Are there ancillary benefits in climate change mitigation policies?

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Abstract. Assessing the Willingness to Pay (WTP) of the general public for climate change mitigation programmes enables governments to understand how much taxpayers are willing to support the implementation of such programs. This paper contributes to the literature on the WTP for climate change mitigation programmes by investigating, in addition to global benefits, the ancillary benefits of climate change mitigation, by considering local and personal benefits arising from climate change policies. The Contingent Valuation Method (CVM) is used to elicit the WTP for ancillary and global benefits of climate mitigation policies in the Basque Country, Spain. Results show that WTP estimates are 53-73% higher when ancillary benefits are considered.

Keywords: willingness to pay; contingent valuation; ancillary benefits; climate change

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1. Introduction

One of the main challenges that societies and economies will have to face in the coming years is how to adapt to and combat climate change. The threat imposed by this phenomenon is becoming more prevalent due to an increase in carbon intensive production and consumption patterns in both developed and developing countries. The Intergovernmental Panel on Climate Change (IPCC) has clearly reiterated in its latest report that societies should no longer delay actions to curb global emissions of greenhouse gases (GHG) if they want to avoid the catastrophic consequences of climate change (IPCC, 2007). Public institutions around the world are designing and implementing plans to mitigate the causes and to adapt to the already existing impacts of climate change. Both options come at a cost to society, as their implementation requires costly technological and behavioural changes. As a consequence, even though in principle the public may support climate change mitigation programs, it is important to assess the extent of the support as households will eventually be presented with aclimate change packages bill, in terms of either higher prices, or taxes, or a combination of both. Therefore, estimating the willingness to pay (WTP) of the current generation for mitigating the effects of climate change is useful to determine the mitigation targets that governments should undertake with the support of taxpayers (Layton and Brown, 2000).

The public authorities of the Basque Country, Spain, have recently agreed to reduce by 16% current GHG emissions levels compared to 1990 levels through the implementation of the "Basque Plan to Combat Climate Change 2008-2012" (BPCCC) (BG, 2008). This Plan would allow the Basque Country (Spain) to be in line with the Spanish targets implied by the Kyoto Protocol. The BPCCC states that, without further action, climate change would result in the following outcome for the region by the end of the 21st century: a reduction in annual rainfall of between 15-20%, with wetter winters and drier summers; maximum temperatures that could rise by between 1.5-3.5 °C and minimum temperatures could rise by between 1-3 °C; greater evapo-transpiration and increased risk of forest fires; significant rises in sea levels and wave power leading to a receding coastline in beach areas by between 11-13 m; increasing risk of flooding in estuaries. Measures identified by the BPCCC to curb GHG emissions in the Basque Country entail, among others: increasing the use of renewable sources and reducing the use of fossil fuels to produce energy, adopting more energy efficient technologies, improving public transport, modernising waste management by improving recycling schemes, as well as managing agricultural areas and forests to reduce GHG emissions.

Economists have mainly used two approaches for evaluating climate change mitigation policies: macroeconomic models and stated preference (SP) models. In the first case, scientific aspects of climate change and economic agents' behaviour are combined for estimating the social benefits and costs of implementing mitigation policies (IPCC, 2001; Dowlatabadi and Morgan, 1995; Maddison, 1995; Nordhaus, 1994). Although they are able to include market and some non-market goods,[1] macroeconomic models rely on detailed and costly data on the world economy to infer the benefits of climate change mitigation measures. Alternatively, SP studies use surveys to directly elicit individuals' WTP for implementing climate change mitigation measures. The Contingent Valuation Method (CVM), a stated preference method, is able to measure all the benefits that the general population experience, including the non-use values of climate change mitigation policies.[2]

Recent studies measuring the WTP of the general population for the global benefits of climate change mitigation include Berk and Fovell (1999), Roe et al. (2001), Berrens et al. (2004), Li et al. (2004), Nomura and Akai (2004), Li et al. (2005), Hidano and Kato (2007), Longo et al. (2008) and Tseng et al. (2009). None of these studies have looked at ancillary benefits induced by climate change policies (i.e. benefits resulting from climate policies that do not relate to the slowing of climate change). Previous research has shown that ancillary benefits may be substantial, as they have been estimated to lie in the range of a multiple of primary benefits of between 0.98 and 6.93 (Pearce, 2000). The scarce economic literature on ancillary benefits has been mainly produced using macroeconomic models (Alfsen, Brendemoen and Glomsrod, 1992; Complainville and Martins, 1994) and through the valuation of the health benefits using the existing literature on use benefit estimation (OECD, 2000)[3]. This paper contributes to the

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[1] Environmental economists classify goods into two groups: market goods, such as cars or oranges, that are traded in markets, and non-market goods, such as air quality or water quality, that are not traded in any markets (see Freeman, 2003).

[2] The total economic value of an environmental good or service is given by its use values and non use values. Use values include direct use values, indirect use values, and option values. Non-use values or existence values are related to non instrumental values which are in the real nature of the good or service, but are not associated with the actual use of the good or service (see Turner et al, 1994).

[3] Since the value of the benefits of reducing GHGs are highly uncertain it is sometimes considered better to give the estimates of co-benefits in terms of US$ per ton of CO2 abated. Earlier studies cited in the Third Assessment Report of the IPCC and in the 2000 OECD review referred to above indicated a wide range of health co-benefits, depending on country, assumptions of baselines, which pollutants were included, the dose-response functions used and the valuation attached to different health end points, particularly premature mortality. The range (in 2000 prices) was from US$0.6 to US$145 per ton of CO2,

literature on ancillary benefits of climate change policies by using stated preference methods.. Using the CVM, we elicit the WTP for ancillary and global benefits of the BPCCC of a sample of 1,000 households in the Basque Country.

The paper is structured as follows. Section 2 reviews the literature on ancillary benefits of climate change mitigation policies. Section 3 describes the survey instrument and its administration. Section 4 addresses the economic and econometric models used to answer our research questions. Section 5 reports and discusses the empirical results and Section 6 provides some concluding remarks and future research needs.

