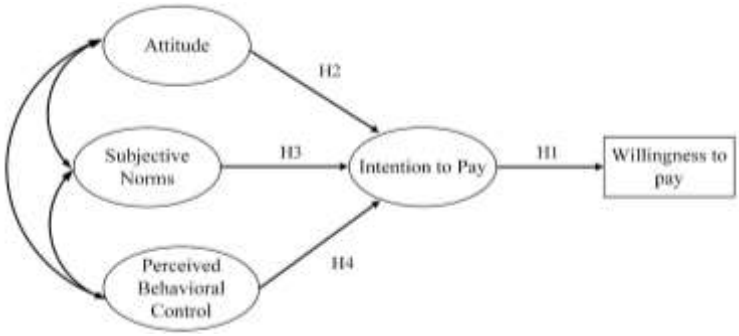

Fig. 1. Initial model based on the original components of TPB to explain WTP.

Note: Circles denote latent constructs; squares denote observed variables.

1.3. The extended model of TPB

The TPB has received many criticisms because it neglected complementary variables and left a considerable unexplained percentage of variance of the analyzed behavior (Ajzen, 1991; Han and Hansen, 2012; Kaiser, 2006). For this reason, and in order to enhance the original TPB's explanatory power, various authors have tried to propose an extended model of TPB by adding new variables (Bamberg et al., 2007; Han and Hansen, 2012; Heath and Gifford, 2002; Kaiser, 2006; Peters et al., 2011). Among these variables, a number of studies have emphasized the role of environmental concern in predicting pro-environmental attitude, intentions and behavior (Bamberg, 2003; Chen and Tung, 2014; Donald et al., 2014; Groot et al., 2007; Hansla et al., 2008; Hartmann and Apaolaza-Ibáñez,

2012). In our study, we will also introduce this variable in the model. Therefore, we propose environmental concern as the antecedent of the variables of the TPB model and formulate the following hypotheses:

H5: There is a significant and positive relation between individuals' environmental concern and attitude toward paying to reduce air pollution and GHG emissions.

H6: There is a significant and positive relationship between individuals' environmental concern and subjective norms toward paying to reduce air pollution and GHG emissions.

H7: The relationship between a person's environmental concern and his/her perceived behavioral control toward paying to reduce air pollution and GHG emissions is significant and positive.

Fig. 2 shows the extended TPB model with regard to WTP.

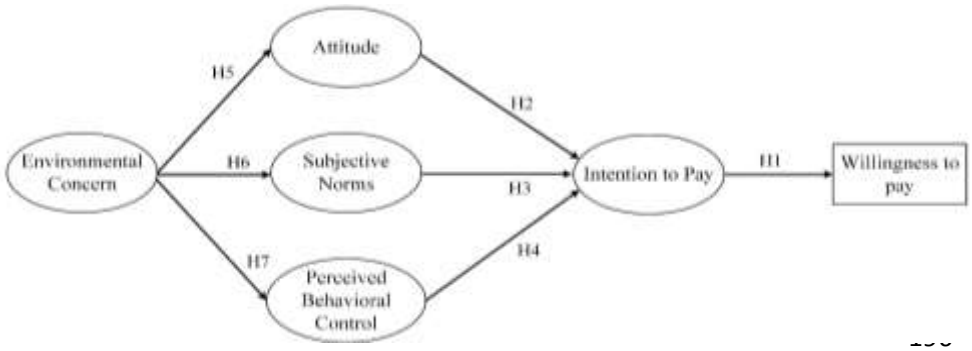

Fig. 2. Extended model of the TPB to explain WTP.

Note: Circles denote latent constructs; squares denote observed variables.

2. Methodology

2.1. Sampling area

Catalonia is ranked as the 2nd autonomous community in Spain with the most vehicles: around 16% of the country's vehicles are circulating in Catalonia. At the end of 2016, there were 5,093,500 vehicles; of these, 3,436,271 were private road vehicles. Catalonia comprised 2,949,700 households and its population was 7,448,332 inhabitants (almost 16% of Spain's population). This means that, on average, each household had more than one private vehicle (IDESCAT, 2016; INE, 2016). Transport is responsible for more than 34% of CO_2 emissions and more than 50% of main air pollutants in Catalonia (Generalitat de Catalunya, 2010; Marti Valls et al., 2010; Parra Narváez, 2004).

2.2. Procedure and measures

Data were collected through an online survey in May and June 2015 in Catalonia. Questionnaires were sent to a sample of Catalan residents. We received 525 answers, of which 406 were valid. Quota sampling was employed in this study by controlling for gender (female, male), age (over 18 years old) and geographical location of the respondents. In order to ensure the user-friendliness and validity of the

survey, prior to implementing the main questionnaire, a pilot survey was realized on a sample of 40 respondents. This survey, with the help of comments and recommendations of experts and the respondents of a focus group, allowed us to make the necessary adjustments. The sample consisted of 63.7% women and 36.3% men; 72.4% in the age range of 30 to 64; 45.8% with only primary or secondary education or less; and 51.35% with a monthly disposable income between 1,125€ and 3,000€. The composition of our sample corresponds to that of the Catalan population, at least in terms of age range (64% of people over 18 are between 30 and 64 years of age) and income (46% with middle class disposable income). However, in terms of gender our sample is not representative of the actual population (IDESCAT, 2015).

