



# What are Households Willing to Pay for Better Tap Water Quality? A Cross-Country Valuation Study

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## What are Households Willing to Pay for Better Tap Water Quality? A Cross-Country Valuation Study

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# Climate Change and Sustainable Development

## Series Editor: Carlo Carraro

### What are Households Willing to Pay for Better Tap Water Quality? A Cross-Country Valuation Study

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#### Summary

We estimate willingness to pay (WTP) for better quality of tap water on a unique cross-section sample from 10 OECD countries. On the pooled sample, households are willing to pay 7.5% of the median annual water bill to improve the tap water quality. The highest relative WTP for better tap water quality was found in the countries with the highest percentage of respondents being unsatisfied with tap water quality because of health concerns. The expected WTP increased with income, education, environmental concern, and health and taste concerns with the tap water.

**Keywords:** Contingent Valuation, Household Data, Interval Model, Water Quality, Willingness to Pay

**JEL Classification:** C24, D12, Q25, Q51

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# **What are Households Willing to Pay for Better Tap Water Quality?**

## **A Cross-Country Valuation Study**

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### **Abstract**

We estimate willingness to pay (WTP) for better quality of tap water on a unique cross-section sample from 10 OECD countries. On the pooled sample, households are willing to pay 7.5% of the median annual water bill to improve the tap water quality. The highest relative WTP for better tap water quality was found in the countries with the highest percentage of respondents being unsatisfied with tap water quality because of health concerns. The expected WTP increased with income, education, environmental concern, and health and taste concerns with the tap water.

**Keywords:** contingent valuation, household data, interval model, water quality, willingness to pay

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## 1. Introduction

A number of studies have documented price and income elasticity of water demand from households in developed countries (see Worthington and Hoffman, 2008, for a recent literature survey). Water quality is rarely considered in demand models, for the main reason that its impact on total water use is likely to be small, at least in high-income countries. A bad water quality is likely to impact only water used for drinking purposes which represents a small share of households' daily consumption. Also, because drinking water quality standards exist and frequent controls of water quality take place in high-income countries, quality of water provided is good on average. This is in contrast with what happens in the developing world where a number of studies have documented households' willingness to pay (WTP) for access to improved drinking water sources using either contingent valuation methodologies or averting expenditure models. Except for surveys made after specific water contamination incidents (mostly in the US) or studies measuring households' perception of water quality in Canada, there are few studies on households' valuation of improved tap water quality in high-income countries. As far as we know, the only studies measuring households' WTP for tap water quality outside the context of particular pollution incidents are Abrahams, Hubbell, and Jordan (2000) and Whitehead (2006). Abrahams, Hubbell and Jordan (2000) estimate the WTP of households in Georgia (USA) for water quality from the observation of their use of water filters and purchases of bottled water. They evaluate the lower bound of the WTP at USD 47 per person per year. In a contingent valuation study, Whitehead (2006) finds WTP for improved water quality in North Carolina (USA) to range between USD 19 and USD 254 per person per year according to water quality perceptions.

We propose to fill this gap by analyzing the opinions of households about their tap water and their WTP for improved water quality in a sample of households from ten OECD (Organisation for Economic Co-operation and Development) countries. The proportion of respondents being satisfied with the quality of water at the tap varies significantly from one country to the other: from 21% in Mexico to 95% in the Netherlands. For those households who declare not being satisfied, the contingent valuation (CV) approach was used to measure respondents' WTP for better tap water

quality as a maximum percentage increase in their annual water bill. We estimate the WTP in the pooled sample and separately in the three countries for which we have enough observations (Italy, Korea, and Mexico) controlling for the effects of socio-economic and demographic characteristics, as well as environmental attitudes and behavior, trust in information sources, and respondents' concerns about the health impact and/or taste of their tap water.

The estimation of WTP for better tap water quality provides useful information for policy makers and water service providers that have to decide on the price of water for residential consumption. The price of water has followed an increasing trend in high-income countries over the last decades mainly because more acute raw water pollution problems have led to an increase in the costs of water treatment. They are expected to increase further since full cost pricing is becoming more and more common (in the European Union, for example, countries have to comply with the European Water Framework Directive which requires that water charges cover the costs of supplying water). How much residential customers are willing to pay for better water quality at the tap can thus provide guidance for setting future water prices.

The rest of the paper is organized as follows: Section 2 contains a review of the relevant literature on WTP for drinking water, its determinants and range of estimates. We describe the survey instrument and the data and present some descriptive statistics in the third section. In Section 4, we discuss the estimation procedure and the results. Section 5 concludes the paper.

## **2. Previous estimates of Willingness to Pay for better drinking water quality**

The WTP for better water quality has usually been elicited from the so-called averting (or defensive) expenditure model. The idea underlying the averting behavior method (ABM) is that an individual's valuation of an environmental "bad" can be measured through the money spent to defend herself against this bad. For example, households may decide to purchase water filters or bottled water when faced with increased health risks associated with exposure to unsafe drinking water. Both revealed and stated preferences approaches have been used to estimate averting expenditures. The latter is based on households stating how much their expenditure would be under hypothetical scenarios of

environmental degradation, while the former calculates actual defensive expenditures by the household. Averting expenditures in response to an environmental “bad” represent a lower bound for WTP for reductions in environmental degradation, which itself provides decision makers with a minimum criterion for cost-benefit comparisons (Courant and Porter, 1981; Abrahams, Hubbell and Jordan, 2000; Birol, Koundouri and Kountouris, 2008).

