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Estimating the non-market benefits of water quality improvement for a case study in Spain: A contingent valuation approach

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ABSTRACT

This article addresses an important topic related to the application of the European Water Framework Directive (WFD) in Spanish watersheds. Results on a contingent valuation study, aimed to assess the non-market benefits of water quality improvements in the Guadiana river basin (GRB), are shown. Special attention has been paid to the issue of zero willingness-to-pay (WTP) responses, while addressing the possible presence of self-selection caused by protest responses. The results (i) indicate that sample selection bias is not a problem in our application, (ii) allow us to identify some key determinants of voting behaviour, and (iii) through the use of different econometric models allows us to find a robust estimate for the mean WTP to accurately inform decision-making.

1. Introduction

In the last decades, protecting the quality of its waters has been one of the most important priorities of the European Union (EU). To accomplish this goal, the EU has undertaken various initiatives including the Urban Wastewater Treatment Directive (1991/271/EEC), the Nitrates Directive (1991/67/EC), and the Drinking Water Directive (1998/8/EEC). However, to consolidate this bundle of earlier legislation, and make it more coherent, in 2000 the EU adopted the Water Framework Directive (WFD, 2000/60/EC). This directive can be considered to be the most important and ambitious piece of EU water legislation for the coming years since it establishes an innovative approach for water resource management, introducing economic principles and methods together with specific basin management plans (Griffiths, 2002). It may be thought of as a ''new generation directive'' in the sense that it requires the EU member states to rethink their entire domestic water policies, including qualitative as well as quantitative aspects, substantive policy goals, and institutionally setting up the policy field (Liefferink et al., 2011). The ultimate aim of the WFD is to guarantee that water resources are sustainably managed at a river basin level, and that water quality reaches ''good ecological status'' by 2015.

The WFD enacts as key economic principles the full recovery of the costs of water services, and the necessity of identifying the most cost-effective set of measures aimed at

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improving the health of water resources. Thus, the WFD sets an obligation for EU member states to understand who uses water and what benefits they derive from its use (Moran and Dann, 2008). While many of these benefits can be straightforwardly calculated since there are observable markets for them, such as for example the reduction in drinking water treatment deriving from increased water quality, other benefits of clean water are more difficult to measure given their non-market nature, one example being the recreational benefits related to clean water.

Non-market benefit estimates must therefore be derived by valuation methods based on preference elicitation for environmental changes brought about by the WFD programme of measures (Glenk et al., 2011). Among these methods, the contingent valuation method (CVM) (Mitchell and Carson, 1989) continues to be the most widely used approach to measuring the demand for non-market goods. This survey approach relies on asking respondents in a hypothetical market how much they are willing to pay (WTP) for the provision of a public good or service that implies an improvement in their wellbeing or willingness to accept compensation (WTA) for the loss of this good and the subsequent decrease in wellbeing.

This paper reports an application of the CVM aimed to the assessment of public preferences with respect to the improvement of water quality in a Spanish watershed, the Guadiana river basin (GRB). Thus, the main goal of the research was to provide to the GRB authorities with useful information that will be integrated in a decision-support system for valuing changes in water quality resulting from meeting the quality targets set by the WFD. In addition, there are three secondary objectives. First, to contribute to the growing literature in this area (see e.g., Bateman et al., 2006a; Hanley et al., 2006a,b; Brouwer, 2008; Martín-Ortega et al., 2009; Brouwer et al., 2010; Martín-Ortega and Berbel, 2010; Glenk et al., 2011; Martín-Ortega and Giannocaro, 2011) with the above-mentioned case study designed to estimate the environmental benefits deriving from improving water quality in the GRB. Considering the perceived property rights on the environment, a WTP contingent valuation scenario was used to estimate these benefits. Second, the issue of zero responses in contingent valuation studies was addressed since it can have a substantial impact on the estimated measures of WTP if it is inadequately accounted for in the estimation process. To deal with this problem, several econometric models were estimated and compared adopting a twofold solution. On the one hand, assuming that a sizeable share of the sample surveyed is not in the market of the environmental good in question, a Spike model was applied (Kriström, 1997). And on the other hand, the problem of self-selection bias, which can arise when zero protest responses are excluded from the sample, was tackled by applying a bivariate Probit model with sample selection (Eklöf and Karlsson, 1997; Yoo and Yang, 2001). And third, factors underlying WTP for improving water quality were analysed thus allowing us to validate the results obtained from a theoretical point of view and to identify the key determinants of the voting behaviour observed in the survey.

The remainder of the paper is structured as follows. The following section presents the case study area. Section 3 reports the results of the contingent valuation approach used to assess the non-market benefits of water quality improvements in the GRB. First, the design of the questionnaire and the sampling process are described. After that, the econometric models for the dichotomous question as well as the statistical procedure followed to deal with the problem of zero responses are exposed. Then the results are presented and discussed, also addressing the aggregation of the individual outcomes. Section 4 draws some conclusions and policy implications.

2. Case study: the Guadiana river basin

The Guadiana river basin corresponds to one of the longest rivers in the southwest of the Iberian Peninsula with a length of 852 km and a catchment area of about 67,000 km^2 shared by Spain and Portugal. The part of its catchment area which is under Spanish jurisdiction (83%) covers about 55,500 km^2 distributed in eight provinces (Albacete, Badajoz, Cáceres, Ciudad Real, Cuenca, Córdoba, Huelva and Toledo), although only just two of them, Badajoz and Ciudad Real, account for 75% of the GRB's total area (see Fig. 1).

The population settled in this river basin amounts to 1.84 million people, with a density of only 33 people per square kilometre compared to 75 people per square kilometre for Spain as a whole. This population resides in 473 municipalities, about 95% of which are rural areas according to Eurostat criteria (less than 100 people per square kilometre). On the other hand, the most important economic activities in the Guadiana river basin, in terms of production and employment, are the sales-oriented services sector (37% of gross added value and 34% of employment), the public administrations sector (20% of gross added value and 24% of employment) and the agriculture sector (12% of gross added value and 16% of employment).

The climate of this river basin is Continental-Mediterranean, with a very well-defined dry season and marked temperature fluctuations. The average annual precipitation is 550 mm, and the annual average temperature is 14 °C. The long dry summers are responsible for the low water levels, which can be virtually zero in some tributaries, exacerbating the problems of contamination.