The questionnaire that was developed to obtain the needed data for this study is composed of five parts. The survey starts with a concise introduction which presents the topic of the survey: "Policy against climate change and air pollution". Respondents are offered a brief introduction: definitions of GHG emissions and air pollution and their possible harms and hazards to the environment.

In the second part, questions related to the citizens' behavioral profile are asked. This part focuses on the extended TPB model, asking respondents about their environmental concern, attitudes, subjective norms, perceived behavioral control and intentions in relation to air pollution and GHG emissions. In order to be consistent with prior research, the constructs are measured through indicators adapted from the literature (see Table 1).

Table 1 Constructs and indicators of the extended TPB model.

Constructs	**Indicators**	**Response scale** (1-5)	**References used**
Environmental Concern (EC)	Think about climate change and air pollution. How much concern do you have about the effects of these environmental issues on your personal health or well-being? (EC1)	No concern – Very high concern	(Fujii, 2006; Wang et al., 2016)
	I think climate change and air pollution problems are becoming more and more serious in recent years. (EC2)	Strongly disagree - Strongly agree	
	The problem of climate change and air pollution is ... for my family and me. (EC3)	Not serious at all - Extremely serious	
Attitude (AT)	I think the idea of paying to reduce emissions is very responsible. (AT1)	Strongly disagree - Strongly agree	(Chen and Tung, 2014; Han et al., 2010; López-Mosquera et al., 2014)
	For me, in general, paying to reduce emissions is … (AT2)	Extremely negative - Extremely positive	
	Generally speaking, I think the idea of paying to reduce emissions is very intelligent. (AT3)	Strongly disagree - Strongly agree	
Subjective Norms (SN)	People whose opinions I value would prefer that I pay for reducing emissions. (SN1)	Strongly disagree - Strongly agree	(Chen and Tung, 2014; Han et al., 2010; Han and Kim, 2010; López-Mosquera et al., 2014; Wang et al., 2016)
	The people who are important to me expect that, in general, I will pay for reducing emissions. (SN2)		
	Most people who are important to me think that one should pay for reducing emissions. (SN3)		
Perceived Behavioral Control (PBC)	Whether or not I pay for reducing emissions is completely up to me. (PBC1)	Extremely disagree - Extremely agree	(Chen and Tung, 2014; Han et al., 2010; Han and Kim, 2010; López-Mosquera et al., 2014)
	I am confident that if I want, I can pay for reducing emissions. (PBC2)		
	I have resources, time, and opportunities to pay to help reduce emissions. (PBC3)		
Intention to Pay (IP)	I will make an effort to pay for reducing CO2 emissions and air pollution. (IP1)	Extremely disagree - Extremely agree	(Chen and Tung, 2014; Franzen and Vogl, 2013; Han et al., 2010; Han and Kim, 2010; López-Mosquera et al., 2014)
	I am willing to pay for reducing air pollution and CO2 emissions. (IP2)		
	How willing would you be to pay for reducing air pollution and CO2 emissions? (IP3)	Very Unwilling-Very Willing	

Part 3 contains the scenario and related monetary valuation question using the Contingent Valuation Method (CVM) to elicit individuals' WTP (Mitchell and Carson, 1989). Prior to asking the valuation

questions, a hypothetical valuation scenario[2] was presented to respondents in as clear and simple a manner as possible. Respondents were reminded of the main benefits and services the hypothetical policy offers to citizens (i.e. less polluted air and GHG emissions through, for example, support to biofuel production, investment in public transport development and encouragement of the use of electric cars); also it reminded them of the main disadvantages of GHG emissions and air pollution. Respondents were then asked to indicate their willingness to make a financial contribution of a specific amount (i.e. a compulsory annual vehicle tax or transport tax[3] for 5 years that would be managed by the Catalan government) to fund a policy that would reduce air pollution and GHG emissions.

The fourth part covers socio-economic characteristics of the respondents (age, gender, income, etc.). The final part of the questionnaire serves to profile the characteristics of the car owner's vehicle(s).

The purpose of the hypothetical policy choice was to reinforce the credibility of the proposed scenario and to minimize misunderstandings and misconceptions that can pose a problem for contingent valuation analysis. In the questionnaire, respondents face two dichotomous choices (single-bounded WTP questions) to carry out proposed policy to reduce GHG emissions and air pollution in Catalonia: (1) by 13% compared to the level of 2012 (back to 1990 level) and pay a penalty to the EU (Plan "L"); (2) by 28% compared to the 2012 level (meet EU 2020 target) without paying a penalty and enjoying an extra capacity of emissions for the next phase of EU 2050 plan as a reward (Plan "H").

Fig. 3 provides the graphical representation of the emission reduction and the penalties and rewards according to EU and Kyoto targets which was shown to the respondents.