Most studies focus on ex post valuation of clean-up of specific types of water contaminants after an incident of drinking water pollution. A first group of studies have analyzed households’ WTP for reducing the concentration of bacteria or contaminating industrial pollutants to the public standard for drinking water quality (Harrington, Krupnick and Spofford, 1989; Abdalla, Roach and Epp, 1992; Laughland et al. 1996; Dupont, 2005). For example, averting behavior decisions were used to approximate the economic costs to households in a South Eastern Pennsylvania community affected by groundwater contamination in the late eighties (Abdalla, Roach and Epp, 1992). Different actions to avoid exposure to the contaminated water were taken by the surveyed households: (1) purchasing bottled water, (2) installing home water treatment systems, (3) hauling water from alternate sources, and (4) boiling water. The induced costs were computed from cash expenditures on averting inputs (bottled water, water treatment systems) and the respondent’s opportunity cost of time. The results indicate that households’ knowledge of contamination, perception of risk, and presence of children determine whether they undertake averting actions, and that their expenditure levels are higher if young children are present. In Canada, the averting expenditure method was applied to study the use of home filtration systems and purchase of bottled water after the contamination of water by bacteria in a small agricultural community in Ontario (seven people were killed after water was contaminated by manure that entered the water system upstream). Monthly amounts spent on bottled water ranged between USD 1 and USD 60 with a mean household amount of about USD 15 (Dupont, 2005). A second group of studies have focused on water pollution by agricultural chemical residues (see, for example, Poe and Bishop, 1999; Sun, Bergstrom and Dorfman, 1992; Jordan and Elnagheeb, 1993; Crutchfield, Cooper and Hellerstein, 1997). This last group of studies yield a higher range of estimates

of WTP for water quality, often because there are multiple pollutants (pesticides and nitrates), some of which have irreversible effects,<sup>1</sup> and the source concerned is groundwater.

The WTP for improved water quality is usually found to vary across households, depending on their socio-economic characteristics (age, level of education, income, household composition) but also on their perception of risk. Some argue that perceived risk should be preferred to objective risk (Um, Kwak and Kim, 2002; Whitehead, 2006), but the perceived risk may potentially be endogenous if some unobserved variables determine both perceived risk and willingness to pay to avoid this risk, and then researchers may face the traditional omitted variables problem (Whitehead, 2006). The minimum values that the citizens in Pusan, Korea, are willing to pay for the change of suspended solid concentration in tap water was found to be higher when perceived risk was used instead of objective risk - the values increased from an interval of USD 0.07 - USD 1.70 to USD 4.2 - USD 6.1 (Um, Kwak and Kim, 2002). In a CV study in the Neuse River in North Carolina, USA, the WTP was reduced from USD 254 to USD 19 as drinking water quality perceptions increased from “poor” to “excellent” (Whitehead, 2006).

If risk perception in a broad sense has been extensively discussed (see Camerer, 1995, or Slovic, 2000, for comprehensive surveys), studies trying to identify factors influencing risk perception related to water consumption are still scarce and their findings not really conclusive. Several studies have been made in Canada, see Dupont (2005) for a review. In this country, there is evidence that an aesthetic problem (an unpleasant odor or taste, for example) is usually perceived as a potential health risk (Jardine, Gibson and Hruddy, 1999). It has further been shown that the taste of water and its source (lake, rivers, groundwater) influence the perception of water quality (Levallois, Grondin and Gingras, 1999). Other factors that influence the perception of water quality are age, income, and distance to the water treatment facility (Turgeon et al., 2004). Attitudinal characteristics have been less frequently considered, with the exception of Luzar and Cosse (1998), who incorporate the influence of a subjective norm and a measure of the individual’s attitudes towards the state of the environment (including water).

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<sup>1</sup> Sun, Bergstrom and Dorfman (1992) capture this by estimating an option value model of WTP for reducing pesticide contamination of groundwater.



The study that comes closest to ours in the sense that it estimates a general WTP for better water quality (i.e., the survey was not intended to study households' behavior after some specific contamination problem) is Abrahams, Hubbell, and Jordan (2000). These authors estimate the effects of risk perceptions, information about risk, and perceived water quality on the use of water filters and purchases of bottled water in Georgia (USA). In this study, the decision to undertake averting behavior is modeled as a function of notification of local water problems, risk perception, concern about water quality (as measured by a composite index of taste, odor, and appearance) and socio-economic variables including race, education, children under 18 and income. The authors demonstrate that respondents spend on average USD 2.21 for bottled water purchases per capita per week. The results indicate that concerns about the safety (risk perception) and the quality of tap water are important determinants in the decision to buy bottled water. Then, the authors combine the adjusted averting expenditures for bottled water and water filters and obtain an estimate of the lower bound aggregate WTP for "safe" water of USD 47 per person per year. A similar study was conducted by McConnell and Rosado (2000) in Brazil. The WTP for improvement in drinking water quality was estimated at around USD 120 per household per year.

Table 1 presents estimates of WTP (in nominal values per household, annually) for improvement in water quality from a set of studies.<sup>2</sup> This comparison is given for illustrative purposes only because the studies are not directly comparable: the type of contamination and its severity varies across places. For each study, we indicate the authors, the country in which the study took place, the method employed (ABM or Averting Behavior Method, CVM or Contingent Valuation Method), and the estimated WTP. Estimated WTP varies from USD 19 to USD 1,388.