According to information provided by the river basin authority (Confederación Hidrográfica del Guadiana, 2009), the natural annual flow levels of the river, characterized by a marked temporal irregularity, are 6,863 Hm^3 for surface water and 878 Hm^3 for ground water. Of these water resources, 93% is used for agriculture, while urban supply and the industrial sector account for only 6% and 1%, respectively.

The main environmental problems of the GRB stem from (Confederación Hidrográfica del Guadiana, 2009; Martínez and Llamas, 2009): (i) the concentration of population in the major urban areas such as the cities of Ciudad Real and Badajoz; (ii) intensive agriculture, particularly in the 416,000 ha of irrigated land; and (iii) livestock farming with more than 15 million head. For meeting the water quality

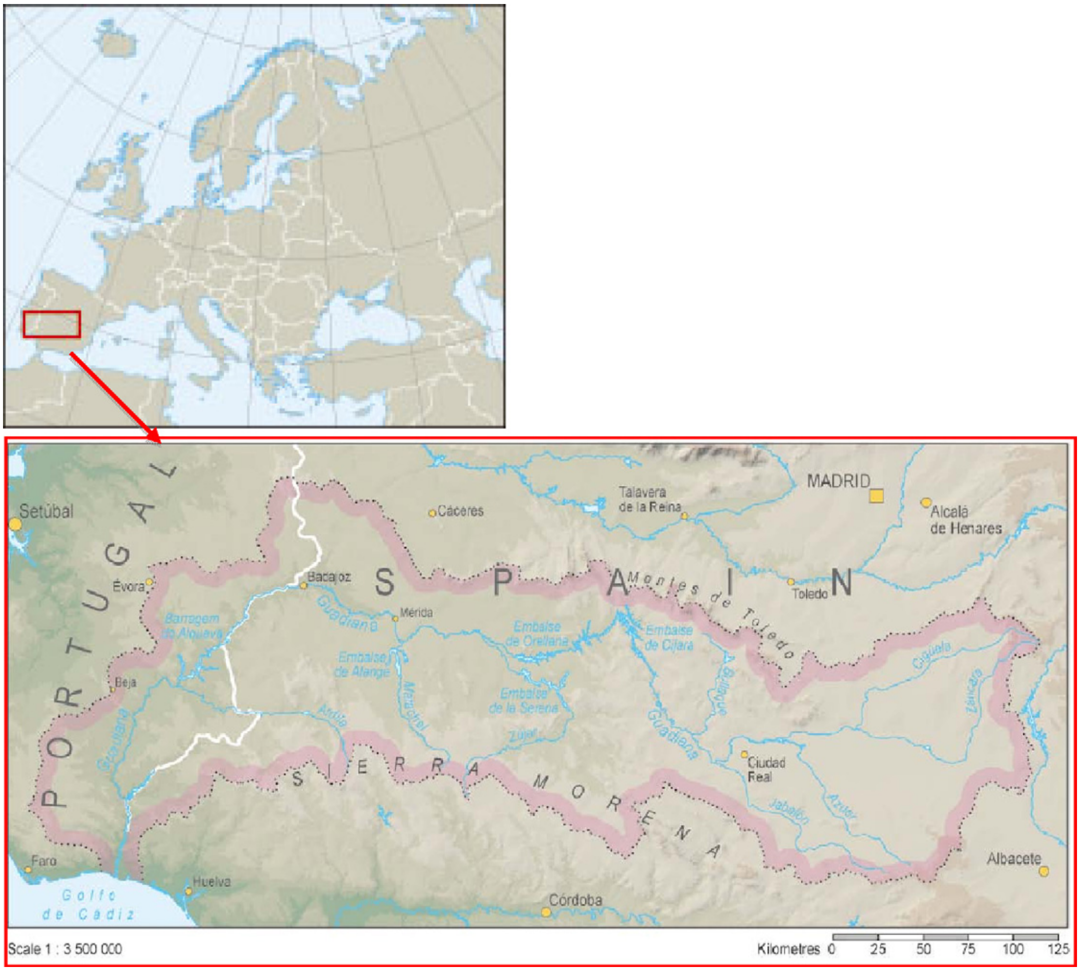

Fig. 1 – Map of the Guadiana river basin.

standards set by the WFD, the available options are, on the one hand, to increase the capacity of the wastewater treatment plants in order to improve the quality of the effluent[1] and, on the other hand, augmenting the availability of natural water flows in particular during the long summer periods in a region characterized by its low levels of annual rainfall.

3. Contingent valuation survey

3.1. *Questionnaire design and sampling*

The goal of a contingent valuation survey is to obtain a reliable economic value for the provision of some good or service (Mitchell and Carson, 1989). In order to attain this goal successfully, careful design of the survey is critical to make the valuation scenario plausible and appropriate for the respondents. The present study took some of the guidelines suggested by the NOAA panel of experts[2] (Arrow et al., 1993). In particular, especially attention was paid to using a pre-test form of the questionnaire to detect sources of bias and to identify unclear wording. The pre-testing procedure consisted of two focus groups and a pilot study of fifty interviews. These two procedures were found to be very helpful in revealing what respondents thought about the proposed water quality policy and its consequences, as well as about the appropriateness of the payment vehicle used.

[1] In the survey, respondents were explained in plain language that the effluent is the treated wastewater that flows out from the plant and that the quality of the effluent can be raised by micro-filtration (tertiary treatment) or by degrading the biological content of the sewage (secondary treatment).

[2] As a consequence of the controversy generated on the validity and reliability of the CVM to inform decision making in natural resource damages after the Exxon Valdez oil spill in Alaska in 1989, the U.S. National Oceanic and Atmospheric Administration (NOAA) convened a Blue Ribbon Panel, co-chaired by two Nobel-Prize winners, to set some strict guidelines that must be followed by contingent valuation practitioners in order to produce reliable estimates of natural resources damages.