2. Ancillary benefits of climate change

Ancillary benefits are sometimes known as secondary benefits, co-benefits or spillover benefits, mainly depending on the relative emphasis given to their relation with the primary effects. An example of ancillary benefits of climate policy is the positive health effects of air pollution reduction accompanying a GHG emissions reduction. Some authors consider also ancillary benefits the altruistic benefit or 'warm glow' that industrialised countries may enjoy from helping more vulnerable and less responsible developing countries (Rübbelke, 2002). Other forms of ancillary benefits may be considered the benefits associated with employment and technological effects in investments in green technologies or afforestation programmes aiming to reduce CO_2 concentrations to improve the habitat for endangered species.

Primary and ancillary benefits of climate policies can be distinguished on the grounds of three features: 'publicness', given that primary benefits are public goods while ancillary benefits contain characteristics of public and private goods; delay, given that primary benefits arise in the long run while ancillary benefits can be enjoyed in the short run; and the required scientific knowledge, because the uncertainties around primary benefits exceed those around the assessment of ancillary benefits (Markandya and Rübbelke, 2004).

The literature on ancillary benefits has shown that they are substantial. Positive health effects derived from GHG emissions reductions are usually considered the main category of ancillary

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with most under US$30. Since marginal abatement costs (i.e. the costs of the most expensive abatement options to meet the proposed target of a 50% reduction by 2050) from the power sector are estimated to be in the range of US$20-40, such benefits could make a big difference in deciding which options to select for reducing GHGs. More recent studies have provided some explanation for the wide range but they have not resulted in really narrowing it. Hence an SP approach such as that adopted here may be a useful alternative to take.

benefits (Ayres and Walter, 1991; Heintz and Tol, 1996; Olsthoorn et al, 1999). Air quality improvements reduce local mortality rates due to air pollution and help mitigating other negative effects like surface corrosion, weathering of materials, impaired visibility and vegetation acidic depositions. In the transport sector, ancillary benefits may include not only the reduction of air pollution but also other social disturbances like noise, congestion and road surface damage (Johnstone and O'Shea, 1993). A comprehensive overview of empirical studies on ancillary benefits may be found in Rübbelke (2002), Burtraw et al. (2003) and Pittel and Rübbelke (2008). These studies are heterogenous from a methodological and geographical perspective, which further complicates a comparison of their results. The majority of studies employ macroeconomic models applied to individual countries. The estimates found in Western Europe usually exceed those found in studies from the USA and this difference has been attributed to demographic and geographical differences, as well as different aggregation levels. Interestingly, the consideration of ancillary benefits of climate mitigation in transition and developing economies has shown that they may be even higher than those obtained for industrialised economies (Pittel and Rübbelke, 2008; OECD, 2009). Comparing results is extremely difficult because of different ancillary benefits considered (air pollution, transport activity, etc.), different baseline situations and mitigation reductions or even absence of monetary estimations.

3. The CV study

For this study, we administered a contingent valuation (CV) questionnaire to a representative sample of the population of the Basque Country. Each respondent was taken to represent his or her household. Two sets of focus groups were conducted that helped us in crafting a questionnaire that was administered firstly to a sample of 100 households in May 2008. A second pre-test of 100 respondents, conducted in June 2008, confirmed that the changes we had made after the first wave of respondents were appropriate and no further indications for any additional change had emerged. The final survey was administered in June and July 2008 when 1,000 completed interviews were collected. Both pre-tests and the final sample surveys were conducted through in-person interviews in the respondent's home by professionally trained interviewees. The sample was selected to represent the population of households of the Basque Country in terms of age, gender and geographical distribution.

The CV questionnaire aimed at assessing the extent to what citizens in the Basque Country support climate change mitigation policies. In the questionnaire, each respondent faced three

(single-bounded) dichotomous choice WTP questions for implementing three programmes to cut GHG emissions in the Basque Country: (i) by 4% compared to the current emissions levels through an increase in the production of renewable electricity; (ii) by 0.5% compared to current emissions levels through the implementation of energy efficient measures in the residential sector; (iii) by 16% compared to the current emissions levels through the application of the BPCCC that incorporates the previous two measures and a set of other measures to reduce GHG emissions. For each programme, respondents were asked to state whether they were willing to pay a proposed tax to fund the measure.

As the questionnaire focused on eliciting households' WTP for implementing the three programmes to combat climate change, the survey instrument followed the standard structure of a CV study (Mitchell and Carson, 1989). The questionnaire opened with "warm-up" questions aimed at making the respondents comfortable with answering easy and general questions also aimed at understanding the relative importance for the respondents of climate change compared to other priorities, such as employment, education, public health, etc. In the second part, respondents were queried about their knowledge of climate change and they were given information about the causes and the threat of global warming to elicit respondents' attitudes towards climate change. In the third part respondents were asked a set of dichotomous choice CV questions to elicit their WTP; debriefing questions followed to explain the answers to the CV questions. Respondents were asked to state their WTP for three programmes aiming at cutting current GHG emissions levels in the Basque Country. In the fourth part, respondents were asked a set of questions about energy, such as their knowledge about the sources of energy used in the Basque Country, respondents' energy expenditures and their transportation habits. The final section collected some socioeconomic characteristics of the respondents, including their age, civil status, occupation, level of education, and income.

Following the standard CV practice, the payment vehicle used was a tax payable to the Basque Government (Bateman et al., 2002; Carson and Hanemann, 2005; Mitchell and Carson, 1989). The climate mitigation programmes and payment vehicle were found to be both credible and understandable by focus groups participants. Following the literature on multiple CV questions, the elicitation format used was single bounded dichotomous choice CV questions (Bannon et al., 2007; Hoehn and Loomis, 1993; Park and Loomis, 1996; Payne et al., 2000; Poe et al., 1997). Although this approach allows collecting high quality data and minimizing protest answers, possible correlation among responses may complicate comparisons of WTP estimates across scenarios (Poe et al., 1997), an issue that we address in the econometric modelling approach (see below).

Respondents were then presented with the CV questions: they were queried about the introduction of three new taxes, one for promoting the production of renewable electricity, one for creating new revenues that the government would redistribute to households for adopting energy efficient measures at their homes, and a third one for implementing a number of measures, including the two described above for renewable electricity and energy efficiency, in order to implement the BPCCC. Respondents were informed that the third tax for the whole BPCCC programme would replace the previous two taxes for promoting renewable electricity and energy efficiency. As standard use in dichotomous choice CV questions, different respondents were presented with different tax values. The set of six different bid amounts ranged from €10 to €180 for the tax for promoting renewable electricity production, from €5 to €150 for the tax for promoting energy efficient measures and from €20 to €350 for the tax for implementing the whole BPCCC. People were randomly assigned to one of six possible sets of tax amounts.

