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Public Preferences for Climate Change Policies: Evidence from Spain

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Public Preferences for Climate Change Policies: Evidence from Spain

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Abstract

Spain faces a complex situation regarding its climate change policies. Since 1990, Spain's greenhouse gas (GHG) emissions have increased far beyond the Kyoto commitments. Moreover, Spain is likely to suffer significant adverse impacts from climate change. However, there has been little action to reduce GHG emissions, particularly in the area of energy prices. Although the Spanish public generally shows great concern about climate change, it has traditionally opposed price increases for energy. In this paper we offer an explanation of this paradox, and we provide a possible strategy for policy design. We find that Spanish households favor reducing GHG emissions from electricity production and would be willing to pay for this if it promotes new, greener technologies and if it eventually lowers the cost of those technologies in the future. This finding emerges from a contingent valuation survey which also provides a rich set of information on households' attitudes regarding various policy options for reducing GHG gases.

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1. Introduction

Climate change has become a major concern for citizens across the world. The first worldwide poll on global warming, conducted by World Wide Views (2009), depicts a vast majority of people (close to 90%) favoring sizeable reductions in greenhouse gas (GHG) emissions for developed countries in the period 2020-1990. A similar proportion of citizens strongly supports keeping global warming within 2 degrees Celsius over pre-industrial levels. In Europe, the Eurobarometer Survey (2009) finds that two thirds of the European public considers that global warming is among the most serious problems faced by humankind today. Although there are some geographical differences within Europe, Spain is among the countries well above the EU average in rating climate change as a very serious problem. At the same time, most Europeans (again, roughly two thirds) believe that governments and industries are not doing enough to fight the problem. As will be seen below, the data collected in this paper show that the Spanish public is greatly concerned about climate change.

This is the general setting of the paper: intense social preferences for climate change mitigation that have not fully materialized in actual policy-making. In this sense, Spain is probably the quintessential country, with a strong concern by citizens and even government (one of the three 'guiding issues' of the current Spanish government) but few policies actually implemented. Spain faces a complex situation regarding its climate change policies. On the one hand, GHG emissions have shown a large increase since 1990 (around 35% at the moment of writing, with a recent sharp reduction due to the recession), being far above the Kyoto commitment (15% over). On the other hand, Spain is likely to suffer significant impacts from climate change due to its geographical location: substantial temperature increases and an exacerbation of water shortages are to be expected in this century (AEMET, Spanish Agency of Meteorology, 2010). However, there has been a rather limited application of corrective policies, particularly in the field of energy prices, which are generally below European averages.

The situation in Spain contrasts with economists' traditional support of pricing instruments in climate policies. Carbon prices, for instance, are seen as a necessary mechanism to achieve cost-effective abatement and to foster carbon-free technologies. Yet in Spain governments have traditionally opposed carbon pricing, despite growing evidence of its positive effects. Fear of a loss of

competitiveness led successive Spanish governments to block any attempt to set a European carbon tax during the 1990s and early 2000s, despite empirical evidence showing that a Spanish green tax reform, based on carbon taxation, could lead to net economic gains with limited distributional impacts (see eg Labandeira, Labeaga and Rodríguez, 2004). This is reflected in Spain's low transport taxes and in the government's negative attitude regarding electricity price increases.

Is there any reason for this phenomenon, despite the ex-ante positive effects from the policy and the underlying social preferences regarding climate change? The intense opposition of the Spanish public to tax-related price increases of automobile fuels during this decade and the strong pressure to keep electricity prices low (with a clear risk of sustainability for the system, which is now operating in deficit as prices do not reflect total costs), provide an explanation for the lack of corrective carbon pricing. The focus group discussions used in the preliminary stages of our research confirm this.

In this paper, we intend to reconcile the strong Spanish social concern about climate change abatement with a corrective policy that is acceptable to citizens. We present evidence that certain programs for the reduction of GHGs would be publicly accepted even when they raise the price of energy. Although these programs are not necessarily ideal from a theoretical perspective, our evidence indicates that they could play an important role in climate change policy in Spain.

We employ a contingent valuation (CV) survey using a questionnaire that elicits from respondents their willingness to pay (WTP) for policies that reduce GHG emissions in two sectors especially responsible for those emissions in Spain: electricity and automobile transportation. However, we do not only seek to calculate WTP for specific climate policies. We also study, in some cases for the first time, public preferences regarding alternatives for the design of corrective policies to confront climate change. Additionally, we provide information on the extent to which Spanish citizens know about the climate change phenomenon and how important they consider it to be.