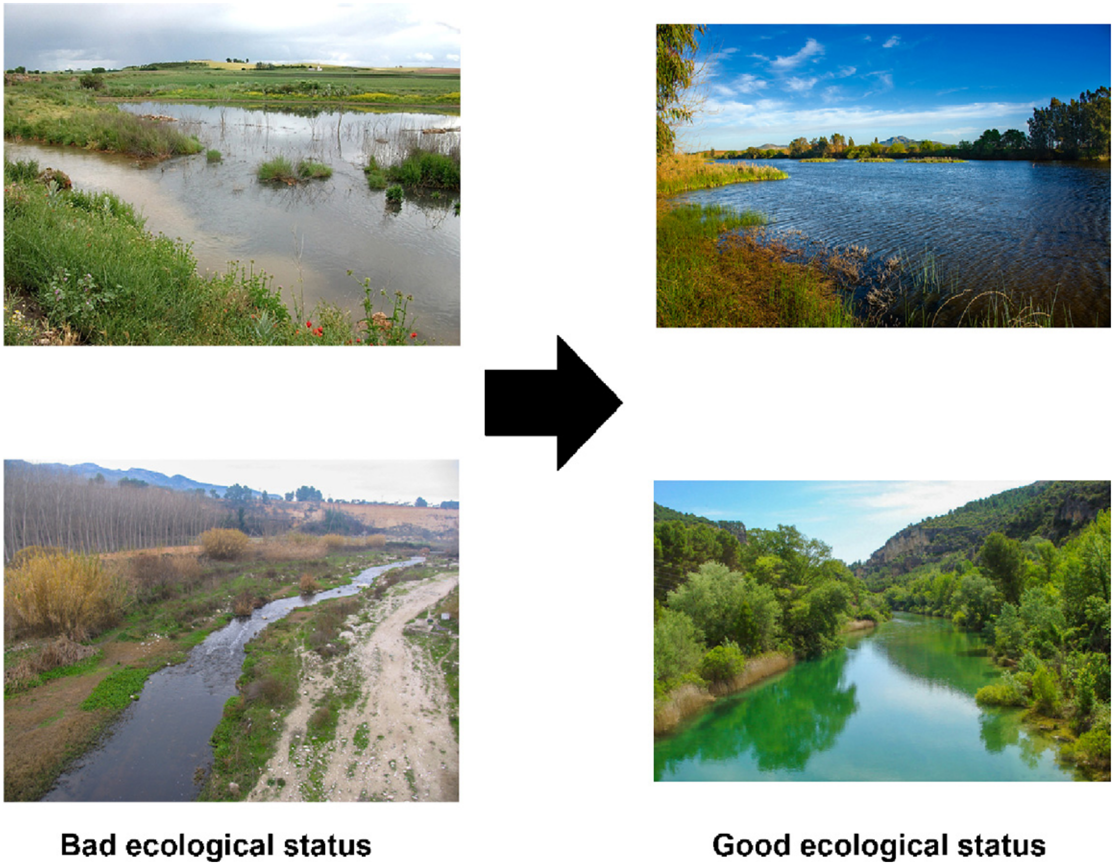

Fig. 2 – Images used to describe the valuation scenario.

After the pre-test stage, a survey of 505 individuals living in 39 municipalities of the GRB area was conducted in February 2010.[3] In order to guarantee the representativeness of the sample, a stratified random sampling procedure (Barnett, 2002) was used so that the main sample parameters (geographical area, age and gender) closely resembled those of the entire population.

As it is usual in CVM studies, the questionnaire[4] (whose full text is available upon request) was divided into three main sections. The first contained attitudinal questions that asked the respondents about the environment in general and more specifically about water resources and their pollution problems. These questions were useful for two reasons. First, they served as an introduction to the valuation scenario in which tougher and more thought-provoking questions were used (Whitehead, 2006). And second, some of the information acquired from this section can subsequently be used as a predictor of WTP.

The second section of the questionnaire was devoted to explaining the contingent valuation scenario, which includes the description of the proposed change in water quality, how this change would be implemented, and the elicitation process or how the respondent's WTP for the proposed change is obtained.

To obtain a valid measure of the non-market benefits of implementing the WFD, it is necessary for the respondents to clearly understand the proposed change in water quality. Hence, to make the CVM scenario more understandable, visual aids play a vital role in maintaining the respondent's attention (Mitchell, 2002). Two types of such aid were employed. One was to describe the proposed improvement in water quality by means of a set of images that showed the current state of water quality and the target to reach once the WFD measures had been adopted (see Fig. 2). And, given that quality targets are defined in the WFD in terms of chemical variables[5] which are in practice not immediately understandable for the vast majority of respondents, the other was a ''water quality ladder'' in which water quality is defined in terms of its suitability for specific recreational activities (e.g., boatable, fishable, swimmable, etc.).[6] In particular, the water quality

[3] This sample size implies a maximum error of 4.5% with respect to the population included in this study. GRB was divided in three geographical areas (upper, middle and lower) according to the GRB authorities and the number of interviews in each area took into account its share on the total population of GRB: upper (43.8%), middle (50%) and lower (6.2%).

[4] The length of the interview was about 15 min and the questionnaire contained 28 items.

[5] Mainly the biological oxygen demand (BOD_5) and the level of phosphorus (P).

[6] Van Houtven et al. (2007), in a meta-analysis of studies on water quality in the USA, show that this is the option adopted in most cases in which a stated preference method had been used.

Water Quality	Level	Characteristics
Excellent	A	Safe for drinking without any treatment Abundant game fish Abundant bank side vegetation
Very good	B	Safe for recreation as swimming Less game fish and some coarse fish Quite bank side vegetation
Good	C	Acceptable for angling and irrigating gardens Virtually no game fish and more coarse fish Less bank side vegetation and some algae
Poor	D	Acceptable for sprinkling and irrigation Less coarse fish No bank side vegetation and abundant algae
Bad	E	Not suitable for any of the above uses No fish No bank side vegetation and abundant algae

Fig. 3 – Water quality ladder used to describe the valuation scenario.

ladder adopted was an adaptation to the GRBs characteristics of the more general-purpose ladder used by Resources For the Future (Vaughan, 1981). However, as is pointed out by Hime et al. (2009), the categories used in the Resources For the Future ladder are somewhat limited since they focus on use values, thus failing to address the ecological change with its associated non-use benefits.