The CV questions were followed by a set of debriefing questions to identify "protest" respondents, i.e. respondents that state that they are not willing to pay the amount requested but they may actually have a positive WTP (Bateman et al, 2002). We flagged as protest respondents those who were not willing to pay because; (1) they complained that companies are the major causes of climate change and therefore they should pay for it; (2) they suggested that the government should pay for climate change, not the citizens; (3) they found the proposed policies unrealistic; or (4) they felt that climate change was a global problem and that not only Basques should pay for it.

A central aspect of this study was to analyse the ancillary benefits of reducing GHG emissions. According to Markandya and Rübbelke (2004), the reduction in GHG emissions will bring benefits not only in terms of mitigating global climate change, but also in terms of improving local air quality at the source where emissions are reduced. We address the WTP for ancillary benefits of climate change in two ways: (i) by varying the level of information across respondents for the damages of climate change and the benefits of climate change mitigation programs; (ii) and by investigating in the econometric analysis the effect of a covariate that takes into account whether respondents that are concerned for local effects of climate change have a higher WTP compared to respondents not particularly concerned with local effects. We decided to vary the level of information provided to respondents about the effects of climate change and mitigation programmes to assess whether respondents perceived the local benefits of climate change only when they were highlighted about those effects. We therefore split the sample of respondents into two subsamples that faced different levels of information in the description of the programs: one half of the respondents was presented with the

climate policies in terms of global benefits and the other half was presented with this information plus information regarding the local effects in the Basque Country caused by climate change and the local benefits in the Basque Country arising from the reduction in GHG emissions.

The scenarios presented to the respondents read as follows (in italics the additional information about the local benefits and damages shown only to half of the respondents):

> "In recent decades, people have been putting large amounts of "greenhouse gases" such as carbon dioxide into the air, mostly by burning gasoline, coal and natural gas. Scientists say that as a result the earth has been getting warmer and that it will continue to get warmer in the future. They have warned that average world temperatures might increase by approximately 3ºC by 2050. If the earth keeps getting warmer and our climate changes, this could hurt people and nature: scientists say that there are likely to be more droughts, flooding of coastal areas where people live, more severe storms, plants and animals will become extinct and many diseases will spread. Global warming could also be beneficial for some areas of the Earth. *Scientists also expect the following consequences for the Basque Country by the end of the 21st century: average summer temperatures should increase as much as 5.5° C, more irregular rainfall will increase the risks of flooding near the coast,; the sea level would rise of about 40cm causing a loss of beach areas, infrastructures and constructions, and an increase in sea storms. Expected effects on human health in the Basque Country include an increase in rates of sickness and death due to heat waves, increased episodes of acute respiratory problems such as pulmonary infections and serious asthma attacks especially among children and the elderly. Possible positive effects of global warming in the Basque Country could include a lower use of heating in winter."*

Similarly, when respondents were presented the hypothetical programs, two different levels of information were offered to the two groups of respondents. For example, for the BPCCC scenario with a tax of 20 €, respondents were told that:

> "The previous two policies would target only 4.5% of all the greenhouse gases emissions of the Basque Country. A recent study by the University of the Basque Country has shown that the total cost of reducing the greenhouse gases emissions of the BASQUE COUNTRY by

16% by 2012 compared to the current emissions trend to comply with the Kyoto Protocol targets is equal to 24 Million € or 20 € for each household in the Basque Country. This cost of 20 € per household includes the costs of the two measures for renewable electricity and energy efficiency previously described and other additional measures such as improving the control of emissions from industry and agriculture, reducing the emissions from private and public transport and restructuring several public buildings to make them more energy efficient.

The Basque Country government is therefore considering, instead of the previous two policies on renewable electricity and energy efficiency, to impose a climate change tax of 20 € that each household in the Basque Country should pay for four years from 2009 till 2012. This tax would decrease emissions by 16% by 2012 compared to the current emissions trend, *improve local air quality and decrease the number of respiratory problems such as pulmonary infections and serious asthma attacks*."

Finally, the questionnaire also included some questions on individual attitudes towards global warming. In one of these questions, respondents were asked about the relative importance that they gave to the effects of climate change on the Basque Country.

4. Economic and econometric models

As mentioned before, each respondent faced three dichotomous choice WTP questions for implementing three programmes to cut GHG emissions in the Basque Country. For each programme, respondents were asked to state whether they were willing to pay a proposed tax to fund the measure. Answers to these questions are analyzed within the random utility model framework (Hanemann, 1984) that assumes that respondents would choose to pay the proposed tax if the utility they would receive from paying the tax would be higher or equal to the proposed tax.

For the econometric analysis, sequential equations can each be estimated consistently by means of individual single equation probit models. However, this procedure would be inefficient because it ignores the possible correlation between the disturbances (Poe et al., 1997). In the presence of sequential CV questions, joint estimation of CV responses provides more precise WTP estimates (Park and Loomis, 1996). In this context, a multivariate probit

model is a generalisation of the probit model that allows for the joint estimation of several correlated binary outcomes. The general specification for a multivariate probit model is:

$$Y_{im}^{*} = \alpha_m' T_{im} + \beta_m' X_{im} + \varepsilon_{im} \quad m = 1,2,...,M \,, \tag{1}$$

$$Y_{im} = 1 \text{ if } Y_{im}^{*} > 0 \text{ and 0 otherwise,}$$

where Y_{im}^{*} is an unobserved variable that represents the latent utility or propensity of accepting the proposed bid by individual *i* in question *m* (in our case, *m*=1,2,3) and is equal to 1 if individual *i* answers 'yes' to the WTP question, and 0 otherwise; T_{im} is a vector of tax amounts presented for programme *m* to respondents *i* in the CV question *m*; X_{im}, is a matrix of observed variables considered relevant for explaining the choice of individual *i* of voting in favour or against the proposed tax in question *m*; α_m and β_m are vectors of coefficients to be estimated for each question *m*; and ε_{im} is an error term assumed to be normally (0,1) distributed. The variance-covariance matrix of the error term is thus (for *m*=3):

$$\Sigma = \begin{bmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{bmatrix}. \tag{2}$$