There is a growing literature on WTP for climate change policies, with recent contributions by Berrens et al. (2004), Cameron (2005a, 2005b), Li et al. (2005), Lee and Cameron (2008), Leiserowitz (2006), and Stedman (2004). Those papers reflect the perceptions towards various climate change policies around the world, mostly through the use of CV methods. Other approaches include discrete choice

experiments (Longo, Markandya and Petrucci, 2008), ordinal responses to valuation scenarios (Diaz-Rainey and Ashton, 2007), and extrapolation from public opinion polls. The policy objectives, or environmental goods under consideration also vary considerably across the papers, including climate stabilizing measures, (Cameron, 2005a), green energy investments (Diaz-Rainey, 2007; Wiser, 2007; Hoyos and Markandya, 2009), minor temperature changes (Viscusi and Zeckhauser, 2006), and sequestration mechanisms (Brouwer et al, 2008). For a comprehensive review of this literature see Johnson and Nemet (2010).

Although the applications in Europe are still limited, they have experienced considerable growth in recent years. For instance, Cole and Brännlund (2009) assess preferences for mitigation policies in Sweden, showing that citizens in Sweden support informational campaigns, as well as measures that carry positive effects on technological development. In Spain, Hoyos and Markandya (2009) investigate preferences for climate change measures in the Basque region, including global (as in previous studies) and ancillary local benefits. They show that estimates are 40% higher when ancillary benefits are also included. This paper contributes to the European and Spanish literature on this matter by concentrating on the two main sources of Spanish GHG emissions and, even though the CV method has been used to assess the impacts of climate change, our application focuses on climate change mitigation policy, the form it should take, and the public's willingness to pay for it to be implemented.

The paper is based on an in-person survey of a representative sample of the Spanish population conducted between May and June 2010. The results show that Spanish households strongly favor the application of an electricity program that makes electricity more expensive but uses the extra revenues for the promotion of renewable sources to reduce carbon dioxide emissions. In particular, the mean willingness to pay per month and household is significant: 11€ over the current electric bill which implies a significant increase in percentage terms. Households also show a positive (although slightly smaller) WTP for a program implemented on automotive fuel producers to reduce GHG emissions even if it leads to an increase in the price of fuel.

Our results in the case of electricity are notably lower than those obtained through a phone survey conducted in December 2009.[1] Besides the difference in different survey mode (phone versus in-person) and the fact that the questionnaire used then was much sparser than the one employed here, we believe that a greater part of the difference in results is due to the timing of the earlier survey – it was conducted immediately before and during the first days of the Copenhagen Summit when climate change issues were being constantly discussed in the media.

In contrast to the previous survey, our present survey provides a wealth of information on citizen opinions on climate change and their attitudes towards possible climate mitigation strategies. In the future all this information will be used to complement the WTP results provided here. This paper aims to present the survey and describe the basic results obtained. In so doing, this paper gives a very detailed overall picture of the general social preferences of the Spanish public on climate policy, and could be especially useful for the design of future policy action in this field.

The article is organized in four sections, including this introduction. The next section describes how we obtained the data and briefly describes the survey. Section 3 deals with the empirical model employed and presents the resulting estimates of the WTP for the electricity and automobile transport programs. The responses to the attitudinal questions are also described. Finally, section 4 presents some first policy implications and summarizes the main contributions of the paper.

2. Data collection and survey

Our research approach is based on the application of a questionnaire (which is available upon request), whose careful design was crucial in obtaining highly reliable quality data. To this end, the following steps were followed: Focus groups, survey pre-testing and the implementation of a field survey.

[1] That survey covered electricity but not transportation policy (see Hanemann, Labandeira and Loureiro, 2011).

2.1. Focus groups and survey pre-testing

Focus groups were held in several Spanish cities with different socio-economic and climatic characteristics: A Coruña, Madrid and Santiago de Compostela. There were 9 or 10 participants in each focus group, and they discussed various aspects of climate change and climate policy. Participants were recruited through a quota system to obtain a diverse panel for each city, with representation of different age groups, educational backgrounds and sexes.

The focus groups were led by members of the research team. Each focus group lasted for two hours during which the participants responded to questions developed by the research team, first answering them individually and then discussing them as a group. In this way, the questions followed an articulated structure with respect to a possible questionnaire. The final survey questionnaire was substantially modified compared to the initial draft based on valuable information from the focus groups regarding expected impacts associated with climate change, willingness to pay specific taxes to reduce GHG emissions, mitigation policies and other aspects of environmental awareness. The first discussion groups opposed the idea of paying higher taxes to reduce the impact of climate change. Consequently, various rounds of modifications were carried out that aimed to present policies to fight climate change that would not be subject to rejection or complaint. The final survey was pre-tested on a group of participants to check for understanding and duration.

2.2. Final Survey

The structure of the survey shares characteristics with others previously successfully used in the US by Cameron and others (for a summary see Villar and Krosnick, 2011). This allows us to compare the results obtained in other countries. Our main objective in the design, however, was to obtain detailed results on the opinions of the Spanish population on corrective policies for climate change. We placed special emphasis on finding out citizens' attitudes regarding alternative policy strategies and their implementation in order to provide some guidance for policy action in this field.

The survey contains four separate parts: a) introduction, where several general issues on climate change awareness are presented; b) the valuation of electricity and gasoline policies associated with the reduction of GHG emissions; c) attitudinal variables; and d) socio-demographic questions.

