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Research article

The income elasticity of Willingness-To-Pay (WTP) revisited: A meta-analysis of studies for restoring Good Ecological Status (GES) of water bodies under the Water Framework Directive (WFD)

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ABSTRACT

The income elasticity of Willingness-To-Pay (WTP) is ambiguous and results from meta-analyses are disparate. This may be because the environmental good or service to be valued is very broadly defined or because the income measured in individual studies suffers from extensive non-reporting or miss reporting. The present study carries out a meta-analysis of WTP to restore Good Ecological Status (GES) under the Water Framework Directive (WFD). This environmental service is narrowly defined and its aims and objectives are commonly understood among the members of the scientific community. Besides income reported by the individual studies, wealth and income indicators collected by Eurostat for the geographic entities covered by the individual studies are used. Meta-regression analyses show that income is statistically significant, explains a substantial proportion of WTP variability and its elasticity is considerable in magnitude ranging from 0.6 to almost 1.7. Results are robust to variations in the sample of the individual studies participating in the meta-analysis, the econometric approach and the function form of the meta-regression. The choice of wealth or income measure is not that important as it is whether this measure is Purchasing Power Parity (PPP) adjusted among the individual studies.

1. Introduction

This work examines the relationship between Willingness to Pay (WTP) for achieving a Good Ecological Status for surface water and income. By definition, WTP is income money that an individual is willing to sacrifice for the production of the environmental good. As such, income must be an obvious empirical factor influencing WTP, beyond solid microeconomic theoretical grounds discussed latter in this work. However, recent review studies and meta-analyses do not reveal clearly this relationship. Indicatively, in Schläpfer (2006) meta-analysis of WTP estimates for environment-related public goods, out of the 83 estimates recorded in 64 studies only 47 (or 56.6%) include an explanatory income variable and only 30 (or 36.1%) record a significant income effect. Similarly, in Jacobsen and Hanley (2009) meta-analysis of WTP for biodiversity conservation, out of the 145 estimates recorded in 46 studies only 95 (or 65.5%) include in their analyses an income variable and only 56 of them (or 38.6% of total) record a significant income effect. Brouwer et al. (1999) in their meta-analysis of wetland contingent valuation studies do not use income data for the survey samples because these are missing in most of the studies reviewed by the authors. Disparate meta-analyses results may be attributed to various reasons. Frequently, the good/service under evaluation is very diverse and/or broadly defined thus creating extreme variation of the average WTP recorded by the studies included in the meta-analysis. Researchers do not share a common understanding of the environmental good or service under evaluation and thus, the information conveyed to the participants is highly heterogeneous. Participants, on the other hand, if they accept to reveal their true income, may under or over report it for a wide range of reasons. This may explain why the overwhelming majority of valuation studies fail to find their sample representative of the population's income or other economic characteristics, while the same sample is representative of socio-demographic characteristics of the population.

Meta-analysis as a process of quantitative research synthesis is a powerful tool. Meta-analysis summarizes and combines the findings of past research that often report diverse results but also compares and evaluates the associations between the effect size

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under consideration and the moderator variables that capture heterogeneity through different study characteristics. Taking into account the wealth of meta-analyses concerning WTP estimates up today, the value added by yet another meta-analysis can be significant only if a new perspective is provided. This paper performs a meta-analysis of WTP estimates for attaining Good Ecological Status (GES) of surface water in Europe since the adoption of the Water Framework Directive (WFD). As such, we aim to reduce heterogeneity coming from diverse definitions of the environmental good under examination. The discussions preceding the adoption of the WFD in 2000 and its application in all Member States, associated countries or countries in the process of accession to the EU, has created, at least among the scientific community, a common understanding of the meaning and pre-conditions for attaining GES for surface and underground water bodies. Therefore, this common scientific understanding is more homogenously transmitted and translated to the general public participating in valuation studies. Surveys show that the general public in Europe also is informed of the processes contemplated by the WFD in the way to attain GES. In addition, by restricting the survey to European regions or countries we can utilize very detailed and precise EU data sources for wealth and income and incorporate them into our analyses. Thus, by assuming that the respective survey samples are representative of the population of the geographic area in which they were carried out, detailed estimates of the various measures of income can replace missing or probably miss-reported income estimates recorded by surveys.