Therefore, the ladder finally used was designed to address both values enabling to reflect the changes in water quality derived from implementing the WFD. As is shown in Fig. 3, the proposed change in water quality is aimed at ensuring that all water bodies reach at least a ''very good'' quality status (level B) that is equivalent to the ''good ecological status'' defined by the WFD. A hypothetical market should be sufficiently believable to the respondent in order that he takes it seriously (Carson, 1991), therefore after analysing the information gathered from expert advice (mainly engineers from the river basin authority) and focus groups, it was thought very unrealistic to achieve the highest quality level (A) that would have implied that the water would be suitable for drinking without any treatment.

The payment vehicle used was an increase in the current water bill. As in Saz-Salazar et al. (2009) and Jones et al. (2008), this was considered the most appropriate with regard to the credibility of the hypothetical market, since it is plausible and familiar to the population surveyed. Its familiarity is because the water bill is currently used to fund other services related to the maintenance of the water supply network. In addition, this obligatory payment avoids the free-rider behaviour typical of voluntary payments (Carson, 1997).

The elicitation method used was the discrete choice or referendum format (Bishop and Heberlein, 1979) given its advantages over open-ended question formats that demand a higher cognitive effort from respondents since they are certainly different from the normal price taking behaviour where consumers react to posted prices (Loomis et al., 1997). However, considering that previous studies carried out in Spain (Saz-Salazar et al., 2009; Martín-Ortega et al., 2009) obtained high rejection rates, it was deemed appropriate to ask the respondents a previous binary question with the purpose of determining whether or not they were in the market. To the respondents who stated that they were not willing to pay, a follow-up question was asked in order to differentiate protest responses from true zero responses.

For the dichotomous question, ten different bids were used ranging from a minimum value of €0.5 to a maximum of €9.0, thus covering a wide range of amounts.[7] The allocation of the total sample to the different bids was based on an adaptation of the model for optimal bid selection proposed by Cooper (1993), assuming a log-normal probability distribution for

[7] The bid vector was: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.0, and 9.0 euros.

WTP, whose parameters were estimated from the responses obtained in the pilot study.

The sequential WTP questions were asked as follows:

Question 1: Considering that (1) the implementation of the proposed change in water quality costs money, (2) you already pay towards some water improvements as a part of your water bill, and (3) any additional money you would pay to improve water quality will not be available to you for other purchases, would you be willing to contribute financially to such a project by means of an increase in your water bill? Yes, No, Don't know.

Question 2 (asked only to those respondents that answered "yes" to the previous question): Considering your willingness to pay, would you pay per month an extra amount of €A in your current water will in order to enjoy the proposed improvement in water quality? Yes, No, Don't know.

Finally, the third section of the questionnaire included demographic and economic questions about the respondents (gender, age, education, income, etc.) that can be used as covariates in explaining the determinants of WTP in a bid function.

3.2. Econometric modelling of the survey responses[8]

Consider an individual or household confronted with a question of accepting or rejecting a project that implies an improvement in water quality for a given sum of money A. The probability that an individual's WTP does not exceed an amount A is $P(WTP \leq A) = F(A)$, where $F(A)$ is a continuous, non-decreasing function whose values range from 0 to 1.

For each individual i, an indicator variable IA can be defined which represents whether or not the individual accepts paying the proposed amount A_i:

$$IA_i = \begin{cases} 1 \text{ if } WTP_i > A_i \\ 0 \text{ if } WTP_i \leq A_i \end{cases} \tag{1}$$

Then, the probability that an individual i accepts paying the proposed amount is given by: $P(i \text{ accepts } A_i) = P(IA_i = 1) = 1 - F(A_i)$.

One of the most commonly assumed forms for $F(A)$ is the logistic function:

$$F(A) = \frac{1}{1 + e^{\alpha + \beta A}} \tag{2}$$

which leads to the well-known Logit model (Hanemann, 1984). This model, along with other popular distributional assumptions such at the log-logistic, log-normal and Weibull, considers that all the respondents are in the market for the public good because it implies that all the respondents have positive WTP.

The Spike model appears to be ideally suited for those situations in which a sizable fraction of the population has a zero WTP (Kriström, 1997; Yoo and Kwak, 2002). Therefore, this model does not exclude a non-zero probability of zero WTP in referendum CVM data, so it allows for the case of some individuals not being in the market for the good in question. In the words of Haab and McConnell (1998) "the good being valued can simply be ignored if it does not provide an increase in utility". So, in this model it is assumed that the distribution function of WTP has the following form (there is a jump-discontinuity – i.e., a spike – at zero):

$$F(A) = \begin{cases} 0 & \text{if } \quad A < 0 \\ \dfrac{1}{1 + e^{\alpha}} & \text{if } \quad A = 0 \\ \dfrac{1}{1 + e^{\alpha + \beta A}} & \text{if } \quad A > 0 \end{cases} \tag{3}$$

In its simplest form, this model divides the sample into respondents with zero WTP and those with positive WTP. Hence two valuation questions are necessary: one asks whether or not the individual would want to contribute to the project, and the other suggests a price A. Thus, instead of a single indicator (IA), one now has another indicator (IO) with which to classify individuals according to whether they wish to participate or not in the hypothetical market created. For each individual i this second indicator is defined as:

$$IO_i = \begin{cases} 1 \quad \text{if} \quad WTP_i > 0 \\ 0 \quad \text{if} \quad WTP_i \leq 0 \end{cases} \tag{4}$$

Therefore, for those respondents who wish to enter the market ($IO_i = 1$), a price A is suggested, and then one has:

$$IA_i = \begin{cases} 1 \text{ if } WTP_i > A_i \text{ and } IO_i = 1 \\ 0 \text{ otherwise} \end{cases} \tag{5}$$

For the Logit model the expected value of WTP, assuming that it is positive, is given by $E(WTP) = -\alpha/\beta$ (Hanemann, 1984), while for the Spike model it is given by $E(WTP) = -\log(1 + e^{\alpha})/\beta$ (Kriström, 1997).

Besides these parametric models, the expected value of WTP can also be calculated using a non-parametric approach that avoids the possible bias in estimating mean WTP values due to the choice of a specific functional form for the probability function $F(A)$ (An, 2000). In this respect, Kriström (1990) proposes a non-parametric approach that allows the expected value of WTP to be determined by the entire set of data available and not by any specific functional form set a priori. This approach is based on the Ayer et al.'s (1955) algorithm, which states that if the proportion of "yes" answers to increasing bids is monotonically non-increasing then the sequence provides a maximum likelihood estimator of the probability of acceptance. Therefore, data are grouped in such a way that the proportion of affirmative answers should be non-increasing for increasing bids, hence the empirical survival function can be estimated. Since only the probability mass at each given bid can be obtained, interpolation between these points should be considered and applied in order to calculate the mean WTP (for a detailed description of this procedure, see Kriström, 1990).