The text relating to the electricity program was as follows:

> "The electricity we use in factories and households is the single main cause of greenhouse gas emissions in Spain: 28% of total emissions. The Spanish government is considering measures to reduce the emissions caused by electricity generation and consumption, so that in 2020 total emissions are 20% lower than in 1990, through a balanced program to reduce the energy we use in our homes and factories. This program includes requiring power companies to make electricity in ways that don't emit greenhouse gases, such as with renewable energy. Also, the government will require factories to use highly efficient energy equipment, and to make products which meet climate requirements. The government will continue to regulate the price of electricity for households, so that electricity companies cannot gain excess profits. In the end, this program will make electricity less expensive to produce, but for an initial period of some years, the price of electricity will be higher. In the end, cleaner technologies and higher energy efficiency will make the cost of living lower and electricity less expensive."

Respondents were then told: "If the government goes ahead with this program, the extra cost to your household is likely to be X€ or per month (or 12X€ per year) until about 2020" where X was one of 7 alternative bid amounts to which they were randomly assigned. They were then asked a single dichototomous question: " Would you be in favour of this program?"

With the gasoline program, the text was:

> "The energy we use for our cars and trucks is the second largest source of greenhouse gas emissions in Spain. Transportation, especially passenger cars and other vehicles, accounts for 25% of Spain's greenhouse gas emissions and is growing very rapidly. The Spanish government is considering a policy to require oil companies to produce gasoline that has lower greenhouse gas emissions per litre than the current gasoline. This would be phased in slowly. Most of the cost of the new investment would fall on the oil companies but there would also be some small increase in the cost of gasoline."

Respondents were asked whether they own a car and, if so, whether they drive to work. If they answered yes to both questions, the text continued:

> "Currently oil companies are developing new types of fuel which produce lower greenhouse gas emissions. Now the price of gasoline or diesel, is about 1€ per Litre. Would you be willing to pay X extra cents per Litre for your fuel in order to reduce your driving emissions?"

2.3. Sample

1200 surveys were carried out in Spain by the independent company *Sondaxe* which conducted the surveys in person applying quotas by age and sex. The surveys were carried out between May and June 2010. In total, 750 surveys were collected. The data were analyzed using STATA 10 software.

A multiple-stage method was used for the sampling. First, different areas were selected in each region, including large, medium and small cities according to their frequency and how representative they were at a national level. Next, interviewers were assigned to the different areas and instructed on how to collect the data. The procedure was the usual in these cases: followed in many cases, for example, by the Spanish Institute of Statistics (INE) to carry out their own surveys. In the following analysis all the responses are included, even complaints. It seems appropriate to do this because in a real election the opinion or vote of these citizens would count.

Regarding the sample characteristics, the main descriptive results can be seen in Table 1. 48.2% of the people surveyed are men; their average age is about 44 years. Self-employed and house workers, represent 9.7% and 13.7%, respectively. 9.4% of the sample are students; 9.6% are unemployed. With regard to household income, 12.2% have annual gross incomes under 10,800€; 49.4% have gross household incomes between 10,800€ and 21,600€; and 21.2% have gross household incomes above 21,600€ per year. Additionally, most of the households (89.6%) consist of 4 people. It is also worth noting that the type of energy used by most households for heating is electricity, while natural gas and propane are much less common.

(Table 1, here)

There are no significant differences in education between the sample and the Spanish population as reflected in the Census for 2001 (INE). As for the average educational level of the sample, 34.6%

have completed primary school and 40% have completed secondary school (including also vocational school). Additionally, about 20% of the sample have a college degree (including both graduate and undergraduate college). As for the place of residence, we could say that most of the sample lives inland (73.1%), while 26.6% lives on the coast. As we can see in the table, the social and demographic variables reflect the reality of Spanish households well.

Table 2 describes the survey respondents' knowledge, attitudes and behavior regarding climate change. Respondents clearly are aware of climate change and consider it a real phenomenon (77.3%), while the majority belive that it will be bad for them (91%). They believe that measures are necessary to control GHG emissions (87.6%), that Spanish households (69.2%) and firms (94.7%) both bear responsibility for reducing emissions, and that the Spanish government should take action (62.1%). Table 3 presents information on respondents' attitudes towards several aspects of climate policy design. Respondents agree that households with larger energy consumption should pay more for energy (63.8%), although they consider that taxes on gasoline are already too high (81.5%). Opinion is split on taxes: 31.4% are willing to pay an anti-climate change tax, but 42.9% are not willing. 77.7% believe that, if environmental taxes are introduced, other taxes should be reduced. 61% agree that energy-efficient housing should be required. 38.2% agree that nuclear energy is a valid way to fight against climate change, but 16.6% disagree and 43.2% neither agree nor disagree. And 57% agree that solar panels should not be promoted in rural areas.