[Table 1 around here]

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<sup>2</sup> The list is not exhaustive. For an excellent review and analysis of water quality valuation studies, see Bergstrom, Boyle and Poe (2001).

### **3. Data and descriptive statistics**

#### **3.1. The survey instrument**

The data come from the 2008 OECD Survey on Household Environmental Behaviour that aimed at collecting new empirical evidence on attitudes, behavior and environment in five areas: food, energy, waste, water and personal transport. Respondents were also asked about characteristics of their household (age, composition, education, income), trustworthiness of information sources, and behavioral attitudes or opinions regarding the environment in general. The purpose of this article is to analyze the respondents' willingness to pay for water quality. The specific format of the questions on tap water quality is presented in each relevant section below.

The survey was implemented in 10 OECD countries (Australia, Canada, the Czech Republic, France, Italy, Korea, Mexico, the Netherlands, Norway and Sweden). About 10,000 respondents were recruited using a web-based access panel, managed by a private company that specializes in web-based panels. For further details on the survey implementation, we refer the readers to Millock and Nauges (2010). Web-based surveys are used as a means to implement targeted surveys at a relatively low cost compared to in-person interviews and are increasingly used in valuation studies (see for example Berrens et al., 2004).<sup>3</sup> The validity of web-based surveys has been questioned but, so far, a majority of recent studies found no evidence of any systematic bias (see for example Lindhjem and Navrud, 2008, who compared web-based surveys with in-person interviews in a controlled field experiment on the same panel of respondents; Fleming and Bowden, 2009, who compared consumer surplus estimates obtained from conventional mail and web-based surveys; Olsen, 2009, in a comparison of two samples obtained through a web-based survey and through mail for a choice experiment and Nielsen, 2011, in a comparison of a web-based survey and face-to-face interviews).

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<sup>3</sup> To the best of our knowledge, web-based surveys have not been found to reduce the hypothetical bias commonly present in contingent valuation studies. Although considerable attention has been devoted to various techniques (cheap talk, follow-up certainty scales, dissonance minimization, see Morrison and Brown, 2009) for reducing the hypothetical bias, these techniques are still under debate and were not implemented in the 2008 OECD Survey on Household Environmental Behaviour.

One exception is Marta-Pedroso, Freitas and Domingos (2007) who showed that the WTP estimates based on the web survey were significantly lower than those obtained through an in-person interview.

The sample in the OECD Household Survey was stratified by income, age, gender and region in each of the ten countries. Along with stratification, the sample size from each country was adjusted to ensure a representative sample.<sup>4</sup> Two of the countries in the OECD Household Survey have lower internet penetration rates than the other countries, which may have an influence on the representativeness of the sample: Mexico and the Czech Republic. The Czech sample did not differ from that of the Czech population in a statistically significant manner. The Mexican sample is younger with a higher schooling level compared with a representative sample of Mexican households, and it also has a larger proportion of men. The mean household size was not statistically different from the general population but the income variable (measured in intervals in the OECD Household Survey) had an under-representation of the middle income categories.

Since many of the variables in the survey are the result of the aggregate behavior of all household members, one of the most important ones is family size. Here the samples for different countries corroborate well, but for Australia, Italy, Norway and Sweden (to a smaller extent) that have too few one-person households compared to the general population. Finally the Canadian and Norwegian respondents in the OECD sample tend to be slightly wealthier and better educated than the general population.

Hence, with only a few exceptions listed above, the mean characteristics in our sample indicate that the surveyed population is fairly representative at the country level, except for Mexico for which we recommend not to extrapolate the results to the entire country.<sup>5</sup>

Water consumption and water prices as stated by the respondents also corroborate well early OECD surveys (see Tables A1 and A2 in the Appendix, respectively).

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<sup>4</sup> In particular, a smaller sample was taken from the Czech Republic (around 700) where internet penetration rates are low and the survey provider could not ensure that a larger sample would be representative.

<sup>5</sup> For more details we refer the reader to the document “2008 OECD Household Survey on Environmental Attitudes and Behaviour: Data Corroboration” available at <http://www.oecd.org/dataoecd/55/19/44101274.pdf>

### 3.2 Opinions about tap water quality and WTP measures

In the survey, respondents were asked whether or not they were satisfied with the quality of their tap water and whether or not they were drinking water from the tap. Respondents who declared being dissatisfied could indicate whether they were more concerned about taste or health impacts (or neither of these), see Table 2.

[Table 2 around here]

Broadly speaking, we can distinguish three groups of countries. The first group gathers countries where 90% or more of the surveyed respondents declare to be satisfied with the quality of their tap water and to drink water from the tap. The “high quality tap water” group includes the Netherlands (95% of respondents satisfied with their tap water), Sweden (92%) and Norway (90%). The “medium quality tap water” group gathers countries where the percentage of respondents satisfied with water quality varies between 50 and 75 percent. It includes the Czech Republic (72%), Australia (71%), France (70%), Canada (67%), and Italy (56%). The percentage of respondents drinking tap water varies from a low of 39% in Italy to a high of 83% in Australia. Finally, the “low quality tap water” group gathers Korea and Mexico, where less than 30 percent of respondents declare to be satisfied with the quality of water from the tap. Only 39% of the respondents from Korea and 19% of the respondents from Mexico drink water from the tap. The correlation between the percentage of respondents satisfied with their tap water and the percentage of those drinking tap water is quite high, except for Italy. This finding is not surprising knowing that the annual per capita consumption of bottled water is the highest in this country.<sup>6</sup> Drinking bottled water in Italy is a cultural habit that may not be directly linked to the quality of the water provided at the tap.