The Logit and Spike models described above can be generalized using a broader set of explanatory variables instead of just the proposed bid A. Thus, if IA_i^* denotes the difference between the indirect utilities that imply for the ith individual a change in water quality from z^0 to z^1, then the equation for the latent variable IA_i^* is:

$$IA_i^* = \alpha + \beta A_i + \delta_1 X_{1,i} + \delta_2 X_{2,i} + \cdots + \delta_M X_{M,i} + \varepsilon_{IA,i} \tag{6}$$

[8] We refer the interested reader to Hanemann and Kanninen (2001) for a comprehensive explanation of the models that use discrete-response contingent valuation data.

where $X_{IA} = \{X_1, X_2, \ldots, X_M\}$ is a vector of explanatory variables in addition to the bid A offered to enjoy an improvement in water quality from z^0 to z^1 (see Table 5 for a detailed description of the explanatory variables initially used in our application). With the introduction of this new indicator variable IA^*, the decision rule of each individual i with respect to accepting or not the offered bid A is now given by:

$$IA_i = \begin{cases} 1 & \text{if} \quad IA_i^* > 0 \\ 0 & \text{if} \quad IA_i^* \leq 0 \end{cases} \tag{7}$$

Analogously, one can assume that behind the decision to participate in the hypothetical market there exists a latent variable IO_i^* given by:

$$IO_i^* = \gamma_0 + \gamma_1 V_{1,i} + \gamma_2 V_{2,i} + \cdots + \gamma_K V_{K,i} + \varepsilon_{IO,i} \tag{8}$$

where $V_{IO} = \{V_1, V_2, \ldots, V_K\}$ is the corresponding vector of explanatory variables for the participation variable (see again Table 5 for a description of all the potential socio-economic regressors) and the decision rule is:

$$IO_i = \begin{cases} 1 & \text{if} \quad IO_i^* > 0 \\ 0 & \text{if} \quad IO_i^* \leq 0 \end{cases} \tag{9}$$

With the introduction of these two decision rules, the Spike model can be seen as a sequential dichotomous choice specification:

$$\begin{cases} IO_i = 0 \text{ if } IO_i^* \leq 0 \\ IO_i = 1 \text{ if } IO_i^* > 0 \rightarrow \begin{cases} IA = 1 & \text{if} \quad IA_i^* > 0 \\ IA = 0 & \text{if} \quad IA_i^* \leq 0 \end{cases} \end{cases} \tag{10}$$

3.3. Results

About half of the respondents (258 of the 505 respondents) stated that they were not willing to pay any extra money in their water bill in order to attain the water quality targets set by the WFD. Although some zero bids are a true reflection of individuals' preferences, others may be motivated by protest behaviour. In this latter case, respondents are either reacting to some component of the survey as might be the payment vehicle used, or simply mistrust the public use of the funds collected. The usual way of differentiating between a true zero WTP and a protest response is to present those respondents that are not willing to pay with a set of debriefing questions. Based on the answers to these questions, researchers are able to ascertain whether the response is a true zero or a protest against the valuation scenario (Meyerhoff and Liebe, 2006).

Table 1 shows the reasons behind a "no" WTP response. True zero responses were received from individuals that "cannot afford to pay" (6.9%) or that considered "too high the amount offered" to them although they would pay a lower amount (5.9%). The proportion of protest responses was 38% of the full sample. A vast majority of respondents who protested stated that they "already pay enough taxes" (16.2%) and that "the public administration should fund the measures needed to meet the water quality targets" (11.1%). Although the rate of protest responses obtained is very close to the upper limit of the range considered usual in a CVM study – from 20% to 40% of the interviews carried out (Carson, 1991) – Johnson and Whitehead (2000) state that WTP questions generate a considerable number of zero responses for many policy issues. For example, Dziegielewska and Mendelsohn (2007) obtained that over 65% of the sample rejected the offered bid while Kriström (1997) also obtained a similar result. Jorgensen et al. (1999) and Jorgensen and Syme (2000) show that depending on the nature of the good being valued and the question format used, protest response may vary considerably while García-Llorente et al. (2011) found that respondents with lower education levels and lower interest in nature had a higher probability of protesting.

Table 1 – Reasons for a "no" WTP response.

Reasons	Number (%)
True zero responses	
The amount given is too high	35 (6.9)
I cannot afford to pay anything	30 (5.9)
Protest responses	
I do not have enough information	31 (6.1)
I consider unethical to assess water resources in monetary terms	24 (4.8)
I already pay enough taxes	82 (16.2)
The government should fund the proposed improvement in water quality	56 (11.1)
Total rejection (true zero + protest responses)	258 (51.0)

Note: Percentages are calculated over the full sample (505 interviews).

Protest responses are generally excluded from a contingent valuation analysis, otherwise they could lead to underestimating WTP since one would be assigning a zero value to some respondents who probably have a positive WTP which they do not show since they reject the hypothetical market created. Although this exclusion was also applied in the present study, in view of the possibility that the exclusion of an important share of the sample could cause a selectivity problem affecting the validity of the WTP estimates (Calia and Strazzera, 2001), a series of statistical analyses were carried out to check whether the factors that cause protest responses are correlated or not with those that affect the probability of accepting the proposed payment. In particular, a bivariate Probit model[9] with sample selection was estimated for the dichotomous question, which considers the possible presence of self-selection caused by the protest responses. In our case, this correlation was statistically insignificant (as will be seen below), thus justifying the decision to exclude the protest responses from the models estimated.

To those individuals who responded "yes" to the first dichotomous question,[10] i.e., they were in the market for this environmental good, a second dichotomous question was asked offering them a bid A. About 73% of this subsample of respondents accepted the suggested bid while about 27% rejected it. One expects the percentage of "yes" responses to be monotonically decreasing, i.e., the higher the bid offered, the lower the probability of accepting it. In the present case, due to the small differences between successive bids, this expectation did not hold, especially for the lower bids.