The probability of observing a 'yes' response conditioned on β, Σ, *T* and X can be written as follows (Chib and Greenberg, 1998):

$$\Pr(Y_i = y_i, i = 1,2,3 \mid \beta, \Sigma) = \int_{A_1} \int_{A_2} \int_{A_3} \phi(z_1, z_2, z_3, \rho_{12,} \rho_{13,} \rho_{23}) dz_3 dz_2 dz_1 \,, \tag{3}$$

where ϕ is the density function of a multivariate normal distribution with mean vector 0 and the variance-covariance matrix Σ, Z_1, Z_2, and Z_3 are matrixes blocked by vector T_m and matrix X_m comprised by and A_i is the interval $(-\infty, \beta_m' X_{im})$ if $y_1 = 1$ and $(\beta_m' X_{im}, \infty)$ if $y_1 = 0$. The mean WTP for programme *m* with respect to preference uncertainty (ε) can be obtained from the following formula:

$$E_{\varepsilon}(WTP_m \mid \alpha, \beta, X_i) = -\frac{\beta_m' Z_{im}}{\alpha_m}. \tag{4}$$

Our Hypothesis I (see Table 1) is that ancillary benefits in climate change mitigation policies do matter. For this purpose, we add a dummy variable (ANCIL) taking on the value of 1 when respondents face the questionnaire version with the description of the local effects of climate change and climate change mitigation measures (ancillary benefits), in addition to the information of the global effects, and 0 when respondents face the questionnaire without the

ancillary benefits information. A positive and significant sign on the ANCIL coefficient would suggest that respondents that were highlighted with the local effects of climate change and climate change mitigation measures have a higher WTP compared to those respondents that were not given such information. A non significant coefficient would suggest that respondents' WTP was not affected by the amount of information received. Therefore, to properly assess the WTP for ancillary benefits, we add a dummy variable (LOCAL) equal to 1 to account for respondents that thought that climate change was an extremely important or very important issue for the Basque Country, and equal to 0 for those that did not consider important the effects of climate change for the Basque Country. A positive and significant coefficient for LOCAL would suggest that respondents that are concerned also for the effects of climate change in the Basque Country have a higher WTP due to the ancillary benefits of climate change mitigation measures.

As a standard procedure to check the validity of the survey instrument, the second hypothesis (Hypothesis II) of our model aims to analyse the internal validity of our responses. To do so, we include a dummy variable (HIGHI) taking the value of 1 if a respondent has a high income.[4]

The third hypothesis (Hypothesis III) of our model is that the CV study passes the 'scope' test. Theoretically, when valuing two nested goods, economic theory suggests that the larger good should be valued the same or higher than the smaller good, although there is empirical evidence showing scope insensitivity. In fact, scope insensitivity has been raised as a major argument against the reliability of CV (Arrow et al., 1993). Given that in our survey, the BPCCC programme nests the other two programmes for promoting renewable energy and for improving energy efficient measures, we would expect that the WTP(energy efficiency)≤ WTP(renewable energy) ≤WTP(BPCCC).

Hypothesis IV aims to examine the importance of energy security concerns on the WTP for climate change mitigation policies. Policies aimed at guaranteeing energy security are of interest to the European Commission and national governments and they have been found to be supported by energy consumers concerned with climate change (Longo et al., 2008). To test for the importance of energy disruptions, we create the dummy variable BLACK equal to one when the individual is extremely or very concerned with the frequency of energy blackouts, and zero otherwise.

[4] Income level was codified in 5 levels (1 being low income and 5 high income level) and it was converted into a dummy variable taking the value 1 if the respondent was in levels 4 and 5.

Hypothesis V aims to test whether cultural identity is a significant explanatory variable of the WTP to protect natural resources, as it has been highlighted by Hoyos et al. (2009). A dummy variable (IDENT) controls for respondents' self-reported Basque cultural identity.

Finally, we wish to test (Hypothesis VI) whether some respondents' characteristics found to be significant in the literature (i.e. level of education, membership in an environmental organisation and left wing political views) influence the WTP for climate change mitigation by adding respective covariates to the model. Previous research on the effect of membership in an environmental organisation on environmental WTP has found a positive influence (e.g. Longo et al., 2008). Research on the effects of education on WTP has found mixed results. On the one hand, Blomquist and Whitehead (1998), Witzke and Urfei (2001) and Li et al. (2004) have reported a positive relation between level of education and environmental WTP. On the other hand, Danielson et al. (1995), Krupnick et al. (2002), Bergmann et al. (2006) and Longo et al. (2008) have found the opposite effect. Finally, studies by Berrens et al. (2004), Veisten et al. (2004) and Popp (2001) have found that the level of education has no significant effect on WTP. In respect to political views, Bannon et al. (2007) find evidence that policies aiming at reducing GHG emissions in the United States were more favoured by Democrats. We deem it interesting to investigate how political views affect WTP for climate change mitigation strategies in the Basque Country, as, to our knowledge, no previous study has looked into this aspect.

5. Results and discussion

5.1. Descriptive statistics and initial questions

Before analysing the answers to the WTP questions, we check how well our sample represents the population of the Basque Country. We do so by comparing our data with the official statistics of the Basque Country and other large household surveys conducted by the government.

The final sample comprises 1,000 completed questionnaires. By comparing our sample with the official statistics for the Basque Country (EUSTAT, 2007; INE 2008) we find that the sample

well matches the official statistics in terms of age, gender, education, occupation, family size and income compared to the official statistics for the Basque Country.[5]

The first set of questions in the survey instrument investigates how important environmental problems are perceived to be and what the respondents' knowledge of and attitudes toward climate change are. The goals of these questions are to let respondents feel comfortable with answering general questions and to assess the order of importance of climate change mitigation measures compared to other public priorities. Table 2 shows that when asked to choose the most important goal for the Basque Country today, respondents consider economic growth and employment the most important goal, followed by reducing political and social conflicts, decrease poverty and then protection of the environment. In ten years time, respondents consider that economic growth and employment will still be important, but less than they are today, whilst environmental problems will be the second most important problem, followed by reducing political and social conflicts. Comparing these results with the answers obtained by the Ecobarometro 2008 survey,[6] we observe that after the recent 'credit crunch,' respondents are much more concerned with both the economic growth and the environment than the respondents that answered the same question one year in advance for the Ecobarometro survey. We find that 42% of respondents claim that economic growth and employment are important, whilst only 32% had the same view in the Ecobarometro 2008 survey. The respondents of our survey are also less concerned with decreasing poverty than the respondents of the Ecobarometro survey were: only 14% of our respondents suggest that the most important goal is to decrease poverty, compared to 21% of the Ecobarometro survey. We read these results as showing that the recent 'credit crunch' has probably lead people to be less altruistic and more worried about the economy. What is most interesting to us is that our results are consistent with the Ecobarometro findings when considering the protection of