(Table 2, here)

(Table 3, here)

3.Empirical models

3.1. Empirical application

The key assumption underlying the analysis of the responses to the payment question in the survey is that, if a respondent says "yes" to a particular level of cost, this implies that his WTP for the

program being evaluated is greater than or equal to this cost, but *not* less than that amount. If the respondent says "no" this implies that his WTP is less than the proposed amount. The dichotomous response therefore provides either a lower bound or an upper bound on the respondent's individual's WTP value. In the present application, WTP responses of "Don't Know" or "No Answer" were recoded as "No". This is a conservative approach that has been employed by Carson et al. (2003) and others.

It is assumed that respondents vary in the preferences and interests, so that a given cost amount may elicit different responses from different individuals. The variation in preferences is conceptualized as a probabilistic variation in WTP represented by a WTP probability distribution for the population being sampled. The pattern of survey responses provides information on this WTP distribution. By analyzing the survey responses one obtains an estimate of the WTP distribution generating the survey responses. The estimation can be parametric or non-parametric. With parametric estimation, the researcher postulates a specific mathematical form for the WTP distribution, such as the normal or the logistic distribution. Given the chosen probability distribution, estimation focuses on estimating the parameters of the distribution (e.g., the mean and the variance).

Non-parametric estimation is a more general approach that avoids the need to select a specific distribution; instead, the form of the distribution and its parameters are both estimated. The WTP distribution is estimated only at certain points, namely those monetary amounts used as bid values in the CV survey. It is not observed at other monetary amounts, and therefore there is no direct estimate at other WTP values. If an estimate is required at some other monetary amount, this has to be obtained by some form of interpolation between the points at which the non-parametric distribution is estimated. Non-parametric estimation thus places minimal assumptions on the WTP distribution. The only restriction on the estimation is that a cumulative distribution function is monotone; in our context, this implies that the probability of responding "yes" should not increase with an increase in the dollar amount presented. In practice, with finite data sets, this restriction is not always satisfied empirically. Therefore it is often necessary to impose the restriction of monotonicity on the estimation. With a parametric approach, the restriction is imposed automatically. With non-parametric estimation, a maximum likelihood technique for imposing this restriction was developed by Ayer et al. (1955) and is known as the ABERS estimator (Morgan, 1992). The ABERS was generalized by Turnbull (1976) to interval-censored data.

To describe this estimator, we observe that the responses to the dichotomous survey question define intervals bounding each respondent's WTP. Suppose a respondent indicates a willingness to pay, *W*, that lies within the interval [t_j and t_{j+1}] where the t_js are the bid values and are indexed as *j=0,1,…M*, with $t_j > t_k$ for $j>k$, and $t_0=0$. Let p_j denote the probability that an individual has a WTP lying between t_{j-1} and *t*

(1) $$p_j = P(t_{t-1} < W \le t_t) \text{ for } j=1,\ldots,M+1.$$

Define the cumulative distribution function (cdf)

(2) $$F_j = P(W \le t_j) \text{ for } j=1,\ldots,M+1, \text{ where } F_{M+1}=1.$$

With the non-parametric approach, the WTP distribution is estimated only at the points corresponding to the t_j's.In effect, what one estimates is the F_j's or the p_j's where

(3) $$p_j = F_j - F_{j-1}$$

and $F_0=0$.

The estimation takes either F_j, $j=1,..,M$, or p_j, $j=1,..,M$ as parameters. When the F_j are parameters, the likelihood function is defined as

(4) $$L(F; N, Y) = \sum_{j=1}^{M} [N_j \ln(F_j) + Y_j \ln(1 - F_j)],$$

where N_j is the number of responses that correspond to "No" at the bid amount t_j, and Y_j the number of responses that correspond to "Yes" at t_j ; $(1-F_M)=p_{M+1}$ is the probability that *W* is greater than the highest offer. When the p_j are the parameters, the likelihood function is expressed as:

(5) $$L(P;N,Y)=\sum_{J=1}^{M}\left[N_j \ln(\sum_{i=1}^{j} p_i)+Yj\ln(1-\sum_{i=1}^{j} p_i)\right].$$

From (5), the sum of the $p_{i's}$ is 1. Yet, if these *p's* are to constitute a valid density function, they should be non-negative and lie within the unit interval. To obtain a valid estimator of the density function (pdf) of WTP, the p_i*'s* should be restricted to be positive.

Ayer et al (1955) and Turnbull (1976) developed an algorithm for estimation of the *p's* in (5) that ensures they are positive. The algorithm solves the first condition for the optimization of (5) while ensuring the non-negativity of the *p's*. The first order conditions for the *p's* are,

(6) $$\frac{\partial L}{\partial p_i}=\sum_{j=i}^{M}\left(\frac{N_j}{\sum_{k=1}^{j} p_k}-\frac{Y_j}{1-\sum_{k=1}^{j} p_k}\right)\le 0 \quad p_i\ge 0 \quad p_i\frac{\partial L}{\partial p_i}=0.$$

By construction equation (5) assumes that $p_1>0$ whenever N_1 is other than 0.