[9] Interested readers should consult Greene (2012, pp. 738–752) for full technical details of the bivariate probit approach.

[10] Here the number of respondents was 239 observations instead of 247 due to lack of response in the remaining 8 cases.

Table 2 – Number and percentages of "yes" responses by interval.

Interval	[€0.5–€2]	[€2.5–€4]	[€5–€9]	Total
Number (%)	86/94 (91.5%)	52/67 (77.6%)	37/78 (47.4%)	175/239 (73.2%)

Source: our own calculations.

Table 3 – Estimation results: Logit and Spike models of the dichotomous question.

Variable	Logit model	Spike model
Constant	1.408*** (0.23)	1.314*** (0.14)
A (bid)	−0.302*** (0.05)	−0.282*** (0.03)
Log likelihood	−190.241	272.710
% Correct predictions	66.6%	–

Note: The estimated standard errors are given in parentheses.
*** 1% significance level.

Table 4 – WTP estimates (€).

Model	Mean WTP	95% confidence interval
Logit	4.66	(3.79–5.53)
Spike	5.51	(4.55–6.47)
Non-parametric	6.31	–

Source: our own calculations.

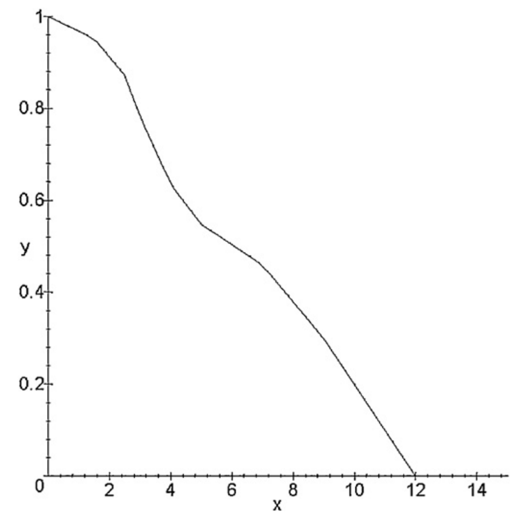

Fig. 4 – Empirical survival function associated with the proportion of "yes" responses. *Note*: This function has been obtained according to Kriström's (1990) non-parametric approach. The vertical axis shows the probability, while the bids offered are shown on the horizontal axis.

However, when the data were grouped into intervals (see Table 2), the percentages of "yes" responses did indeed decrease as the offered bid increased.

In order to obtain the mean WTP for an improvement in water quality, the three econometric models exposed earlier were estimated for the dichotomous question. The estimation results for the parametric models are shown in Table 3 while Fig. 4 shows the empirical survival function associated with the Kriström's (1990) non-parametric approach. The corresponding mean WTP estimates are listed in Table 4. As can be seen, there are differences between the mean WTP estimates obtained from the three models. Such differences are usual in contingent valuation analyses as is shown by Bengochea-Morancho et al. (2005). Nevertheless, it can be concluded that these differences are not statistically significant since the mean WTP values estimated from the Logit and non-parametric approach lie within the 95% confidence interval for the mean WTP estimated from the Spike model (€4.6–€6.5). This can be interpreted as a sign of the robustness of the results given by the different models.[11] Therefore, when aggregating the individual WTP values, we shall choose the mean WTP value obtained from the Spike model (€5.5), which coincides precisely with the mid-point of the aforementioned confidence interval.

At this point, it is necessary to construct an equation that predicts WTP for the environmental good with a reasonable explanatory power and coefficients with the expected sign, thus validating the results theoretically, i.e., the survey has indeed measured the intended construct (Carson, 2000). The explanatory variables used and their main descriptive statistics are listed in Table 5. These variables were obtained from the first section of the questionnaire, which asked about general attitudes on the environment and water resources, and from the last section of the questionnaire, which included socio-demographic questions.

The estimated equations are shown in Table 6.[12] First, as described above, a Probit selection equation was estimated to explain the differences between protest and non-protest responses. As a by-product of this equation, the associated inverse Mills ratio was calculated (Amemiya, 1981), and this variable was included as an additional explanatory variable in the equation estimated to explain the participation in the hypothetical market created (for a detailed description of this procedure, see Van de Ven and Van Praag, 1981). As can be seen, the parameter associated with this variable is not statistically different from zero, so that the protest response does not lead to any significant sample selection bias. In other words, the

[11] And also as a sign that the distributional hypothesis on which the Logit and Spike models are based does not lead to a biased estimate of the mean WTP.

[12] The presented models are reduced versions of the full models considering only the statistically significant variables. Model selection was done using a stepwise procedure.

Table 5 – Explanatory variable descriptions and statistics.