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[5] Descriptive statistics for our survey compare to official statistics (reported in parenthesis) as follows: percentage of males is 45% (48.84%); average age is 40.15 (41.29) years; the average number of adults in the household is 2.60 (2.51); the average number of children living at home is 0.51 (0.41); the unemployment rate is 4.90% (5.60%); the percentage of student is 10.51% (12.27%); the percentage of respondents with basic education is 31.12% (33.14%); personal monthly income is €1119.26 (€1137.25).

[6] The Ecobarometro Social (Social Ecobarometer) is a periodical publication aiming at monitoring the evolution of the Basque public opinion about the environment. For the Ecobarometro Social 2008, conducted in November 2007, 2000 home interviews at a representative sample of the population were carried out. Results can be compared with the European Eurobarometer surveys, co-ordinated by the European Commission, conducted in 2004 and 2007 as well as with past Ecobarometro Social 2001 and 2004 (Euskobarometro, 2008).

the environment: we (Ecobarometro) find that 10% (12%) and 26% (26%) of respondents consider the protection of the environment as the most important goal today and in ten years respectively. These results highlight how, despite the recent financial crisis, the protection of the environment remains an important goal and it will be more and more important in the coming years.

Answers to other initial questions of the survey show that a majority of Basques believes that climate change is occurring (93%) and they are willing to change their habits to be more environmentally friendly (53%). Results show that the respondents are generally aware of the existence of human induced climate change, with only 3.5% of the respondents stating that climate change is a natural process of the Earth. These results are in consonance with similar studies in Spain (Fundacion BBVA, 2008) and the United States (Bannon et al., 2007).

After acknowledging that the characteristics of our sample are comparable with those of the population of the Basque Country, we focus on the results from the CV questions. A complete description of the variables used in the econometric models estimation along with summary statistics is provided in Table 3. In addition to age and gender, other explanatory variables used in the econometric models include: the bids for the three policies - renewable electricity (BIDRE), energy efficiency (BIDEE) and the full climate change mitigation plan (BIDCC); NGO (dummy variable equal to 1 when the individual is member of an environmental organisation), HIGHI (dummy variable equal to one when the individual has high income level), LSTUDY (dummy variable equal to one when the level of education of the individual is low),[7] IDENT (dummy variable equal to one when the respondent has Basque cultural identity), LEFT (dummy variable equal to one when the individual tends to favour left political views), ANCIL (dummy variable equal to one when respondent faces the questionnaire version with additional information on local effects), LOCAL (dummy variable equal to one when the respondent is extremely or very concerned with the local effects of climate change) and BLACK (a dummy variable equal to one when the individual is extremely or very concerned with the frequency of energy blackouts). Potential problems or correlation or multicollinearity were examined but none of them was found.

[7] Educational level was codified in 5 levels (1 being low and 5 high educational level) and it was converted into a dummy variable taking the value 1 if the respondent was in levels 1 and 2.

5.2. Model specification and estimation results

In this section, the answers to the WTP questions for the three programmes are analysed. The data were first analysed using binary probit models, and then, to account for the panel structure of our dataset and for the interdependence in responses across alternative valuation scenarios, a multivariate (trivariate in this case) probit model was used. Maximum likelihood parameters and correlations of the error terms were estimated using LIMDEP econometric software (Greene, 2007). Protest responses were excluded from the analysis.

The results from a parsimonious specification of the multivariate probit specification that explains the answers to the payment questions with the bid vector and a constant term for each equation are reported in Model 1 (see Table 4). This model shows that the three coefficients for the constant terms are positive and significant, suggesting that the respondents support the proposed climate mitigation policies, and the three coefficients for the tax amounts are negative and significantly different from zero, suggesting that utility decreases if the cost of the programme increases (a different but equivalent interpretation is that respondents are less likely to choose a programme the more expensive it is, other things being constant). Estimates of mean WTP are also reported in Table 4, showing that the respondents have a mean WTP of €173.27, €129.92 and €279.08 for implementing the programmes for supporting renewable electricity, energy efficient measures in the house and the BPCCC respectively. Finally, the output from Model 1 reports a strong positive correlation between the individual probit equations. Positive correlation among the three equations suggests that when a respondent supports one programme, she is also more likely to support the other programmes. We specifically find a very strong and positive correlation between the equations for the WTP for renewable electricity and for the WTP for energy efficiency (the correlation coefficient is equal to 0.91), suggesting that most respondents (not) supporting one programme would also (not) support the other one. The correlations between the WTP equations for the BPCCC and the other two programmes are still positive and significant but smaller than the correlation between the two partial programmes. The correlation coefficients are equal to 0.49 between the equations for the BPCCC and the renewable electricity and 0.61 for the equations for the BPCCC and energy efficient measures. The magnitude of the coefficients and the fact that they are statistically different from zero supports the choice of the multivariate probit model as a correct model to analyse the data. The results conform with the literature on CV, as Poe et al. (1997) suggest that nested goods are likely to result in a positive correlation between the error terms.

A second specification, Model 2, aims at investigating the WTP for ancillary benefits in climate change mitigation policies. It explains the answers to the payment questions by adding to the previous specification two dummy variables (ANCIL and LOCAL) in each equation. A likelihood ratio test suggests that including these variables significantly improves the fit of the model (LR=22.86 > χ^2_6=12.59). The non-significant coefficient of the variable ANCIL suggests that adding information on local benefits of climate change policies has no influence on respondent's WTP answers. On the contrary, the coefficient for the LOCAL variable is significant and positive, suggesting that utility increases if ancillary benefits are considered: respondents that are concerned for ancillary effects of climate change are more likely to support the programmes for reducing GHG emissions and have a higher WTP for the programmes compared to those that are not concerned with local effects of climate change and climate change mitigation measures. Furthermore, these results for the ANCIL and LOCAL coefficients suggest that the consideration of ancillary benefits is not 'informationally'-induced but an intrinsic part of respondents' WTP. In fact, the results are robust in two ways: the questionnaire is robust because providing more information with emphasis on the local effects of climate change and climate change mitigation programmes does not affect WTP values; ancillary benefits are not affected by what the respondents are told in the description of the programmes, suggesting that those respondents that care for ancillary benefits do so irrespectively of what they are told (i.e. there is no information bias). Therefore, Model 2 provides us with reasons not to reject Hypothesis I: ancillary benefits positively affect the WTP for climate change mitigation policies and therefore they do matter.