The reasons for being dissatisfied vary from one country to the other. In the “high quality tap water” group, taste is the major concern (for about two-third of the dissatisfied respondents) while health is the primary concern in the “low quality” group gathering Korea and Mexico. In the “medium

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<sup>6</sup> European Federation of Bottled Waters at <http://www.efbw.eu/>

quality” group, the concerns are slightly more balanced, except in Italy where the health concern dominates. These simple statistics indicate that we should expect significantly different WTP for better tap water quality from one country to another.

Only those respondents who declared NOT being satisfied with their tap water were asked how much they would be willing to pay for improvement. More precisely, the analysis of respondents’ WTP for better tap water quality is based on the answer to the following question: “*What is the maximum percentage increase that you would be willing to pay above your actual water bill to improve the quality of your tap water, holding water consumption constant?*”. The six possible answers were: (1) nothing, (2) less than 5%, (3) between 5% and 15%, (4) between 16% and 30%, (5) more than 30%, and (97) don’t know (for more details on the questionnaire, see Appendix B). On the pooled sample, 34% of the respondents were not willing to pay anything above their actual bill to get improved water quality, 29% were willing to pay less than 5%, 22% were willing to pay between 5% and 15%, 5% of the respondents were willing to pay between 16% and 30%, and less than 2% of the respondents were willing to pay more than 30% above their actual bill. 9% of the respondents declared that they “do not know”.

Due to the survey design which implies that respondents stated their WTP for an improved water quality only if they declared not being satisfied with the quality of their tap water for drinking, we miss data on WTP for a large number of respondents. About 66% of respondents in the original sample declared being satisfied with water at the tap and hence did not have to answer the subsequent WTP question. Also, the answer on WTP had to be given as a percentage of the water bill. Thus, respondents who stated that they were not charged for water consumption (and hence should not receive any bill) but answered the WTP elicitation question anyway were excluded from the analysis, for consistency reasons (this amounts to 437 observations overall).

### **3.3. Explanatory variables**

In addition to health and taste concerns, the survey contains information on the respondent’s socio-economic, behavioral and attitudinal characteristics. The following variables are expected to influence WTP for better tap water quality:

i) socio-economic characteristics including household income, age, gender, and education level of the respondent. Income falls into five classes, class 1 gathers households with the lowest income and class 4 gathers households with the highest income. Respondents who did not answer the question on income are found in class 5.

ii) two indicator variables describing whether the respondent devotes time to an environmental organization (variable *i\_time\_orga*) and whether the respondent is a member of, or has donated money to, such organizations (variable *i\_member\_orga*).

iii) an index measuring environmental concern in general (not just concerning water quality), that could be interpreted as a proxy for the perception of a general environmental threat. For each of the following environmental issues (waste generation, air pollution, climate change, water pollution, natural resource depletion, genetically modified organisms, endangered species and biodiversity, noise), respondents had to state whether they were not concerned (1), fairly concerned (2), concerned (3), very concerned (4), or had no opinion (5). We calculate the mean score for each respondent on the answers coded from 1 to 4 (we do not consider in the computation the case of answers equal to 5).<sup>7</sup> A higher value of the index indicates a higher degree of environmental concern.<sup>8</sup>

iv) trust in government regarding information on environmental issues, i.e., respondents had to rank the following sources of information in terms of their trustworthiness: independent researchers and experts, national/local governments, environmental non-governmental organizations (NGOs), consumers' organizations, and producers' and retailers' associations. We build a variable (*notrust\_gov*) which corresponds to the rank attributed to national/local governments such that a higher value of the index indicates less confidence.

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<sup>7</sup> See Lam (2006) for a similar approach. We also tried to build an index using Principal Component Analysis (PCA) but the index built following the sample mean approach was found to be more significant in general. Factor analysis would be another possible technique for aggregating answers measured on a Likert scale (Gill and Barr, 2006).

<sup>8</sup> This index will be treated as a continuous variable, which relies on the underlying assumption that the ordering is linear. In other words, we assume that moving from "not concerned" to "fairly concerned" is equivalent to a move from "fairly concerned" to "concerned". Instead, one could have considered separately the answer to each separate item and build dummy variables corresponding to each answer and each item. This procedure would, however, increase significantly the number of parameters to be estimated in the model.

The list of explanatory factors that are used in the econometric analyses and the sample mean of each variable (for the entire sample and for each country separately) are given in Appendix (Tables A3 and A4 respectively).

## **4. Empirical analysis**

### **4.1. Estimation procedure and results**

For now, we consider that respondents who are dissatisfied with water quality but “do not know” how much they would be willing to pay for improved water quality, are indeed willing to pay nothing (see Haab and McConnell, 2002). The sensitivity of our estimates to this assumption will be discussed in the following section.

As stated above, the elicitation of the WTP for better tap water quality provides interval data expressed as percentages of the water bill. More precisely, the respondent was asked to pick the range that corresponds to the amount he/she is willing to pay in percentage of his/her water bill (see Appendix B). Since the methodological paper from Cameron and Huppert (1989) this payment card method has been widely used in contingent valuation studies (see Boman et al., 2011, for a recent application to moose hunting in Sweden and Haab and McConnell, 2002, for theoretical considerations). Econometrically, the basic idea is that the probability to pick a specific range is the probability that the WTP lies between the bounds of this range. The corresponding model is known as the maximum likelihood interval model. When the underlying distribution is assumed to be normal, this leads to the generalized Tobit model (see Hynes and Hanley, 2008, for a detailed presentation). However other distributions can be tested, in the spirit of the survival analysis (see Kalbfleisch and Prentice, 2002).