Variable	Description	Mean	Standard deviation	Minimum	Maximum
AGE	Respondent's age	46.90	17.79	18	92
AGE1840	Dummy variable (<40 = 1)	0.41	0.49	0	1
AGE65	Dummy variable (>65 = 1)	0.21	0.41	0	1
SEX	Dummy variable (female = 1)	0.51	0.50	0	1
MARRIED	Dummy variable marital status (married = 1)	0.64	0.48	0	1
EDUCATION	Level of studies completed (no studies = 1 to university studies = 5)	2.35	0.99	1	5
PEDUCATION	Dummy variable education level (only primary education = 1)	0.67	0.47	0	1
EDUCMS	Dummy variable (high school and university studies = 1)	0.11	0.32	0	1
FM	Number of family members	3.12	1.54	1	19
FM16	Number of family members under 16	0.60	0.96	0	10
OCCUPIED	Dummy variable labour status (occupied = 1)	0.47	0.50	0	1
INCOME	Net personal income (no income = 1 to > €3000 per month = 10)	3.52	1.80	1	10
INCOME2	Net family income (<€600 = 1 to > €4000 per month = 7)	2.55	1.20	1	7
ECOLOGIST	Dummy variable for association (environment or nature defence group and citizen's platform = 1)	0.02	0.14	0	1
LOWERAREA	Dummy variable (lower area = 1)	0.06	0.24	0	1
UPPERAREA	Dummy variable (upper area = 1)	0.44	0.50	0	1
INHABITANT	Residence area (municipality <5000 = 1 to municipality > 20,000 inhabitants = 4)	2.71	1.28	1	4
INHAB010	Dummy variable residence (municipality < 10,000 inhabitants = 1)	0.43	0.50	0	1
INHAB1020	Dummy variable residence (municipality between 10,000 and 20,000 inhabitants = 1)	0.14	0.35	0	1
ENVCP	Dummy variable about importance given to protection and conservation of the environment (very important = 1)	0.78	0.41	0	1
ENVS	Dummy variable about the degree of deterioration of the environment (very deteriorated = 1)	0.26	0.44	0	1
ENVHE	Dummy variable about if environment state harms respondent's health (harms it a lot = 1)	0.29	0.45	0	1
ENVPOLLUT	Indicator variable about importance given to the environmental problem of pollution (not important = 1 to very important = 5)	4.72	0.65	1	5
ENVNOISE	Indicator variable about importance given to the environmental problem of noise (not important = 1 to very important = 5)	4.11	1.01	1	5
ENVSPECIES	Indicator variable about importance given to the environmental problem of species extinction (not important = 1 to very important = 5)	4.68	0.68	1	5
ENVLANDSC	Indicator variable about importance given to the environmental problem of landscape (not important = 1 to very important = 5)	4.59	0.76	1	5
ENVFIRE	Indicator variable about importance given to the environmental problem of fires (not important = 1 to very important = 5)	4.83	0.54	1	5
ENVCLIMA	Indicator variable about importance given to the environmental problem of climate change (not important = 1 to very important = 5)	4.52	0.81	1	5
ENVWSCAR	Indicator variable about importance given to the environmental problem of water scarcity and pollution (not important = 1 to very important = 5)	4.69	0.72	1	5
INVESTPA	Dummy variable about respondent's opinion regarding if public expenditure on protecting the environment is enough (yes = 1)	0.21	0.41	0	1
RECICLE	Dummy variable about recycling (yes = 1)	0.77	0.42	0	1
SAVEWATER	Dummy variable about saving water at home (yes = 1)	0.89	0.31	0	1
EXPENSIVEW	Dummy variable about respondents' opinion regarding current water price (expensive or very expensive = 1)	0.53	0.50	0	1
GRBWATER	Dummy variable about current state of GRB waters (bad or very bad = 1)	0.29	0.45	0	1
RECREA	Dummy variable about recreational activities in the GRB (yes = 1)	0.37	0.48	0	1
WFDTAR	Dummy variable about the importance of complying with the WFD targets (yes = 1)	0.98	0.14	0	1

hypothesis of no interdependence between the decision to protest and the decision of willingness to pay some extra amount in order to increase water quality (the decision to enter the market for this environmental good) cannot be rejected. This result thus reaffirms the decision taken to eliminate the protest responses from the subsequent econometric analysis.

With respect to the Probit participation equation, in which the dependent variable (IO) takes the value "1" if the respondent decides to enter the market agreeing to pay some

Table 6 – Econometric results.

Variable	Selection equation (do not protest = 1)	Participation equation (IO = 1)	Acceptance equation (IA = 1)
Constant	0.657** (0.31)	−1.081* (−1.72)	0.424 (0.50)
A (bid)			−0.371*** (0.05)
INCOME		0.172*** (0.06)	0.120** (0.06)
AGE1840		0.569*** (0.23)	
MARRIED		0.409** (0.21)	
PEDUCATION	−0.361*** (0.13)	−0.488** (0.24)	
UPPERAREA	0.233* (0.12)		
INHAB010		−0.516*** (−2.57)	
INHAB1020	−0.465*** (0.17)		
GRBWATER	−0.444*** (0.13)		0.687** (0.31)
SAVEWATER	0.365** (0.19)		
ENVNOISE	−0.145*** (0.06)		0.255** (0.11)
ENVCLIMATE		0.310*** (0.12)	
RECICLE	0.229* (0.14)		
RECREA	0.280** (0.13)		
INV. MILLS RATIO	–	−0.134 (0.66)	0.135 (1.03)
Log likelihood	−306.774	−108.306	−77.699
% Correct predictions	68.2%	79.0%	79.3%

Notes: All the variables are defined in Table 5. The estimated standard errors are given in parentheses.
* 10% significance level.
** 5% significance level.
*** 1% significance level

extra amount in the water bill in order to increase water quality, and the value "0" otherwise,[13] the regression results suggest that the likelihood of a "yes" response is positively related with the respondent's family income, so the higher income is, the higher the probability of entering the market. Another variable that also shows positive sign is to be aged between 18 and 40. Usually in the contingent valuation literature is found that middle-aged and young people have a higher probability of entering the market than older people since this latter group has a different scale of values regarding the environment (Saz-Salazar et al., 2009). Being married and to be aware of the importance of climate change also affect positively the decision of to enter the market. On the other hand, having a low educational level (no formal education or primary only), and living in municipalities of fewer than 10,000 inhabitants affect the decision negatively.

The third column of Table 6 presents the results of the Probit acceptance equation in which the dependent variable records whether ($IA = 1$) or not ($IA = 0$) a respondent was willing to pay the bid offered once he accepted to enter the market (this is the second equation of the sequential model, the first being the participation equation). As expected, this probability is negatively and significantly related to the offered bid, i.e. the higher the payment offered to the respondent, the lower the probability of acceptance. Another important variable showing the expected sign is household income, so the higher respondent's household income, the higher his WTP. The non-market valuation literature strongly suggests that income is positively related with environmental quality improvements (Hanley et al., 2009). Similarly, the respondents who consider the current state of water resources in the GRB as "bad" or "very bad", and that noise is a serious environmental problem, are more willing to pay than the rest of the respondents. Therefore, as expected, respondents that have a higher environmental concern have a higher probability of accepting the offered payment.

After concluding the econometric analysis of the individual responses, now we address the aggregation[14] issue in order to estimate the social benefits that stem from the hypothetical increase in water quality in the GRB in accordance with the WFD. From the different WTP estimates obtained, we chose €5.5 as a representative value since it was that obtained from the Spike model whose confidence interval, as was noted above, includes the estimates of the other two models.