Model 3 incorporates to the specification of Model 1 the influence of socioeconomic characteristics of the respondents: membership in environmental organisations (NGO), high income level (HIGHI), cultural identity (IDENT), left wing political views (LEFT), low educational level (LSTUD) and the consideration of energy disruptions (BLACK). Note that the fit of this model is again significantly higher than the fit of Model 1, as shown by the corresponding likelihood ratio test (LR=63.48 > χ^2_{21}=32.67). All the coefficients in the three equations have the expected signs, but their significance level varies across equations. Here we only discuss the coefficients that are significant. Firstly, a respondent is more likely to support the programme on renewable electricity if she considers ancillary benefits, is politically left-winged oriented or concerned about energy security issues. Secondly, a respondent is more likely to support the programme on energy efficiency if she considers ancillary benefits, her cultural identity is Basque, is left-winged oriented or concerned about energy security issues. And thirdly, a respondent is more likely to support the whole BPCCC if she considers ancillary benefits, is

member of an environmental organisation, has a high income level and is left-winged oriented. The level of correlation between the three probit models is similar to those observed in Models 1 and 2.

5.3. Willingness to pay

In this section, the heterogeneity of respondents' WTP values is further examined.

First, we examine the difference in WTP values for respondents that do consider the ancillary effects of climate change and climate change policies and those that do not using Model 3 and equation (4) (see table 5). The mean WTP for only the primary benefits of the renewable electricity programme is estimated at €124.74, increasing to €200.30 when respondents care about the ancillary benefits of climate change programs. Similarly, the mean WTP for the primary benefits of the energy efficiency programme is estimated at €94.60 for and it increases to €149.45 when respondents consider the ancillary benefits of climate change programs. Finally, the mean WTP for the primary benefits of the BPCCC is estimated at €186.35 and it increases to €326.71 for respondents concerned about the ancillary benefits of climate change programs. In other words, WTP for climate change mitigation measures is 60%, 58% and 75% higher for the three programmes when ancillary benefits are considered. These results are in line with the lower bound estimates of the ancillary benefits assessed through macroeconomic models (Pearce, 2000).

We further examine the heterogeneity of the respondents considering their individual characteristics using Model 3. Table 4 shows the difference in WTP according to the significant socioeconomic variables. WTP measures are calculated at sample means conditioned on the data. Results show that (1) membership of an environmental organisation increases the estimated WTP for the implementation of the BPCCC by 158%, (2) high income level individuals' WTP for implementing the BPCCC is 49% higher, (3) left wing political views increases estimated WTPs by 48% in the case of the policy for promoting renewable electricity, 36% in the case of the policy for promoting energy efficiency and 58% in the case of the policy for implementing the BPCCC, (4) Basque cultural identity of the respondents increases their estimated WTP by 15% in the policy for promoting energy efficiency, and (5) energy security concerned people's WTP is 115% higher if a policy for promoting renewable electricity is implemented and 123% higher if a policy for promoting energy efficiency is implemented.

The relationship between income and WTP is usually analysed to test for internal validity of the survey (Bateman et al, 2002). In this case, we find that respondents with higher income are more willing to support the BPCCC. We can therefore conclude that our WTP estimates are internally valid and that Hypothesis II cannot be rejected. These results also conform with the literature on CV and provide evidence in support of Hypothesis III: we find that WTP increases for programmes offering a higher reduction in GHG emissions and that the WTP is greater for the options that result in greater cuts in GHG. Scope effects were tested by measuring the difference in mean WTP using the test for non-independent distributions proposed by Poe et al. (1997). The *p*-value for the null hypothesis that the E[WTPCC] ≤ E[WTPPR] was <0.001, and the *p*-value for the null hypothesis that the E[WTPPR] ≤ E[WTPEE] was 0.002. We cannot therefore reject the hypotheses that our WTP estimates pass the scope test (see also Figure 1 and Figure 2). Hence, the result that WTP(CC)>WTP(RE)>WTP(EE) confirms that this research passes the scope test: respondents are willing to pay more money for a programme that offers larger cuts in greenhouse gases emissions. Similar results were found in Layton and Brown (2000).

Another interesting result is that the WTP for the BPCCC is smaller than the sum of the two other programmes for reducing GHG emissions from promoting renewable electricity and from encouraging more energy efficient systems in the house. This outcome has been well explained by Carson and Hanemann (2005, p.910) that point out that "when the goods being valued are normal goods and (Hicksian) substitutes for each other, the value of a particular public good should be progressively smaller the later in a WTP sequence it is valued."

The positive and significant signs of the coefficient BLACK for the renewable energy and energy efficiency measures equations provide support for Hypothesis IV, suggesting that respondents concerned with black outs are willing to pay more for the two nested public programmes that reduce the emissions of GHG. Table 4 also provides support in favour of Hypothesis V: similar to the results reported in Hoyos et al. (2009), we find that Basque cultural identity positively affects the WTP for the environmental programmes. However, only for the equation for energy efficient measures the coefficient of IDENT is significant. Therefore, we conclude that having Basque cultural identity increases the mean WTP for climate change mitigation by promoting energy efficiency at home by 15%.

Finally, with regards to Hypothesis VI we find mixing results. Left wing political views positively affect WTP for the three programmes and being members of an environmental NGO positively affect WTP for the BPCCC (but not for the two nested programmes, as the coefficient for NGO is not significant for the renewable energy and the energy efficient measures equations). However, we find no effect of the level of education on the WTP for climate change mitigation

policies, as the coefficients for this variable are not significant in the three equations.[8] These results are similar to those obtained by Longo et al. (2008) with regards to the effect of membership of environmental NGO and to those obtained by Berrens et al. (2004), Veisten et al. (2004) and Popp (2001) with regards to the effect of education level. The positive influence of left wing political views has also been reported by Bannon et al. (2007).