An interval model was first estimated on the pooled data and then separately for each of the three countries with the highest percentage of respondents dissatisfied with their tap water quality, namely Italy, Korea and Mexico. The number of observations for the other countries was too small to allow for a country-by-country analysis. Multicollinearity was tested by checking the condition number of the matrix of independent variables (see Belsley, Kuh and Welsch, 1980). Various

distribution assumptions (normal, lognormal, Weibull) were tested. According to the Bayesian information criteria, the normal distribution was found to fit the data better. The estimation results for the pooled data (Model 1) and for Italy, Korea and Mexico (Models, 2, 3, and 4, respectively) are given in Table 3. The likelihood ratio tests indicate global significance of the four models.

[Table 3 around here]

In Model 1 on the pooled data, we find that respondents who are members of wealthier households are willing to pay more, on average, for improvement in drinking water quality: the coefficients of the categorical variable measuring income (class 2 to class 4) are positive and statistically significant with respect to the lowest income bracket (class 1) chosen as the reference category. Class 5, which gathers respondents who did not answer the question on income, is not significant. Our results also indicate that respondents with greater environmental concern as well as respondents who devote time to environmental organizations and donate money to such organizations have on average a higher WTP for drinking water quality.<sup>9</sup> Trust in information provided by national or local governments does not have any impact on the WTP. Willingness to pay for a better water quality is found to be lower for older respondents, which confirms the findings of Abrahams, Hubbell and Jordan (2000) and Um, Kwak and Kim (2002). We tested a nonlinear effect of age but it was significant neither in the pooled sample nor in the country estimations. Women are found to have a lower willingness to pay for better drinking water quality while the presence of young children - or other variables related to the composition of the household - was never significant in the estimations. This is in contrast with the findings of Abdalla, Roach and Epp (1992) and Luzar and Cosse (1998) that the presence of young children in the household increases the willingness to pay for water quality. Respondents with a high education level (about 9% of the whole sample) are willing to pay more for water quality. Higher

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<sup>9</sup> We also estimated the WTP model by replacing the index of environmental concern (*index\_env\_concern*) with indicator variables describing the respondent's concern about water pollution, the item which was directly related to the question studied. We considered one indicator variable for each possible answer: not concerned (1), fairly concerned (2), concerned (3), very concerned (4), or had no opinion (5). None of these indicators were found significant.



education, which can be considered a proxy for the ability to interpret water quality information (Janmaat, 2007), is normally expected to be positively related to willingness to pay, but previous research does not always find it significant.

The country-specific coefficients in Model 1 are significant (at a level of 1%, 5% or 10%) except for France, the Netherlands, Norway and Sweden. The country-specific effects should capture differences in the water provision infrastructure, regulatory standards for water quality, and cultural differences or habits in drinking water from the tap compared to the reference country (Australia). A recent survey conducted by Istat (2006) indicated that more than a third of Italians do not trust the water supplied by operators and about a sixth complains of irregular water supply (disruptions, shifts in supply, rationing), which may explain the positive sign and the magnitude of this country-specific coefficient. The positive effect for Canada may be the consequence of several water contamination incidents that have caused severe casualties in the past. In Mexico, a history of federally-subsidized water service and poor financing, while encouraging economic development, has limited the capacity of the government to expand the network, treat water and wastewater, and fund repairs (Tortajada, 2006). A relatively low quality of the service combined with a currently low price of water may thus explain respondents' WTP for a better tap water quality. The country-specific effect for Korea is positive, which is in line with the findings of the National Survey on Public Awareness for Environmental Conservation (Korean Ministry of the Environment, 2008) that 37% of the respondents were satisfied with quality of the water at the tap but only 1.4% drank tap water directly. Um, Kwak and Kim (2002) also found that Korean households were dissatisfied with the quality of tap water. The positive coefficient for the Czech Republic can be explained by three facts. First, a study conducted by the Pacific Institute (Gleick, 2006) shows that Czechs were the thirteen largest per capita consumers of bottled water in 2003 and 2004. Second, although tap water is considered as "good" by the public opinion analysis conducted in 2008 by Eurobarometer,<sup>10</sup> microbiological contamination of surface and underground waters is not uncommon in the Czech Republic (Novakova, Svec and Sedlacek, 2009). Finally, water expenditure (the share of household disposable income) is relatively low compared with

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<sup>10</sup> [http://ec.europa.eu/public\\_opinion/index\\_en.htm](http://ec.europa.eu/public_opinion/index_en.htm)

expenditure on other utilities (gas and electricity), 1.4% against respectively 2.4% and 3.7% in 2004 (Czech Statistical Office). This indicates the capacity of the households to support an increase of the water price.