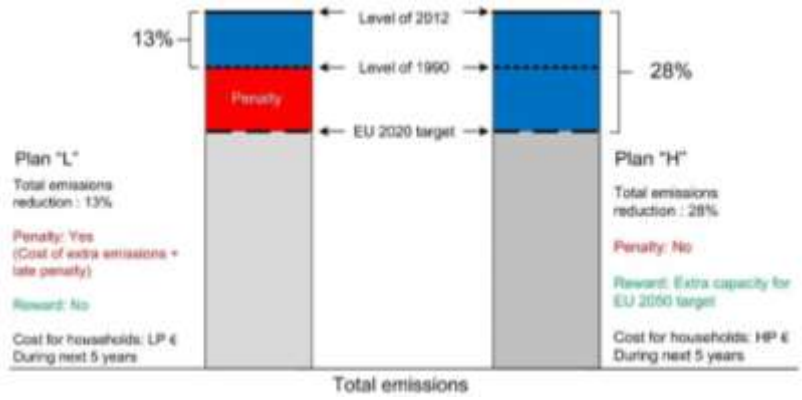

Fig. 3. Graphical representation of advantages and disadvantages of each scenario.

According to the multiple CV questions literature, single-bounded dichotomous-choice question was used as elicitation question format for this study. Therefore, in order to minimize ordering effects, WTP for the two plans was randomly distributed among respondents (Hoehn and Loomis, 1993; Longo et al.,

[2] The proposed valuation scenario and the contingent valuation questions are presented in the Appendix.

[3] Tax is a means of payment which is completely known for most of Spanish people and they are familiar with the process and time of money collection, therefore they can plan for it in household budget; accordingly, tax is selected as the payment vehicle for this study. Based on Wiser (2007), this payment method facilitates acceptance and understanding of the CVM scenario from respondents' point of view. Also, after comparing different payment vehicles, Bateman et al. (2003) have found stated WTP which is obtained via taxes is significantly higher than the stated amount obtained through voluntary donations. This tax can be defined as "earmarked tax" which is raised and allocated to specific expenditure programs (IMF, 2007).

2012; Payne et al., 2000). This approach allowed us to gather higher quality data and to minimize protest answers (Poe et al., 1997). Using standard form of dichotomous choice CV questions, five different bid amounts[4] for the proposed tax were randomly presented to five different groups of respondents. Each group had to indicate whether they agreed to pay a specific tax for plan "L" and a specific tax for plan "H". For plan "L", these amounts varied between €13 and €96 to finance the policy reducing GHG emissions and air pollution by 13% compared to the level of 2012. For plan "H", these amounts varied from €24 to €185 to finance the policy reducing emissions and pollution by 28% compared to the level of 2012. Respondents were randomly assigned to one of these possible groups. The distribution of WTP according to the bid amount is shown in Table 2.

Table 2 Bid values and percentage of respondents willing to pay the proposed plan

	Number of respondents	Plan "L"			Plan "H"		
		Bid (€/year)	% yes		Bid (€/year)	% yes	
			First step	Confirmed		First step	Confirmed
Group 1	94	13	57.45	25.53	24	60.64	50.00
Group 2	70	32	61.43	30.00	61	41.43	28.57
Group 3	79	54	49.37	32.91	102	45.57	32.91
Group 4	89	69	48.31	29.21	134	34.83	23.60
Group 5	74	96	43.24	18.92	185	41.89	33.78

The valuation question was asked in two steps. In the first step, respondents had to state whether they are "in favor" or "against" each of the two plans. In the next step, they had to confirm their choice and select one of the following three options: plan "L", plan "H" or "neither one".

Following the examples of Jorgensen et al. (2001) and Bateman et al. (2002), we introduced a control question to determine the reasons why the respondents were unwilling to pay the proposed tax. Using Longo et al. (2012) and our focus group observations, we offered the following motives for not wanting to pay the proposed tax: (1) The proposed tax is a fixed tax and I am in favor of a variable tax (e.g. tax per km driven); (2) Companies are the major causes of climate change and air pollution, and therefore they should pay for it; (3) The proposed policies are unrealistic; (4) The government should pay for climate change and air pollution, not the citizens; (5) I am not concerned about climate change and air pollution; (6) I do not feel responsible for climate change and air pollution; therefore, I should not pay for it; (7) I feel that climate change is a global problem and people in Catalonia should not be the ones to pay for it; or (8) I already pay high taxes and face high transport costs.

2.3. Econometric model of WTP

The mean WTP is calculated by means of the contingent valuation method (Mitchell and Carson, 1989). Mean WTP was calculated by integrating under a logit function where price was truncated at

[4] The bid amounts for both Plans ("L" and "H") are hypothetically proposed in this study. They are calculated based on national and regional information in Spain and Catalonia provided by Marti Valls et al. (2010); Parra Narváez (2004) and Generalitat de Catalunya (2010); also based on previous studies at the EU level and at the country level reported in Korzhenevych et al. (2014); Maibach et al. (2008); van Essen et al. (2011); European Commission (2013b) and (EEA, 2015).