Now it is necessary to identify accurately the extension of the market since otherwise the aggregate estimates can be severely biased (Bateman et al., 2006b). Therefore, considering that the payment vehicle was an increase in the water bill, the aggregation criterion chosen was the number of families living in the area covered by the GRB. This population is about 1,840,000 inhabitants, and given that the average family size is 3.12 people,[15] one has that around 590,000 families are living in this area. Multiplying the number of families by the chosen WTP value, one obtains that the annual value of the social benefits from improving the water quality is about 39 million -euros. If instead one takes the lower and higher levels of the confidence interval calculated for the mean WTP (€4.6 and €6.5), then the annual social benefits range from a minimum value of approximately 32 million euro per year to a maximum

[13] Given that the protest responses were excluded, the observations $IO = 0$ can be taken as genuine zero responses related to economic reasons ("... I consider excessive the amount of the bid offered or I cannot afford to pay any extra amount").

[14] Aggregation of money measures of utility (as WTP) is a controversial issue in welfare economics since is seemingly impossible without value judgements (Just et al., 2004).

[15] Both these data were provided by the INE (Spanish Institute of Statistics).

of 46 million euro per year. These figures refer only to the non-market benefits deriving from improving the water quality. In order to obtain all the benefits that accrue from these policies, it would be necessary to also consider the market benefits.

3.4. Discussion

In contingent valuation analysis, a common phenomenon is that a proportion of respondents answer that they would refuse to pay any amount for a public good because (i) some mitigating circumstances (e.g. they cannot afford to pay) or (ii) some dissension regarding the contingent valuation scenario itself (e.g. the payment vehicle, the perceived unfairness of having to pay for protecting the environment, etc.). Whatever their nature, the treatment of zero responses become problematic since there is a large potential for influencing the size of the mean WTP estimates (Lindsey, 1994), hence this problem is frequently viewed as a threat to the validity of the CVM in informing decision making. Therefore, in this research this important issue was addressed in two ways. On the one hand, assuming that a sizeable part of the respondents were not in the market for the environmental good in question (i.e. they gave a true zero response), a Spike model was applied that is especially suited for these cases. And on the other hand, it was possible to exclude protest zero responses from the analysis without compromising the results since the estimated bivariate Probit model with selectivity showed that self-selection bias was not a problem.

With respect to the estimated mean WTP values, it is well known that the results of any contingent valuation study are sensitive to the assumed econometric specification (Clinch and Murphy, 2001; Bengochea-Morancho et al., 2005). While this study is of course no exception, its results can be said to be robust for at least two reasons. First, the values of the mean WTP obtained from the three approaches considered (two parametric, and a non-parametric one) were quite similar and were not statistically different. And second, in explaining the determinants of WTP, all the valuation functions estimated were able to pass some minimal test of theoretical validity since the main variables were statistically significant and had the expected sign. In particular, attitude towards paying was negatively related with the payment offered while it was positively related with family income. In the same way, our results also showed that there is a positive and significant relationship between the environmental awareness of the respondents and their WTP. More precisely, those individuals that were concerned with the current quality status of water and with other environmental problems, such as noise and climate change, showed a higher probability of accepting the proposed payment. This result conforms to the findings of two previous contingent valuation studies carried out in Spain in the context of the WFD. Both Martín-Ortega et al. (2009) as Saz-Salazar et al. (2009), found evidence of the existence of a positive correlation between WTP and the fact of being aware of the current quality status of water in their respective water basins analysed.

From a policy perspective, it is necessary to recall that one of the key elements of the WFD is its call for water services, such as supplying clean drinking water, to be charged at a price which fully reflects the costs of the services provided (e.g. operational and maintenance costs and environmental and resource costs). Therefore, the implementation of the WFD will imply that users are going to be charged higher prices for the use of water resources. Hence the mean WTP estimates obtained from this study can be used as a benchmark for calculating the necessary increase in water prices at the level of individual households. So if we consider (i) that the average resident in the GRB is willing to pay an annual increase in his water bill of €33 (5.5×6)[16] and that (2) the average annual water bill[17] paid by a household in Spain is €308, then the resulting increase in the water bill for a resident in the GRB would be of an 11%. Martín-Ortega et al. (2009) obtained a similar result for the Guadalquivir river basin since the annual mean WTP estimated was €39, what would imply a hypothetical increase in the water bill of 12%. However, Saz-Salazar et al. (2009) found that the annual mean WTP for improving water quality in a river in Eastern Spain was €110, being in this case the hypothetical increase in the water bill considerably higher (36%). Therefore, this comparison shows that, as expected, the resulting increase in water prices depends mainly on the proposed change in quality levels as well as other factors such as the differences in attitudes and preferences about the environment of the different populations involved.

4. Conclusions and policy recommendations

This study has provided an insight into public preferences for water quality improvements in the GRB in the south of Spain. Thus, the CVM has been applied to estimate the value people place on these improvements as they are envisaged by the WFD. This valuation process was particularly urgent in the case of Spain, and other European Members states, as a consequence of the delay in submitting their respective basin management plans on time to the European authorities as it was required by the WFD.

In order to address the critical issue of zero responses, several models were estimated concluding that sample-selection bias was not a problem, hence protest responses were excluded from the sample in estimating the different models. The results showed that the mean WTP for the proposed change in water quality was about €33 per family and per year. Aggregating by the number of households residing in the GRB, this yields that the social benefits of improving water quality are around 39 million euro per year.

At a practical level, the results obtained could have important policy implications. First, the estimated mean WTP can serve a reference point for future price increases for water quality improvements what would imply and average increase in the current water bill of around 11% for the residents in the GRB. Second, distributional effects among different regions in Spain can arise considering that the WTP values obtained depend mainly on the proposed change in water quality. Therefore, residents in regions with lower

[16] In Spain the water bill is issued in a bi-monthly basis.

[17] Information provided by the Spanish Ministry of Environment (Ministerio de Medio Ambiente, Medio Rural y Marino, 2007).

quality levels will have to bear higher water prices to achieve the good ecological status of their water bodies. And third, considering this asymmetrical distribution of the burden of implementing the WFD, the question here is if this outcome is acceptable to everyone.

Finally, as Brouwer (2008) points out, the WFD is widely considered and interpreted as an ecological directive based on ecological principles of sustainable water management. Therefore, despite their popularity, survey research techniques, as the contingent valuation method, are not intended to replace current decision-making procedures and expert assessment about what is the good ecological status of water resources, but to complement the flow of relevant information to support decision-making in this field.

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