6. Conclusions

This study has examined the preferences and attitudes towards climate change of the population of the Basque Country by interviewing a representative sample of 1,000 households using a Contingent Valuation questionnaire. Results to the attitudinal questions show that the respondents are generally aware of the existence of human induced climate change and are concerned with its effects at global and local scale, in addition to worry for its consequences on future generations. The CV was used to elicit the WTP for global and ancillary benefits of climate mitigation policies under the recently approved BPCCC. Basque households were queried about their WTP for (1) promoting renewable energy aiming at reducing GHG emissions by 4%, (2) improving energy efficient measures at home, aiming at reducing GHG emissions by 0.5% and (3) and for implementing the BPCCC, aiming at achieving the emission targets agreed in the Kyoto Protocol by reducing GHG emissions by 16%. Following the literature on multiple CV questions, single bounded dichotomous choice CV questions were used and models were estimated accounting for interdependence in responses across alternative valuation scenarios. When we looked at the WTP for implementing the BPCCC, we found that respondents favour the implementation of the plan and are willing to pay an increase in taxes to fund the programme. The results of the CV questions reveal that respondents are on average willing to pay an additional annual tax of 281.61 € for a four year period to fund projects aimed at attaining the reductions in GHG emissions required under the BPCCC (16% reduction in GHG emissions). Respondents were on average willing to pay an additional annual tax of 132.01 € for implementing a programme for supporting renewable energy (4% reduction in GHG) and 176.24 € for implementing a programme for supporting energy efficient measures at home.

[8] In a specification not reported here, we checked whether a model with dummy variables for each level of education would improve the fit of the model, but it did not.

These results are policy relevant. From a policy perspective, these results show that Basque citizens are willing to support the implementation of the BPCCC through the introduction of a new tax. The social benefits of implementing the Plan, estimated at 850.66 million €[9], largely exceed its costs of implementation, estimated at 79.50 million € (BG, 2008), so that Plan would be cost-efficient. Furthermore, ancillary benefits represent 79% (672.64 million €) of the social benefits derived from implanting the BPCCC. In other words, almost 80% of the perceived benefits can be attributed to the ancillary benefits of climate change mitigation policies.

Our study further aimed at disentangling ancillary benefits from global benefits of climate change mitigation. The consideration of ancillary benefits has been found to significantly increase the probability of voting in favour of climate mitigation policies. On average, estimated WTP for climate change mitigation policies was increased by 58-75% when ancillary benefits were considered. If this results are converted into a figure per ton of CO2 abated, we find that individuals are WTP 57 € (83 $)/ton CO2 abated in the case of the policy for promoting renewable electricity, 332 € (488 $)/ton CO2 abated in the case of the policy for promoting energy efficiency and 26 € (39$)/ton CO2 abated in the case of the implementation of the BPCCC. These results are slightly higher than those obtained in macroeconomic models reviewed by OECD (2000), excepting for the policy for promoting energy efficiency which is excessively high probably due to the existence of some scope effect.

Other major results of interest from our study are the following: (1) the research is internally valid and passes the scope test; (2) black-outs avoidance concern increases estimated WTP for promoting renewable electricity and energy efficiency; (3) Basque cultural identity is positively related to environmental WTP; and (4) membership of an environmental NGO and left wing political views positively affect the WTP. So, in line with Layton and Brown (2000), the results show, on the one hand, that people care about long-term effects of climate change that in many cases they may no even suffer and, on the other hand, that preferences regarding climate change mitigation are very heterogeneous. Finally, our results are policy relevant as they provide useful information to the Basque government on how much the general population is willing to pay for abating GHG emissions, how much people are concerned about local and personal consequences of climate change compared to global consequences, and which levels of different policy instruments are acceptable by the public for implementing a climate change mitigation strategy. Future research is needed to address different ways of capturing ancillary benefits of climate mitigation policies using CV studies.

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[9] Social benefits are calculated considering the number of households in the Basque Country and a social discount rate of 5%.

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Table 1| Hypotheses tested with the model

Hypothesis	Description
I	Ancillary benefits of climate change mitigation measures matter
II	WTP measures are internally valid
III	WTP measures pass the scope test
IV	WTP is higher when accounting for energy security
V	WTP is higher for those having Basque cultural identity
VI	Members of environmental NGOs, education level and left wing political views positively affect the WTP for climate mitigation policies

Table 2| Most important goals for the BAC today, and in ten years

	Our survey		Ecobarometro 2008	
	Today (N=1000)	In ten years (N=1000)	Today (N=2000)	In ten years (N=2000)
Economic growth and employment	42.20%	31.10%	32%	23%
Decrease poverty	14.10%	12.40%	21%	14%
Protect the environment	10.00%	26.30%	12%	26%
Reduce political and social conflicts	24.80%	15.60%	20%	13%
Improve public health	4.90%	7.60%	8%	12%
Give more participation to people on important decisions (government, city council)	2.00%	3.00%	4%	4%
Other	1.40%	1.40%	2%	2%
Don't know	0.60%	2.60%	2%	7%

Table 3 | Socioeconomic variables and summary statistics

Variable	Definition	Mean	Std. Dev.	Min	Max	Cases
AGE	Age of respondents	39.66	16.09	18	100	738
MALE	Percentage of male respondents	0.45	0.50	0	1	738
BIDRE	Tax amount for the renewable electricity program	68.25	59.26	10	180	738
BIDEE	Tax amount for the energy efficiency program	53.41	51.16	5	150	738
BIDCC	Tax amount for the BPCCC program	134.93	116.80	20	350	738
NGO	Dummy variable equal to 1 if respondent is member of an environmental organisation; and 0 otherwise	0.04	0.19	0	1	738
IDENT	Dummy variable equal to 1 if respondent has Basque cultural identity; and 0 otherwise	0.18	0.38	0	1	738
LEFT	Dummy variable equal to 1 if respondent tends to favour left political views; and 0 otherwise	0.29	0.45	0	1	738
LSTUD	Dummy variable equal to 1 if the level of education of the individual is low; and 0 otherwise	0.16	0.36	0	1	738
HIGHI	Dummy variable equal to 1 if respondent has high income level; and 0 otherwise	0.33	0.47	0	1	738
ANCIL	Dummy variable equal to 1 if respondent faces the questionnaire version with the description of the local effects of climate change and climate change mitigation measures	0.51	0.50	0	1	738
LOCAL	Dummy variable equal to 1 to if respondent thinks that climate change is an extremely or very important issue for the Basque Country; and 0 otherwise	0.68	0.47	0	1	738
BLACK	Dummy variable equal to 1 if respondent is extremely or very concerned with the frequency of energy blackouts; and 0 otherwise	0.90	0.30	0	1	738