The impact of the explanatory variables is better illustrated by marginal effects (see Table 4): our results indicate that moving from the lowest income category to the category just above would increase WTP (stated as a percentage of the annual bill) by about 0.3 percentage points. Education has a slightly lower impact on the relative WTP than income. The effect of the general index of environmental attitudes is smaller than the one of income (0.2) but the variables representing environmental behavior are about the same magnitude as moving from one income category to another, and in some cases, even somewhat larger. More precisely, our findings show that respondents who are members of, or contributors/donors to, an environmental organization exhibit a greater WTP (by about 0.4 percentage points). Also respondents who have invested some time to support or participate in an environmental organization exhibit a WTP which is higher by 0.3 percentage points on average. However, and without much of a surprise, health and taste concerns are the main drivers of WTP: WTP as a percentage of the annual water bill increases by 1.1 and 1.4 percentage points if respondents have taste and health concerns, respectively.<sup>11</sup> This is as expected and in line with the findings of Sun, Bergstrom and Dorfman (1992).

[Table 4 around here]

The country-specific estimation results (Models 2 to 4) exhibit similarities with the pooled data results (Model 1), but the coefficients are less significant in general. The income categories are significant for the low income countries (Korea, Mexico) but not for Italy. Among the attitudinal and behavioral characteristics, only membership in, or donations to, an environmental organization (in Italy and Korea) and the decision to devote time to an environmental organization (in Mexico) are statistically

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<sup>11</sup> Computed test statistics indicate significant difference in the marginal effect on WTP of health concerns compared to taste concerns.

significant. Taste concerns are only significant for the WTP of respondents in Italy, whereas health concerns are significant in explaining WTP of respondents in Italy and Mexico.

The estimated parameters of the four models were used to assess the WTP for an improved drinking water quality (see Table 5).<sup>12</sup> We report not only the mean but also the median WTP (in percentages of the water bill) because we observe some extreme values in the annual bills that have been reported. The mean and median values for the pooled data represent about 7.5%-7.8% of the median annual water bill (calculated on the pooled data). At the country level, the median WTP in Italy, Korea and Mexico represents respectively 8.6%, 5.8% and 10.3% of the country-specific median water bill. The highest relative WTP is, without any surprise, observed in the country with the highest number of unsatisfied respondents (Mexico).

[Table 5 around here]

Cross-country comparisons have to be made with caution, though, because of the subjective appraisal of an “improved tap water quality”. The reference situation (current tap water quality) and the target conditions which are not precisely defined here (improved quality without any specifics as to what improved really means) may be interpreted differently across countries and even across individual respondents among each surveyed country.<sup>13</sup> The vagueness of the reference and target conditions in the survey questionnaire will also likely produce low estimates of WTP for water quality improvements.

The average estimated WTP in EUR is presented in Table 6; it is simply computed as the product of the median percentage predicted by each model and the median water bill. For the pooled data, the annual WTP estimate (2008 EUR) is 14.03 (or equivalently USD 22.45). But the results differ across countries since we obtain EUR 17.25, EUR 5.02 and EUR 7.60 for Italy, Korea and

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<sup>12</sup> We provide non-conservative WTP estimates, i. e., estimates based on the truncated data, rather than based on the censored data.

<sup>13</sup> In the pooled model the country dummies may capture part of the country-specific expectation in terms of “improved tap water quality”.

Mexico, respectively (or equivalently USD 27.6, USD 8.03 and USD 12.16, respectively). It is lower than the WTP obtained by Abrahams, Hubbell, and Jordan (2000) using data from a survey undertaken in 1995: USD 47 per person and per year (USD 63 in 2008 USD equivalents). It may also seem low in comparison with households' expenditure for bottled water. A recent study made in France indicated that an individual drinks about 0.5 liter per day and that the price of bottled water is approximately EUR 0.28 per liter (Bontemps and Nauges, 2009). A rough calculation shows that the annual consumption of bottled water would be 475 liters per year and would cost around EUR 133 for a household of 2.6 persons not drinking tap water (or equivalently USD 212), which is far higher than the estimates presented here. Again, this may be explained in part by the imprecise description of what an "improved tap water quality" means in the survey questionnaire.

[Table 6 around here]

#### **4.2. Robustness checks**

These estimates have been obtained under the assumption that respondents who "do not know" are willing to pay nothing for improved tap water quality (on a sample of 2,741 observations). This assumption implies a conservative estimate of WTP. We test the robustness of the WTP estimates relative to this assumption by re-computing WTP on the sample for which respondents who do not know have been withdrawn. The restricted sample has 2,524 observations. The estimated WTP are found to be quite robust to the specification (see Table 6): the annual WTP estimates are respectively equal to EUR 14.14, EUR 17.49, EUR 5.08 and EUR 7.68 for the pooled data, Italy, Korea and Mexico (or equivalently USD 22.62, USD 27.98, USD 8.13 and USD 12.29 respectively).

Up to now, WTP has been computed based on the sub-sample of respondents who declared not being satisfied with water quality at the tap. One could consider that respondents who expressed satisfaction with water quality are willing to pay zero for quality improvement. We re-estimated the WTP model on the entire sample of respondents (7,144 observations overall). The estimates are not directly comparable since the latter model does not include the indicator variables describing households' concern about health and taste; a question which was not asked to the respondents who

declared being satisfied with the tap water quality. The WTP on the entire sample is estimated at EUR 10.91 (or USD 17.46), which is 23% smaller than the WTP that was estimated on the sub-sample of respondents who declared not being satisfied with water quality at the tap (see Table 6).