2. The Water Framework Directive and the income elasticity of willingness to pay for GES

The EU has more than 100,000 surface water bodies. Of them, 80% are rivers, 15% are lakes and 5% are coastal and transitional waters. The European Union adopted the WFD in 2000 with a view to restore all European waters into GES by 2015. The definition of ecological status is multidimensional as it looks simultaneously at biological factors (the abundance of aquatic species, phytoplankton, macroalgae and angiosperms in transitional and coastal waters, macrophytes and phytobenthos, benthic invertebrate fauna and fish fauna), chemical and physicochemical elements (thermal conditions, oxygenation, salinity, nutrient status, acidification status and the concentration of specific pollutants including priority substances). The ecological status of water bodies is classified into five classes, i.e., High (class I), Good (II), Moderate (III), Poor (IV) and Bad (V). By the end of 2015, 47% of EU surface waters have not reached GES (class II). Furthermore, the chemical status of 40% of surface waters is unknown, showing that monitoring is inadequate in many Member States. As concerns ground waters, about 25% of them have poor chemical status due to human activities. Pollution of inland surface and ground waters is a long-standing environmental concern among European citizens. The latest Eurobarometer conducted in 2012 on water related issues shows that for European citizens the biggest threat to water resources is chemical pollution (84%) followed by climate change (55%) and changes in water ecosystems (49%). In the same Eurobarometer survey respondents declared that were not aware of EU initiatives to water management and especially of the River Basin Management Plans foreseen by the WFD (Eurobarometer, 2012).

The Environmental Kuznets Curve depicts a statistical relationship between national income and pollutants (Grossman and Krueger, 1995). Pollution increases with income up to a level and then decreases. Two processes may support this disputed empirical relationship (Arrow et al., 1995). First, in low-income levels, individuals are unwilling to trade consumption for investment in environmental protection and thus environmental quality is low. As the income of individuals grows above the "income turning point", individuals start to demand increased investments for an improved environment that, in turn, decreases pollution and environmental degradation. Second, in the process of economic growth, economies undergo structural economic changes towards less polluting industries and acquire higher levels of technological development in production and abatement that restrict pollution.

Following Barbier et al. (2015), who provide the most integrated theoretical framework of the relationship between Willingness to Pay (WTP) for pollution control and income, and Hökby and Söderqvist (2003), the income elasticity of demand for an environmental service z with virtual price p, and consumer's income y, is:

$$\varepsilon_y = \frac{y}{z}\frac{\partial D_z}{\partial y} = \frac{\partial(\ln D_z)}{\partial(\ln y)}$$

As it is well known, contingent valuation studies do not allow the estimation of demand functions and, consequently, the estimation of income elasticities (Hökby and Söderqvist, 2003). Contingent valuation studies end up by estimating a WTP function, WTP most often representing a compensation variation function or, the marginal willingness to pay for pollution control. In this setting, an individual's income and other characteristics explain variation in WTP. Thus, the income elasticity of WTP for pollution control ε_w becomes:

$$\varepsilon_w = \frac{y}{WTP}\frac{\partial WTP}{\partial y} = \frac{\partial(\ln WTP)}{\partial(\ln y)}$$

Estimates of the above elasticity are not estimates of income elasticity of demand. However, they are extremely important in the case of the WFD. Kriström and Riera (1996) construct a function of the share of the income directed to WTP as $s = (WTP(y)/y)$. If this function is decreasing, then, the share of income that is assigned to WTP for controlling pollution decreases as income increases. Then, pollution control is said to be distributed regressively, i.e., would be relatively more beneficial for low-income groups than for high-income groups. Thus, pollution control is regressively distributed if $\partial s/\partial y < 0$ which, by applying the chain rule, results to:

$$\varepsilon_w = \frac{y}{WTP}\frac{\partial WTP}{\partial y} < 1$$

Correspondingly, if $s = (WTP(y)/y)$ is increasing, pollution control is distributed progressively and the income elasticity of WTP for pollution control is greater than one ($\varepsilon_w > 1$). The WFD aims to bring all European water bodies at least to GES. This means that the decision to take all water bodies from a "Bad", "Poor" or "Moderate" ecological status to "Good" environmental status, irrespective of the social profitability of the project, will have significant implications for poorer households which are more constrained by income than richer households if $\varepsilon_w < 1$.

Many individual studies and meta-analyses report contradicting income elasticity of WTP results or they do not report on income at all. The reason for this may be searched, among others, to data collection mechanisms and responses for individual's income, which is one of the most sensitive pieces of filed collected data. In addition, most surveys report on the representativeness of the collected sample by comparing collected socio-demographic and economic data with data reported by official statistical sources for the same geographic area covered by the survey. The overwhelming majority of surveys end up with a sample that is representative of the wider area or the country at least as concerns socio-demographics. Collected income data, however, may not be recorded or may not be representative of the area for, mainly, two