Using (6) and solving for p_1, one obtains

(7) $$p_1=\frac{N_1}{N_1+Y_1}$$

Likewise, solving for p_2, we get

(8) $$p_2=\frac{N_2}{Y_2+N_2}-p_1$$

Thus, p_2 is positive since

(9) $$\frac{N_2}{Y_2 + N_2} > \frac{N_1}{N_1 + Y_1}.$$

Note that these probabilities have a natural interpretation, given that $\frac{N_j}{N_j + Y_j}$ is the proportion of the negative responses at bid amount t_j. Therefore, it is a natural estimator of F_j, Consequently, following (6), the estimator is $p_j = F_j - F_{j-1}$.

This assumes that there is a greater proportion of negative responses to the bid amount t_2 than to the bid amount t_1. Suppose this did not hold, and a situation existed where $\frac{N_2}{Y_2 + N_2} < \frac{N_1}{N_1 + Y_1}$; then the unrestricted probability p_2 would be negative. However, if a non-negativity restriction is to be satisfied, the cell width is increased until we find a non negative p_2.

In summary, when p_j is positive, p_{j+1} is calculated until all of the p_j's have been estimated. If p_j is negative, then neighboring intervals are aggregated until this results in a p_j which is positive.

Thus, the algorithm is[2]:

(a) For $j=1 \rightarrow M$, calculate $F_j = \frac{N_j}{(N_j + Y_j)}$

(b) Starting with $j = 1,$ compare F_j and $F_{j+1.}$

b.1) If $F_{j+1} > F_j$ then we continue with this process.

b.2) If $F_{j+1} < F_j$ then we put cells *j y j+1* together in one same cell with limits (t_j, t_{j+2})

(c) We continue until the cells are grouped together sufficiently to generate a monotonically increasing cumulative distribution function.

(d) We calculate the density function as a step function of the cumulative distribution function.

[2] This algorithm can be programmed manually. It is also programmed in software packages such as GAUSS.

One of the advantages of directly calculating the empirical distribution function is that it is easy to estimate the variance-covariance matrix. To obtain this we use the likelihood function (4). The first order condition with respect to F_j is

$$\frac{\partial L}{\partial F_j} = \frac{N_j}{F_j} - \frac{Y_j}{(1-F_j)}, \tag{13}$$

and the matrix of the second derivative is a diagonal matrix with terms

$$\frac{\partial^2 L}{\partial F^2{}_j} = -\frac{N_j}{F^2{}_j} - \frac{Y_j}{(1-F_j)^2}. \tag{14}$$

So, the variance of F_j is

$$V(F_j) = \left(-\frac{\partial^2 L}{\partial F_j^{\,2}} \right) = \frac{F_j}{(1-F_j)^2 N_j + F_j{}^2 Y_j} = \frac{F_j(1-F_j)}{N_j + Y_j}. \tag{15}$$

The variance of the p_j's is also easily estimated. The F_j's are the cumulative distribution function and the p_i's are the density function. Given that F_j and F_{j-1} have zero covariances,

$$V(p_j) = V(F_j) + V(F_{j-1}) = \frac{F_j(1+F_j)}{N_j + Y_j} + \frac{F_{j-1}(1-F_{j-1})}{N_{j-1} + Y_{j-1}}. \tag{16}$$

So far, we have focused on the non-parametric estimation of the WTP distribution. In many practical cases, however, the researcher wants a single statistic to summarize the distribution, such as the mean or median WTP. Here we focus on the mean

$$E(W) = \int_0^\infty W \partial F(W) = \sum_{J=1}^{M+1} \int_{t_{J-1}}^{t_J} W \partial F(W). \tag{17}$$

We employ Kaplan and Maier's (1958) lower bound estimator of the non-parametric mean

$$E(LB_{WTP}) = 0.P(0 \le W < t_1) + t_1 P(t_1 \le W < t_2) + ... + t_m P(t_m \le W < t_{m+1}) = \sum_{j=1}^{M+1} t_{j-1} p_{j.} \quad (18)$$

The Kaplan-Meier non-parametric estimator of the mean WTP follows an asymptotically normal distribution, given that it is a linear combination of p_i's, which, in turn, are asymptotically normal. The variance of the Kaplan-Meier estimator is given by

$$V\left(\sum_{j=1}^{M+1} p_j t_{j-1}\right) = \sum_{j=1}^{M+1} t_{j-1}^2 (V(F_j) + V(F_{j-1})) - 2\sum_{j=1}^{M} t_j t_{j-1} V(F_j). \quad (19)$$

With these estimates of the mean and the variance of WTP, confidence intervals can be constructed and hypothesis tests can be performed.

The non-parametric estimate of mean WTP for the green electricity program in the survey is presented in Table 4. The estimated mean WTP is about €11 Euros per household per month. This would be a significant increase compared to the average cost of electricity for Spanish families (approximately 25% before the recent price increase in January 2011). Table 5 shows that respondents were relatively sure of their answers: about 70% of the respondents were sure at a level of 9 or 10 points on a scale of 1 to 10.