96€ and 185€ for plan "L" and "H" and bounded to be positive based on the work of Bateman et al. (2002) and Hanley et al. (2007).

The mean WTP is calculated by:

$$Mean\ WTP = \int_0^T [1 - G_{wtp}]dW \quad (1)$$

where G_{wtp} is the distribution function of the true WTP. T is infinite for the true intention to pay and is truncated at some value for the purpose of estimation.

3. Results

3.1. WTP analysis

Mean WTP was estimated by means of a logit model. Dependent variable was extracted from the continuous variable for the following structural equation modeling estimations. According to equation (1), the results of the estimation of the logit model for the overall user sample (*n = 406*) reveal that the mean WTP is 64.47€ for implementing plan "L" and 120.17€ for implementing plan "H". The significance of the two bid price variables ($t = 6.454;\ p < 0.01; and\ \ t = 5.502;\ p < 0.01$), indicates the presence of starting-point bias. In addition, another logit model with covariates was used to determine the influence of socio-economic variables on the WTP of the respondents. Higher WTP amounts for reducing emissions and air pollution in both scenarios were obtained from people with a higher income level ($t = 2.782;\ p < 0.01; and\ t = 2.934; p < 0.01$) and people younger in age ($t = 2.432;\ p < 0.05; and\ t = 2.981; p < 0.01$).

3.2. Measurement and structural model

The structural model specified in Fig. 2 is estimated by using Maximum Likelihood. Following the two-stage approach proposed by Anderson and Gerbing (1988), we first tested the measurement model by means of Confirmatory Factor Analysis (CFA) and then estimated the Structural Model. At the beginning, in an attempt to ensure convergent and discriminant validity as well as the reliability of the measures, a confirmatory factor analysis (CFA) was conducted to test the measurement quality of the model (Anderson and Gerbing, 1988). Second, we tested the structural relationship among the latent variables of the model in Fig. 2. Sequentially, SPSS 22.0 and LISREL 8.80 were used to assess the hypotheses presented in this study. Once we had assessed the unidimensionality of each reflective construct, we checked whether all loadings (λ in Table 3) of the reflective indicators per factor were above .65. Then reliability was assessed using Cronbach's (1951) α, which requires that the items be tau-equivalent. When this assumption was not fulfilled alpha is biased (Raykov, 1997), we then used instead the simplest alternative, Heise and Bohrnstedt's Ω (Heise and Bohrnstedt, 1970), which only requires a unidimensional factor analysis model fitted to the indicators of each factor.

Next, the convergent validity was assessed by the Average Variance Extracted (AVE; i.e., the average communalities per competency) for each factor, which should exceed 0.5 (Hair et al., 1998) for all reflective constructs. Finally, discriminant validity was measured by comparing the square root of the AVE (Table 3) of each reflective construct with the correlations between the constructs (Table 4).

As far as the goodness of global fit is concerned, the following fit indices were considered to determine how the model fitted the data: Satorra-Bentler χ^2 (chi-square); χ^2/df ratio; CFI (Comparative Fit Index), GFI (Goodness Fit Index) and NFI (Normed Fit Index) indices should be close to 0.9 or 1.0 and the RMSEA (Root Mean Squared Error Approximation) should ideally lie between 0.05 and 0.08 (Hooper et al., 2008; Hu and Bentler, 1999).

It should be noted that mentioned indexes based only on statistical significance could lead to inaccurate conclusions (Saris et al., 2009). Accordingly, rather than only focusing on overall model fit in the diagnostic stage, we considered more detailed diagnosis indicators such as: 1) reasonable estimated values in the expected direction, 2) addition of justified correlated specificities and 3) the assessment of modification indexes and their expected parameter changes, which led to plausible estimates. This process, in line with the proposal of Saris et al. (2009), considers significance as well as the power of the test, paying more attention to identifying misspecification errors than just looking for the global fit.

3.2.1. Construct validity and Confirmatory Factor Analysis (CFA)

First, the measurement model was assessed by means of a CFA of the estimated extended model of TPB, which included all latent variables (intention to pay, attitude, subjective norms, perceived behavioral control and environmental concern). The data show a very good fit with the hypothesized structural model (χ^2=152.527; df=87; GFI=0.950; CFI=0.995; NFI=0.989; SRMR=0.030; RMSEA=0.043).

As can be seen in Table 3, all the indicators are reflective and Tau-equivalents (α *and* Ω have similar values) and show high reliability of the constructs. Moreover, as mentioned, AVE is always above 0.5, the usual threshold for convergent validity, and the comparison of its square root with the correlations among factors (Table 4) shows strong evidence discriminant validity.

Table 3 Reliability and Confirmatory Factor Analysis for the extended TPB model.