Table 4 | Multivariate probit models results[10]

		Model 1		Model 2		Model 3	
	Loglikelihood function	-1093.045		-1081.614		-1061.304	
		Coeff	*t-stat*	Coeff	*t-stat*	Coeff	*t-stat*
Renewable electricity equation	Constant RE	0.9502	*12.21*	0.6509	*5.71*	0.0958	*0.37*
	BIDRE	-0.0054	*-6.77*	-0.0054	*-6.64*	-0.0055	*-6.45*
	ANCIL			0.0518	*0.51*		
	LOCAL			0.4075	*3.87*	0.3625	*3.30*
	NGO					0.3953	*1.23*
	HIGHI					0.1031	*0.87*
	IDENT					0.1490	*1.06*
	LEFT					0.3640	*3.06*
	LSTUD					-0.1613	*-1.12*
	BLACK					0.5289	*3.17*
Energy efficiency equation	Constant EE	0.9233	*12.38*	0.6295	*5.55*	0.0939	*0.47*
	BIDEE	-0.0071	*-7.46*	-0.0071	*-7.44*	-0.0071	*-6.93*
	ANCIL			0.0518	*0.41*		
	LOCAL			0.4075	*3.87*	0.3536	*3.14*
	NGO					0.4446	*1.25*
	HIGHI					0.0309	*0.26*
	IDENT					0.2425	*1.70*
	LEFT					0.2754	*2.45*
	LSTUD					-0.1613	*-1.12*
	BLACK					0.5289	*3.17*
BPCCC equation	Constant CC	0.5317	*7.30*	0.4521	*3.93*	0.2607	*1.37*
	BIDCC	-0.0019	*-4.73*	-0.0019	*-4.67*	-0.0019	*-4.68*
	ANCIL			-0.1829	*-1.91*		
	LOCAL			0.2593	*2.54*	0.2094	*1.97*
	NGO					0.7121	*2.49*
	HIGHI					0.1821	*1.70*
	IDENT					-0.1141	*-0.89*
	LEFT					0.2066	*1.86*
	LSTUD					-0.1061	*-0.77*
	BLACK					0.0323	*0.20*
	Corr(RE,EE)	0.9101	*49.47*	0.9067	*47.44*	0.9032	*43.90*
	Corr(RE,CC)	0.6142	*13.46*	0.6027	*12.78*	0.5979	*12.08*
	Corr(EE,CC)	0.4974	*9.53*	0.4859	*9.11*	0.4826	*8.80*
		Mean WTP	*Standard error*	*Mean WTP*	*Standard error*	*Mean WTP*	*Standard error*
	WTP for RE (€)	173.27	*17.33*	176.03	*17.88*	176.24	*18.33*
	WTP for EE (€)	129.92	*11.85*	131.46	*12.38*	132.01	*9.61*
	WTP for CC(€)	279.08	*38.94*	280.79	*39.60*	281.61	*40.12*

[10] Dependent variables are the probability of choosing "yes" to the WTP questions. From the top of table to the bottom, we first report the output for the probability of choosing "yes" to the CV question for the renewable electricity programme; followed by the probability of choosing "yes" to the CV question for the energy efficiency programme; followed by the probability of choosing "yes" to the CV question for implementing the BPCCC. *t*-statistics are reported in italics. Standard errors for WTP are calculated with the Delta method.

Table 5 | WTP for climate change mitigation

	Implementation of the BPCCC			Promotion of Renewable Electricity			Promotion of energy efficiency		
	Base group	Control group	% change	Base group	Control group	% change	Base group	Control group	% change
Ancillary benefits	186.35	326.71	75.32%	124.74	200.30	60.57%	94.60	149.45	57.99%
Environmental NGO	266.08	686.01	157.82%						
High income	243.47	361.99	48.68%						
Left wing politics	241.35	380.94	57.84%	154.83	228.32	47.47%	119.36	162.70	36.32%
Energy concerns				86.82	186.36	114.65%	62.72	139.82	122.94%
Cultural identity							128.63	147.68	14.82%

Figure 1 | Simulated WTP for climate change mitigation

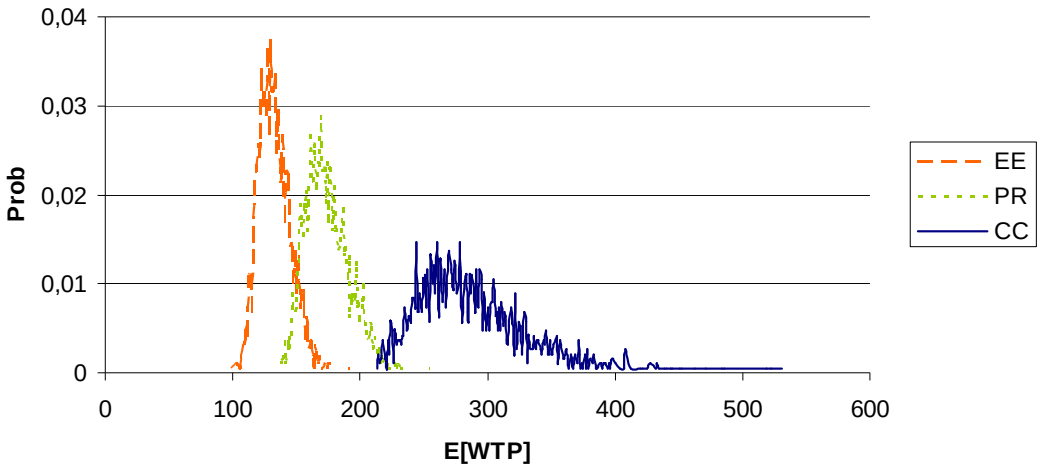

Figure 2 | CDF of the differences of the mean WTP distributions