(Table 4, here)

(Table 5, here)

The non-parametric estimate of mean WTP for the gasoline program in the survey is presented in Table 5.[3] The estimated mean WTP is about 105€ per household per year, an amount slightly lower

[3] Note that this valuation question was asked only of respondents who both own a car and drive most days to work.

than the one obtained for electricity. This is largely explained by the fact the prices and taxes already applied on fuel for transportation are considered to be too high. While the certainty of the responses continues to be high, with about 65% stating a certainty level of 8, 9 or 10, it is a bit lower than the certainty in the case of electricity. In addition, Table 8 provides some information on the characteristics of the respondents relating to their transportation behavior.

(Table 6, here)

(Table 7, here)

(Table 8, here)

4. Conclusions and policy implications

This work emerged with two fundamental aims. Its first one was to try to explain why climate mitigation policies that involve changes in energy prices have not been implemented in Spain. Previous policy analyses for Spain using simulation methods have demonstrated the superiority in economic terms of using price instruments for climate mitigation, and have shown that these would have minimal adverse distributional impacts. However, if one considers public preferences and perceptions, as revealed by our survey, the reluctance to apply price signals is more readily understood. The Spanish public is historically opposed to increases in energy prices. However, as we show, this opposition could perhaps be overcome with a policy design that stressed the promotion of green energy. This brings us to the second aim of this paper: to provide some guidance for the design of a viable climate policy in Spain. We have found that the Spanish public does seem to have a positive willingness to pay for electricity if the revenue will be used to reduce GHG emissions, preferably by adopting cleaner technologies, and if this eventually lowers the cost of those technologies in the future.

In the rest of the paper, the study presents additional results that reinforce what has been previously stated (Table 2). The questions on attitudes (Table 3) are especially revealing and deal, for the first

time in Spain, with the opinion of citizens on matters that are key to national and international climate policies. In this sense, Spanish citizens put the weight of the responsibility on companies and governments. They are generally technologically optimistic and hope that it will be easier to achieve reduction of GHG emissions in the future, although at the same time support the application of corrective policies now. In contrast to other countries, the Spanish public supports action against climate change regardless of whether developing countries participate or not. However, Spanish citizens are not too keen on the use of flexible mechanisms that permit investment exchange in other countries for emissions (such as the Kyoto clean development mechanism) and favor reducing GHG in Spain.

Few are willing to pay a GHG tax, although there is a widespread preference for the use of environmental taxes whose revenues are devoted to a reduction of other conventional taxes.This suggests that a green tax reform may be a viable and a useful alternative for Spain, especially in a moment of crisis like now. The need to reduce Spain's GHG emissions, the promotion of new technologies and the limited adverse distributional impacts align with the empirical evidence shown here of a willingness to bear a higher cost for electricity and car fuels under certain circumstances.

We should also note that these results are preliminary. We have collected a rich data set through our survey and considerable additional analysis needs to be performed. In future research the responses to the attitudinal questions will be integrated into the analysis of the valuation questions. We will also attempt to compare the valuation results here with the data on the actual reactions of consumers facing similar green electric systems (Pérez and Linares, 2008) or the use of bio fuel.

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TABLES

Table 1. Socio-demographic variables of the sample vs 2001 census (percentages)

Variable	Sample	Census
Sex		
Female	*51.8%*	*51.0%*
Male	*48.2%*	*49.0%*
Educational background		
No Studies	*1.4%*	*3.9%*
Primary School/First part of secondary and similar	*34.6%*	*39.9%*
Vocational school	*23.0%*	*17.5%*
Secondary school complete or partial or similar	*17.0%*	*17.0%*
Undergrad college tech school or similar	*9.7%*	*9.6%*
Graduate Studies or similar	*12.2%*	*12.2%*
DK/NA	*2.0%*	
Age		
18-34	*33.1%*	*29.0%*
35-54	*34.0%*	*37.4%*
55 or older	*32.9%*	*33.6%*
Occupation		
Employee	*43.9%*	*39.8%*
Self-employed	*9.7%*	*8.0.%*
Unemployed (looking for first-time employmen/has never worked before)	*0.9%*	*1.0%*
Unemployed (previously employed)	*8.7%*	*11.8%*
Student	*9.4%*	*5.7%*
Housekeeper	*13.7%*	*11.5%*
Retired	*12.3%*	*18.4%*
Other	*0.6%*	*3.9%*
DK/NA	*0.7%*	
Gross Annual Salary		
<3,600	*2.0%*	
>=3,600<7,200	*2.6%*	
>=7,200<10,800	*7.6%*	
>=10,800<14,400	*18.5%*	*n.a.*
>=14,400<18,000	*16.3%*	
>=18,000<2,.600	*14.6%*	
>=21,600	*21.2%*	
DK/NA	*17.3%*	
Place of residence		
Inland	*73.1%*	
Coast	*26.6*	*n.d.*
DK/NA	*1.0%*	
	0.3%	

Table 1 (cont.)

