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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