Constructs	**Indicators**	**Mean (s.d.)**[a]	λ	α	Ω	AVE
Intention to pay (IP)	IP1	3.17 (1.05)	.867	.925	.926	.792
	IP2	3.04 (1.12)	.912			
	IP3	2.95 (1.15)	.890			
Environmental concern (EC)	EC1	4.09 (0.65)	.807	.783	.790	.557
	EC2	4.46 (0.63)	.646			
	EC3	3.78 (0.78)	.777			
Attitude (AT)	AT1	3.38 (1.06)	.874	.907	.908	.765
	AT2	3.18 (1.04)	.882			
	AT3	3.05 (1.11)	.867			
Subjective norms (SN)	SN1	3.06 (1.01)	.822	.906	.907	.764
	SN2	2.93 (1.02)	.906			
	SN3	2.93 (1.02)	.892			
Perceived behavioral control (PBC)	PBC1	2.94 (1.12)	.744	.863	.866	.683
	PBC2	3.07 (1.03)	.888			
	PBC3	2.77 (1.08)	.841			

[a] s.d: Standard deviation; λ: factor loading; α: reliability (Cronbach's α); Ω: Omega coefficient; AVE: Average variance extracted;

Table 4 shows the correlations among the factors of the extended model. High correlation among attitude, subjective norms and perceived behavioral control is likely to lead to multicollinearity consequences in the structural model estimates.

Table 4. Correlations matrix among factors.

	1	2	3	4	5	6
1. Willingness to pay	1.000					
2. Intention to pay	0.539	1.000				
3. Attitude	0.511	.948	1.000			
4. Subjective norms	0.484	.898	0.894	1.000		
5. Perceived behavioral control	0.478	.886	0.796	0.877	1.000	
6. Environmental concern	0.165	.311	0.337	0.278	0.241	1.000

3.2.2. Structural models

Once we ensured that measurements could be trusted, we proceeded to estimate the parameters of the extended structural model (Fig. 4). Global fit indexes show a very good fit ($\chi^2 = 157.861;\ df = 92\ GFI = 0.948;\ CFI = 0.995; NFI = 0.989; SRMR = 0.031; RMSEA = 0.042$), and following the strategy of Saris et al. (2009) we detected no misspecification errors. The relevant structural coefficients of this model are significant ($P < 0.01$) and agree with the expected direction. Intention to pay on WTP showed a positive significant relation which supports H1, being the standardized regression coefficient ($\beta = 0.539;\ t = 12.998$). Attitude appears to have the strongest effect ($\beta = 0.703\ t = 7.393$) on intention to pay followed by the perceived behavioral control ($\beta = 0.390.\ t = 4.431$), thus H2 and H4 are also supported. However, we did not find evidence of a relationship between the subjective norms and intention to pay ($\beta = -0.073;\ t = -0.620$), so H3 would seem, on the one hand, to have to be rejected. On the other hand, we suspect that this point estimate has been distorted due to the aforementioned multicollinearity in Table 4. The relationships between environmental concern and attitude ($\beta = 0.337;\ t = 5.670;\ P < 0.01$), subjective norms ($\beta = 0.278;\ t = 4.516, P < 0.01$) and perceived behavioral control ($\beta = 0.241;\ t = 3.773;\ P < 0.01$) were supported, so H5, H6 and H7 are acceptable hypotheses based on our data.

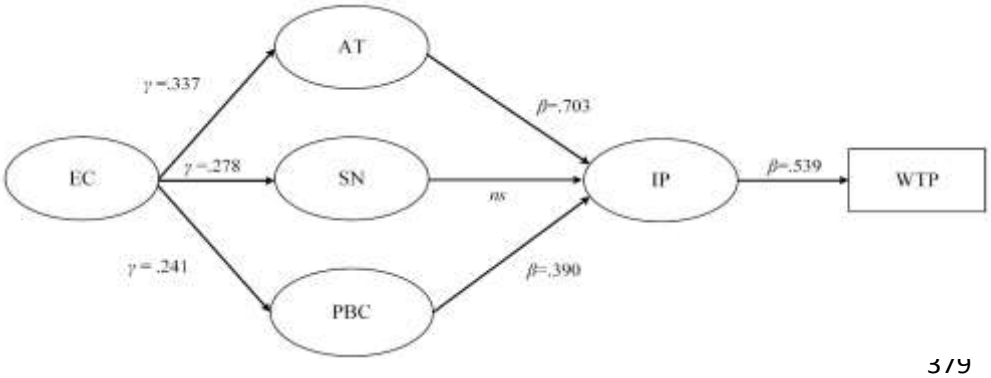

Fig. 4. Structural model of WTP based on the extended Theory of Planned Behavior model.

β *and* γ: standard regression weight. ns: non-significant

In order to see the aforementioned effect of multicollinearity, we have specified a model (Fig. 5) excluding attitude (due to its high inter-factor correlations). Results show a very good fit ($\chi^2 = 63.207;\ df = 31\ \ GFI = 0.966;\ CFI = 0.996; NFI = 0.992; SRMR = 0.020;\ RMSEA = 0.051$), and demonstrate that, as mentioned, both the contribution of subjective norms on IP ($\beta = 0.524. t = 4.523$) and the contribution of perceived behavioral control on IP ($\beta = 0.424. t = 3.566$) are actually positive and statistically significant. Results confirm that the previous estimates were distorted by the multicollinearity among attitude, subjective norms and perceived behavioral control.