## **5. Conclusions**

The analysis of households' WTP for improved tap water quality in OECD countries indicates that households are willing to pay on average rather small amounts: for the pooled data the WTP represents 7.5% of the median annual water bill. Our results are close to the lower bound of those obtained by Whitehead (2006) who finds WTP for improved water quality in North Carolina (USA) to range between USD 19 and USD 254 per person per year according to water quality perceptions (with the same methodology, contingent valuation). Indeed, the annual WTP estimates converted in money, EUR (2008), are equal to 14.03 for the pooled sample, 17.25 for Italy, 5.02 for Korea and 7.60 for Mexico (or equivalently USD 22.45, USD 27.6, USD 8.03 and USD 12.16, respectively). These estimates are lower than the ones obtained by Abrahams, Hubbell, and Jordan (2000) on the USA: USD 47 per person per year (USD 63 in 2008 USD equivalents). The discrepancy in the WTP estimates is probably explained by the specificity of each region and the method employed (averting behavior model for the study in the USA and contingent valuation for the 10 OECD countries). Further research is needed to get greater confidence in the WTP for improved tap water quality.

Our findings also indicate that income, education, awareness and concern about environmental problems along with health and taste concerns are significant drivers of the willingness to pay for a better tap water quality. The magnitude of these effects is found to be quite small though: the largest increase comes from taste and health concerns which increase WTP by 1.1 to 1.4 percentage points.

Finally, our results indicate the need for further analysis of the set-up of the water provision infrastructure. In particular, it would be useful to include measures not only of the respondents' general perception of the quality of their tap water, but rather the level of and the exceedance of the regulatory standards and type of water provision and organization. More elaborate measures of trust in the supplier could usefully be included in future surveys.

## Acknowledgment

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## Appendices

### Appendix A

**Table A1. Water consumption (liter per day per capita).  
Comparison between two OECD surveys.**

Country	Years 1996/1997 Source: OECD (1999)		Year 2008 Source: this survey	
	Average water use	Rank	Median water use	Rank
Australia	268	2	205	2
Canada	326	1	268	1
Czech Republic	113	9	105	10
France	137	7	110	9
Italy	213	3	205	3
Korea	183	5	189	5
Mexico	n.a.	-	197	4
Netherlands	130	8	137	8
Norway	140	6	153	6
Sweden	191	4	138	7

Note: n.a. is for "not available".

**Table A2. Water price per m<sup>3</sup> (EUR). Comparison between two OECD surveys.**

Country	Years 1999-2001 Source: OECD (2003)		Year 2008 Source: this survey	
	Average price	Rank	Median price	Rank
Australia	1.62	5	0.65	8
Canada	0.72	7	1.06	6
Czech Rep.	1.07	6	1.44	5
France	2.65	4	2.80	1
Italy	0.67	8	0.94	7
Korea	n.a.	-	0.42	9
Mexico	0.28	9	0.30	10
Netherlands	3.39	2	1.76	3
Norway	5.41	1	1.52	4
Sweden	2.68	3	2.36	2

Note: n.a. is for “not available”.

**Table A3. List of explanatory factors**

Variable names	Variable definitions
<b><i>Economic variables</i></b>	
rev_cat1	Household income category 1 (lowest income group)
rev_cat2	Household income category 2
rev_cat3	Household income category 3
rev_cat4	Household income category 4 (highest income group)
rev_cat5	Equal to 1 if the respondent does not want to answer on income
<b><i>Demographic variables</i></b>	
i_female	Equal to 1 if the respondent is female
age	Age of the respondent
i_pgrad	Equal to 1 if the respondent holds a post graduate degree
<b><i>Respondent's opinion about water at the tap</i></b>	
i_taste_concern	Equal to 1 if the respondent is most concerned about the taste of the tap water
i_health_concern	Equal to 1 if the respondent is most concerned about the safety of the tap water
<b><i>Attitudinal characteristics</i></b>	
index_env_concern	Index of concern about environmental issues
i_time_orga	Equal to 1 if the respondent has invested some personal time to support or participate in an environmental organization
i_member_orga	Equal to 1 if the respondent is currently a member of, or contributor/donator to, any environmental organizations
notrust_gov	Categorical variable: ranks the local/national government sources of information on environmental issues 1 stands for the most trustworthy and 5 for the least trustworthy

**Table A4. Sample mean of socio-economic, demographic, and attitudinal variables, overall and by country**

Variable	OECD (10)	Australia	Canada	Czech Rep	France	Italy	Korea	Mexico	Netherlands	Norway	Sweden
rev_cat1	0.24	0.20	0.21	0.25	0.21	0.13	0.23	0.26	0.36	0.25	0.34
rev_cat2	0.26	0.24	0.24	0.27	0.24	0.24	0.21	0.14	0.45	0.29	0.30
rev_cat3	0.24	0.28	0.27	0.22	0.34	0.33	0.24	0.17	0.12	0.20	0.15
rev_cat4	0.24	0.26	0.25	0.22	0.20	0.27	0.30	0.40	0.05	0.24	0.18
rev_cat5	0.02	0.02	0.02	0.04	0.01	0.03	0.03	0.03	0.01	0.02	0.03
income (EUR) <sup>(a)</sup>	30,258	34,981	38,548	11,710	32,349	30,735	24,912	6,782	28,467	58,627	28,743
i_female	0.52	0.55	0.51	0.51	0.50	0.52	0.51	0.49	0.53	0.48	0.56
age	42.15	43.90	43.21	39.51	45.74	43.52	38.61	34.77	45.05	43.52	42.07
i_pgrad	0.10	0.07	0.06	0.10	0.13	0.07	0.09	0.12	0.05	0.26	0.03
index_env_concern	3.03	3.06	3.05	2.95	3.04	3.18	3.30	3.54	2.59	2.76	2.74
i_member_orga	0.14	0.15	0.11	0.08	0.09	0.13	0.18	0.15	0.25	0.08	0.17
i_time_orga	0.10	0.07	0.07	0.07	0.05	0.11	0.08	0.27	0.04	0.06	0.15
notrust_gov	3.53	3.79	3.70	3.63	3.74	3.54	3.53	3.68	3.35	3.19	3.19

(a) Computed using International Monetary Fund nominal exchange rates 16/01/08.