Other personal data	Sample	Census
Autonomous region of birth		
Andalucía	*20.2%*	*18.2%*
Aragón	*3.6%*	*2.6%*
Asturias	*2.7%*	*2.2%*
Baleares	*1.7%*	*1.4%*
Canarias	*3.9%*	*3.4%*
Cantabria	*1.4%*	*1.2%*
Castilla y León	*6.6%*	*6.8%*
Castilla La Mancha	*5.3%*	*5.1%*
Cataluña	*13.0%*	*10.9%*
Comunidad Valenciana	*7.4%*	*7.5%*
Extremadura	*4.0%*	*3.3%*
Galicia	*6.0%*	*6.0%*
Madrid	*11.6%*	*8.8%*
Murcia	*2.4%*	*2.7%*
Navarra	*1.3%*	*1.1%*
País Vasco	*3.6%*	*3.9%*
La Rioja	*0.7%*	*0.6%*
Ceuta/Melilla	*0.1%*	*0.4%*
Foreign	*2.7%*	*14.0%*
DK/NA	*1.7%*	
No of people living in household		
1	*9.4%*	
2	*28.5%*	
3	*29.0%*	
4	*22.6%*	
5	*7.9%*	*n.a.*
6	*2.0%*	
8	*0.1%*	
11	*0.1%*	
DK/NA	*0.3%*	
Type of energy in household		
Electric	*45.8%*	
Natural Gas	*6.0%*	
Propane	*3.6%*	*n.a.*
Other	*44.1%*	
DK/NA	*0.6%*	

Table 2. Knowledge, Attitudes and Behaviors

Knowledge of Climate Change	%
Have you heard about climate change?	
Yes	98.3%
No	1.7%
Extent to which s/he is informed on climate change	
Very Informed	10.0%
Quite informed	45.1%
Little informed	39.1%
Uninformed	5.0%
Don't know	0.8%
In your opinion is climate change real or not?	
It is real	77.3%
Real but exaggerated	17.2%
Not real or serious	3.2%
DN/NA	2.4%
Could climate change be good or bad for you and your family?	
Good	1.6%
Bad	91.0%
Neither good nor bad	7.4%
Attitudes	**%**
Extent to which Spanish households should assume responsibility in reducing atmospheric pollution	
No responsibility	*5.2%*
Small responsibility	*25.3%*
Large responsibility	*51.5%*
Total responsibility	*17.7%*
DN/NA	*0.3%*
Extent to which firms should be responsible for reducing atmospheric pollution	
No responsibility	*1.3%*
Small responsibility	*3.0%*
Large responsibility	*32.5%*
Total responsibility	*62.2%*
DN/NA	*1.0%*
Likelihood of finding technological solutions to avoid the negative affects of climate change	
Very likely	*18.9%*
Quite likely	*44.8%*
Neither likely nor unlikely	*14.0%*
Little likely	*14.7%*
Very little/hardly likely	*7.4%*

DN/NA	*0.1%*
How necessary are measures nowadays to control GHG emissons?	
Absolutely necessary	*41.8%*
Quite necessary	*46.8%*
Little necessary	*7.4%*
unnecessary	*2.2%*
DN/NA	*1.9%*
The Spanish government should do something to control GHG emissions	
Only if developing countries cooperate and control their emissions	
Regardless of whether or not developing countries cooperate	*29.0%*
No, Spain should do nothing:	*62.1%*
DN/NA	*4.3%*
	4.6%

Consumption Habits		
Habits	Yes	No
Separates and recycles solid residues	*81.0%*	*19.0%*
Uses energy-saving equipment and/or recycled paper	*47.5%*	*52.5%*
Attends courses on environmental education	*5.0%*	*95.0%*
Member of an environmental organization	*2.2%*	*97.9%*
Other	*0.0%*	*100.0%*
DN/NA	*6.7%*	*93.3%*
None	*8.3%*	*91.7%*

Table 3. Some Opinions and Preferences

	Totally Agree	Quite Agree	neither agree nor disagree	Quite disagree	Totally disagree	DK/ NS
A.6. Its better to spend on reducing emission in developing countries	10.9%	23.0%	25.8%	17.2%	14.2%	9.0%
A.7. The government should not tell companies what to produce	13.9%	21.8%	22.0%	17.6%	17.9%	6.9%
A.8. The best we can do too help developing countries fight CC is to help them grow	25.5%	39.3%	17.3%	8.4%	5.9%	3.6%
A.9. Funds for economic recovery should be used to improve energy efficiency in buildings	15.2%	30.5%	28.2%	12.9%	10.0%	3.1%
A.10. Households with greater energy consumption should pay more for energy	32.2%	31.6%	16.5%	8.7%	10.0%	1.0%
A.11. Taxes on gasoline are already way too high	53.5%	28.0%	10.0%	3.4%	1.4%	3.6%
A.12. Energy efficient housing should be required	29.2%	31.8%	14.9%	14.9%	7.2%	2.2%

Table 3 (cont.)