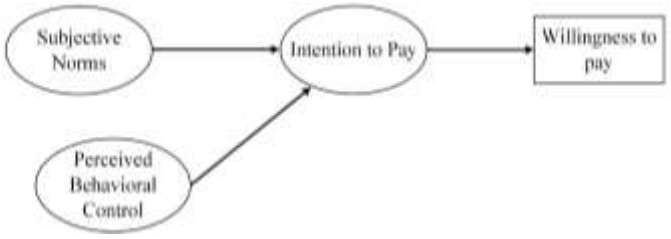

Fig. 5. A part of extended model—excluding attitude—to account for the multicollinearity effect.

In total, our results imply that the extended TPB model could predict households' intention to pay for the improvement of air quality and mitigation of climate change. Fortunately, multicollinearity doesn't affect global goodness of fit indices, so we can trust the predictive power of the specified model. Thus, R-square –percentage of variance of WTP accounted for IP is 29.1%, while Attitude, Subjective Norms and Perceived Behavioral Control explain 94.7% of the intention's variance.

4. Discussion

The TPB model, which was proposed by Ajzen (1991), is adopted in the current study to investigate households' intention to pay to reduce air pollution and GHG emissions from private road transport. Empirically, the study shows that the proposed extended TPB model offers a useful framework for identifying the attitudinal factors motivating this intention to pay. As has been argued in many studies, entering additional constructs to the TPB model, such as the case of environmental concern, leads to an improvement of the explanatory power of this theory (Bamberg, 2003; Chen and Tung, 2014; Donald et al., 2014).

As we reported, the mean WTP, which was calculated through the contingent valuation method, indicated that households are willing to pay €64.47 and €120.17 for reducing CO_2 emissions and air pollution, respectively, under plan "L" and plan "H". The percentage of positive WTP answers in our study is similar to the percentage obtained in previous studies in Spain and other studies around the world (see Table 5). Mean WTP differs in each study because of different social, political and economic situations of the respondents, the time of the survey and the valuation scenarios used in the study.

Table 5

Mean WTP to reduce air pollution and GHG emissions in previous studies.

Author (year)	Country	Estimated Mean WTP				% of Positive	Scenario
Carlsson and Johansson-Stenman (2000)	Sweden	2000 SEK/year (235€/year[a])				66%	50% reduction of harmful substances
Adaman et al. (2011)	Turkey (26 cities)	150 TL/year (69.77€/year)				63.7%	Decrease CO_2 emissions by making existing power plants more efficient and green
Carlsson et al. (2012)	Sweden, USA, China	US$/year (€)	30%	60%	85%		Reduce CO_2 emissions by 30%, 60%, and 85%
		Sweden	21.7 (18)	39.54 (33)	54.24 (50)	92%	
		USA	17.27 (15)	27.95 (25.5)	36.43 (34.3)	75%	
		China	4.99 (4.2)	8.32 (7.52)	11.18 (9.3)	88%	
Longo et al. (2012)	Spain (Basque Country)	16%	4%	0.5%			Reduce GHG emissions by 16%, 4%, and 0.5%
		281.61 €(PH/Y)[c]	176.24 €(PH/Y)	132.01 €(PH/Y)		> 65%	
Kotchen et al. (2013)	USA	Between $79 and $89 per year (58.6€ to 66€ per year)				49.6%	17% reduction in emissions by 2020
Lera-lópez et al. (2013)	Spain	9.31€/year and 9.56€/year				53.9% and 54.2%	Reduce air pollution for mildly and severely affected populations
Istamto et al. (2014)	NL, UK, DE, ES, FI[b]	1	2	3			1: General health risk 2: Half year shorter life expectancy 3. 50% decrease in road-traffic air pollution
		130 €/(PP/Y)[d]	80 €/(PP/Y)	330 €/(PP/Y)		43.6% (General)	
Yang et al. (2014)	China (Suzhou)	314.4 CNY/year (80€/year)					30% carbon mitigation
Current study		Plan "L"		Plan "H"			Plan "L": Reduce 13% Plan "H": Reduce 28% In air pollution and GHG emissions
		64.47 € (PH/Y)[d]		120.17 € (PH/Y)		61.42%	

Source: Own elaboration

[a]. Costs are proximately exchanged to euro based on the related rates in the period of study.

[b]. NL: Netherlands; UK: United Kingdom; DE: Germany; ES: Spain; FI: Finland.

[c]. PH/Y: Per Household per Year.

[d]. PP/Y: Per Person per Year.

The empirical results of our study reveal that respondents' WTP to reduce air pollution and GHG emissions, as the closest factor influencing their behavior, is in turn affected by intention to pay. The latter is significantly motivated by people's attitude and perceived behavioral control. Finally, we observe a positive relationship between environmental concern and attitude (H5), subjective norms (H6) and perceived behavioral control (H7).

This study represents, for the first time, the application of the TPB extended by the addition of environmental concern, in the context of reducing CO_2 emissions and air pollution from private road transport in Catalonia. It improves understanding of how psycho-social determinants motivate the intention to pay to reduce GHG emissions and air pollution from private road transport. As a result, the proposed extended TPB, as a psychological approach, may be useful in public policy, for example in order to propose a new vehicle tax system.

Policy makers must try to understand which factors lead people to pro-environmental behavior, especially in the case of reducing GHG emissions and air pollution. Accordingly, investigation of the persuasive constructs that affect this behavior, such as attitude and environmental concern, is

recommended. This information would be useful in supporting efforts to reduce the attitude–behavior gap and to encourage pro-environmental behavior.

One research finding is that people's attitude and perceived behavioral control towards payment for reducing GHG emissions and air pollution leads them to be more willing to pay for the policy if their environmental concern is first increased. In line with previous studies, environmental concern was directly related to attitude (Gardner and Abraham, 2010; Groot et al., 2007), subjective norms (Chen and Tung, 2014) and perceived behavioral control (Bamberg, 2003).

As expected, we found a significant and positive relation between intention, which is defined as the extent of effort an individual is planning to exert to perform a specific behavior (Ajzen, 1991), and willingness, which is an individual's openness to performing a certain behavior (H1). Despite confirmation of this hypothesis, results demonstrated that "intention to pay" and "willingness to pay" are not a same construct.

The attitude of an individual regarding paying for GHG emissions and air pollution reduction was found to be the strongest determinant of intention to pay (H2). Numerous authors have shown the same significant direct relation between attitude and intention to behave pro-environmentally (Spash et al., 2009; Wall et al., 2007).

The component that had the second greatest impact on intention to pay to reduce GHG emissions and air pollution was people's perceived behavioral control (H4). This supports the results found in other studies that mentioned PBC as one of the incentives for people to pay for improvements in environmental issues (Pouta and Rekola, 2001; Spash et al., 2009).

It should be emphasized that the extended TPB model of our study had extraordinary model fit and comparing indices. More than confirming most of our research hypotheses, the square multiple correlations indicate that 29.1% of willingness to pay and 94.7% of intention to pay is explained by the constructs of the study.

Finally, the results found here cannot yet be generalized to Catalonia as a whole. The sample used represents all citizens who have and who don't have vehicles, but it needs more deep studies to find the best way of separating vehicle tax from other types of transport taxes. In addition, since respondents were asked only about private road transport, the results obtained cannot be generalized to all types of transport nor to other environmental goods.

5. Conclusions

The results of our study give support for the usefulness of enriching the TPB framework by introducing into it a new factor—environmental concern. As this study has demonstrated, environmental concern significantly affects attitude, subjective norms and perceived behavioral control. Individuals with positive attitudes and perceived behavioral control present higher intention to pay and WTP for the reduction of CO_2 emissions and air pollution. As we discussed, the relationship between subjective norms and intention to pay is not confirmed statistically, but the high correlation among

constructs of TPB indicates that subjective norms influence intention to pay. An increase in intention to pay thus relies on the combined effects of environmental concern and other elements of the extended TPB model as suggested by Wang et al. (2016).

Environmental activists and urban managers should try to inform citizens about the importance of reducing GHG emissions and air pollution, thus increasing the public's environmental concern. This in turn will positively affect the public's economic valuation of policies that make such reductions possible. A potential target population segment of this awareness-raising campaign should be that part of the society which shows less environmental concern and therefore less WTP to reduce air pollution and GHG emissions. It should be especially focused on people in the mid-income level range and in the following age groups: middle-aged adults (age 30-55 years) and older adults (age 55 and above). All types of media such as social networks, TV, radio and the printed press are helpful tools for promoting environmental knowledge and pro-environmental behaviors in that they can educate people in car-use reduction habits, promote the use of travel alternatives, encourage WTP to reduce pollution, and so forth (see Gärling and Schuitema, 2007). These behavioral changes can improve the effectiveness of economic tools such as taxes (higher WTP, less car use and more use of alternative transport modes).

In addition, for supporting the message of the campaign, drawing people's attention to the type of payment vehicle for these policies (i.e. an earmarked tax) could be a positive point. Individuals may increase their intention to pay if they are informed that the tax revenue will only be used to tackle the specific environmental problems mentioned.

Regarding the limitations of this study, at the theoretical level, we would like to point out that it would be interesting to examine the influence of motivational factors of the proposed model on real payment rather than WTP. According to Ajzen (1991), the most accurate prediction of behavior will be provided by an appropriate measure of intention. However, there is a gap between adoption intention and actual behavior (Ajzen and Fishbein, 1980).

Furthermore, the sample used was a general sample based on the Catalonia census. In order to obtain a more specific result based on vehicle ownership status, it would be interesting to do the same study on two different and independent samples: one on vehicle owners and another one on individuals or households without vehicles. A proper sample size of the two groups would help to determine whether there are differences in their respective environmental profiles regarding the economic valuation of the reduction of air pollution and GHG emissions.