A.13. Nuclear energy is valid to fight against CC	17.0%	21.2%	43.2%	5.9%	9.7%	3.0%
A.14. Solar panels should not be promoted in natural areas.	26.5%	30.5%	19.7%	9.3%	8.2%	5.9%
A.15. Education is the best way to fight against CC	52.5%	33.1%	7.2%	3.3%	3.2%	0.9%
A.16. Resources should be dedicated to other environmental problems	18.5%	31.9%	31.3%	7.4%	5.6%	5.3%
A.18. If environmental taxes are introduced, others should be reduced.	40.9%	36.8%	14.0%	3.4%	2.7%	2.2%
	Very Willing	Somewhat Willing	Don't know/ Not sure	A Little unwilling	Very unwilling	DK/NS
A.17. Willingness to pay an anti-climate change tax	6.01%	25.46%	22.32%	14.31%	28.61%	3.29%

Table 4. Estimate of the monthly willingness to pay for the electricity program using the Kaplan-Meier estimator

Bid amount (t_j)	Yes	No	Cdf (F_j)	Pdf (p_j)	$p_j * t_j$
5	67	49	0.4224	0.4224	0.0000
10	45	72	0.6154	0.1930	0.9649
20	22	95	0.8120	0.1966	1.9658
35	16	101	0.8632	0.0513	1.0256
40	13	102	0.8870	0.0237	0.8298
60	10	107	0.9145	0.0276	1.1029
			1.0000	0.0855	5.1282
				E{WTP}	11.0173
			Confidence interval		(9.32; 12.71)

Table 5. Degree of certainty in the response to WTP for Electricity Program

	%
P.12. On a scale of 1 to 10 where 1 is totally unsure and 10 is totally sure, where would you place your opinion?	
1	*2.4%*
2	*0.3%*
3	*1.1%*
4	*1.1%*
5	*10.3%*
6	*4.4%*
7	*5.7%*
8	*15.5%*
9	*18.9%*
10	*40.2%*

Table 6. Estimate of the annual WTP for the gasoline program using the Kaplan-Meier estimator

Bid (t_j)	Yes	No	Cdf (F_j)	Pdf (p_j)	t_j*p_j
25	39	29	0.4265	0.4265	0
50	36	30	0.4545	0.0281	0.7019
75	27	42	0.5923	0.1378	6.8881
100	26	35	*pooled*		
175	20	45	0.6923	0.1000	10
250	13	56	0.8042	0.1119	19.5804
400	15	59	*Pooled*		
			1	0.1958	78.3217
				E{WTP}	115.4921
			Confidence interval	(103.40; 127.58)	

Table 7. Degree of certainty in your response on WTP for the transportation program

	%
P.20. On a scale of 1 to 10 where 1 is totally unsure and 10 is totally sure, where would you place your opinion?	
1	*10.5%*
2	*0.9%*
3	*0.9%*
4	*0.7%*
5	*6.2%*
6	*2.9%*
7	*6.2%*
8	*18.0%*
9	*15.8%*
10	*33.8%*
NS/NC	*4.0%*

Table 8. Responses regarding transportation program

	%	% real
P.14. Do you own a car?		
Yes	*77.7%*	*77.4%*
No	*22.3%*	*22.6%*
P.15. What type of car do you own?		
Small (e.g., Clio)	*30.8%*	27.9%
Medium (e.g., Golf)	*46.4%*	42.6%
Big (e.g., A4)	*18.2%*	19.2%
SUV	*3.3%*	4.8%
DK/NS	*1.3%*	
P.16. Do you usually drive to work?		
Yes	*56.2%*	
No	*42.8%*	*n.d.*
DK/NS	*1.0%*	
P.17. How many kilometers do you drive in a typical week?		
Less than 200 km	*46.1%*	
From 200 to 400 km	*25.2%*	
From 400 to 600 km	*6.5%*	*n.d.*
From 600 to 1000 km	*4.4%*	
Over 1000 km	*3.0%*	
DK/NS	*14.8%*	
P.18. What type of fuel does your car run on?		
Gasoline	*43.1%*	
Diesel	*48.1%*	*n.d.*
Bio fuel	*1.8%*	
DK/NS	*7.0%*	

Table 8 (cont.)

	%
P.21. If the extra cost of using your car per kilometer was x Euro more per kilometer, would this affect how much you use your car each month?	
Yes	*40.7%*
No	*45.1%*
DK/NS	*14.1%*
P.22. What would you do to change how much you use your car?	
Car pool	*15.1%*
Use pubic transport	*24.6%*
Use bike or walk	*12.3%*
Other	*5.1%*
Nothing, I would use it all the same	*34.1%*
DK/NS	*8.8%*

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