Concerning future lines of research, we first suggest that people's WTP should be examined by their level of trust in the government, at both local and national level, as well as in the legal system for collecting taxes. A positive mindset towards the efficiency and honesty of the government facilitates this intention to pay for the policy. Accordingly, a comparison of WTP a tax in different countries could be interesting in revealing the consequences of people's trust in their government.

Second, other kind of taxes, instead of the annual obligatory transport tax, could be considered in the survey; these might include taxes in function of the pollution generated (e.g. tax per kilometer or tax

based on vehicle pollution category) or taxes in function of income of the taxpayer. If people consider the tax fairer, they will likely be more willing to pay for the environmental policy. Other payment vehicles, such as voluntary payment, could also be considered as an alternative for a tax. Research could also demonstrate whether there are changes in WTP amount and percentage of positive answers according to the payment vehicle (e.g. Akcura, 2015; Wiser, 2007).

Third, it would be interesting to use other methodological frameworks of stated preference such as Choice Experiments (Adamowicz et al., 1994) instead of contingent valuation method. This technique offers an attribute-based definition of the good in question. As Bateman et al. (2002) explained, Choice Experiment is easier for people to understand because this technique does not openly ask "How much are you willing to pay?" In fact, here the design of the valuation scenario is different with the one in Contingent Valuation.

Finally, there are cultural differences between territories (countries and regions), and that is why, in order to increase the generalizability of the model, we need to study the effect of the cultural specificity of the territory on the psycho-social factors and intention to pay to reduce GHG emissions and pollution.

We believe the findings of this study can contribute to the discussion about environmental valuations and its implications for policies related to road transport GHG emissions and air pollution.

Appendix

Questions used in the contingent valuation:

Valuation scenario

The energy we use in transportation is the main cause of air pollution and greenhouse gas (GHG) emissions in Catalonia, Spain and the second largest in Europe. Scientists say that GHG emissions, mainly CO2, are the main sources of global warming, irregular rainfall and sea level rise; on the other hand, air pollutants, such as particulate matter (PM2.5 and PM10), are the main reasons for pulmonary infections and serious asthma attacks, especially among children and the elderly.

The Catalan government is considering measures to reduce the emissions and air pollution caused by all sectors, so that in 2020 total emissions have to be 20% lower than in 1990. For this purpose they have a new plan and the government needs more financial resources.

What is the Catalan government plan?

This program, regarding private transport, includes policies such as requiring oil companies to produce gasoline and diesel that has lower GHG emissions and pollutants per liter, support bio-fuel production by paying subsidies, invest in public transport development and pay subsidies and encourage the use of electric cars, etc.

The current income is not enough to implement this plan. So if all households would agree to voluntarily pay more for transportation during the next 5 years, the Catalan government will be able to implement

all proposed projects and will hit the target of the Europe 2020 (20% lower than 1990 level) for air pollution and GHG emissions.

Let's assume the Catalan government has proposed two options:

1. Reduce air pollution and GHG emissions to 1990 levels (13% lower than 2012) and pay a penalty to the EU (Plan L). Studies have shown that the cost of this policy (plan "L") is equal to X € per year for each household during the next 5 years.

2. Reduce air pollution and GHG emissions levels to meet EU 2020 target (28% lower than 2012) without paying a penalty, and enjoying an extra capacity of emissions for the next step of EU 2050 plan as a reward (Plan H). Studies have shown that the cost of this policy (plan "H") is equal to X € per year for each household during the next 5 years.

Valuation questions

Please think about “Plan L” and "Plan H".

"Plan L": Pay X €/year for 5 years as a transportation tax to reduce air pollution and GHG emissions to 1990 levels (13% lower than 2012) and pay a penalty to the EU.

"Plan H": Pay X €/year for 5 years as a transportation tax to reduce air pollution and GHG emissions to meet EU 2020 target (28% lower than 2012). Not only does this plan have no penalty; it also has an extra emissions capacity as a reward for Catalonia.

If an election were being held today, would you vote in favor of or against this policy that would promote a 13% reduction in air pollution and GHG emissions, and cost each household in Catalonia X €/year for 5 years as a transportation tax?

☐ In Favor ☐ Against

If an election was being held today, would you vote in favor of or against this policy that would promote a 28% reduction in air pollution and GHG emissions, and cost each household in Catalonia X €/year for 5 years as a transportation tax?

☐ In Favor ☐ Against

	Reason for unwillingness to pay
○	This is a fixed tax and I’m in favor of a variable tax. (e.g. pay per Km)
○	Companies are the major causes of climate change and air pollution: they should pay for it.
○	I find the proposed policies unrealistic.
○	The government should pay for climate change and air pollution, not the citizens.
○	I am not concerned with climate change and air pollution.
○	I do not feel responsible for climate change and air pollution; therefore I should not pay for it.
○	Climate change is a global problem; people in Catalonia should not be the ones to pay for it.
○	I already pay high taxes and transport costs.

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