## Appendix B. Selected questions from the OECD Household Survey

### Part G - WATER

The following section will cover water consumption and use.

**87. Is your household charged for water consumption in your primary residence?**

1. Yes
2. No
3. Not sure

**88. What would best describe your situation in your primary residence?**

1. Not connected to the mains water (using a well/bore, a rainwater tank)
2. Connected to the mains water but not charged for water consumption
3. Don't know

**89. How is your household charged for water consumption?**

1. Charged according to how much water is used (*e.g.* via a water meter)
2. Flat fee (*e.g.* lump sum included in charges or rent)
3. Don't know

**90. Approximately how much was the total annual cost for water consumption for your primary residence?**

*Please indicate if possible amount in \$ and corresponding annual consumption in m<sup>3</sup>*

Amount in \$ per year <i>Please provide answer to the nearest dollar</i>	Volume of water consumed in m <sup>3</sup>
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Don't know ☐

...

**95a. Do you drink tap water for your normal household consumption?**

1. Yes
2. No

**95. Are you satisfied with the quality of your tap water for drinking?**

1. Yes
2. No

**96. In your tap water, what is of most concern to you?**

1. Taste
2. Concern about health impacts
3. Neither of these

**97. What is the maximum percentage increase you would be willing to pay above your actual water bill to improve the quality of your tap water, holding water consumption constant?**

1. Nothing
2. Less than 5%
3. Between 5% and 15%
4. Between 16% and 30%
5. More than 30%
6. Don't know

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## Tables

**Table 1. Estimates of WTP for improvement in water safety / quality  
(per household per year)**

Author(s) and date	Country	Valuation Method	Estimated WTP (updated to 2008 dollars)	Type of Water Quality Change
Abdalla, Roach and Epp (1992) <sup>(a)</sup>	USA	ABM	USD 19 – USD 42	WTP evaluated by the average increase in averting expenditures per household that undertook averting actions to avoid effects of trichloroethylene (TCE) contamination.
Abrahams, Hubbell and Jordan (2000)	USA	ABM	USD 63	WTP evaluated by the amount spent by the residents to avoid risks associated with poor water quality (bottled water and filtration).
Dupont (2005) <sup>(b)</sup>	Canada	ABM	USD 134 – USD 141	WTP evaluated by the costs of using tap water substitutes (container style water filter, tap filter, bottled water).
Laughland et al. (1996) <sup>(c)</sup>	USA	ABM	USD 53 – USD 317	WTP evaluated by averting expenditures for households who experience a surface water contamination episode.
Um, Kwak and Kim (2002)	Korea	ABM	USD 63 – USD 93	WTP to improve the tap water to acceptable levels of pollution (to reduce suspended solid concentration in tap water) evaluated by the increase in expenditures taken to avoid using tap water and the amount of time required for each averting action.
Adamowicz et al. (2011) <sup>(d)</sup>	Canada	CVM/CE	USD 58 – USD 651	WTP for reducing risks of microbial/cancer illness and deaths in a public drinking water context by comparing and evaluating results from various methods (Contingent Valuation / Choice Experiment) and model specifications.
Benson (2006) <sup>(e)</sup>	USA	CVM	USD 20 – USD 52	WTP for raising water quality in accordance with bacteria standards. Water quality improvements were described in terms of improved sport (game), fish populations and the safety of swimming and wading.

Crutchfield, Cooper and Hellerstein (1997) <sup>(f)</sup>	USA	CVM	USD 744 - USD 1065	WTP for reducing nitrate concentration to the standard level or eliminating nitrate completely in drinking water.
Jordan and Elnagheeb (1993) <sup>(g)</sup>	USA	CVM	USD 96 – USD 129	WTP to protect drinking water for two types of water consumers (municipal sources and private wells). The proposed policy was installation and maintenance of equipment to clean water for private well users and cleaning by the local water supply company for other users.
Kwak, Lee and Russell (1997)	Korea	CVM	USD 55	WTP to reduce the stated subjective probability to close to zero that the respondent will experience, in their life, an accident similar to the phenol accident in the Nak-Dong river, which was widely reported in Korea. The specification controls for averting expenditures (filtering, bottled water purchases, traveling to a spring to get water).
Luzar and Cosse (1998) <sup>(h)</sup>	USA	CVM	USD 98	WTP for a change in water quality. The hypothetical market compared water quality to many other publicly provided goods, such as police and fire protection, highways, and education.
McConnell and Rosado (2000) <sup>(i)</sup>	Brazil	ABM	USD 147	WTP evaluated by expenditures to have safe drinking water and to protect against diarrheal diseases (filters, boil, bottled water).
Poe and Bishop (1999) <sup>(j)</sup>	USA	CVM	USD 619	WTP for reducing nitrate exposure levels (in the groundwater) to 25%.
Powell, Allee and McClintock (1994)	USA	CVM	USD 49-139	WTP for establishment of water supply protection districts that would ensure that drinking water remained safe.
Schultz and Lindsay (1990) <sup>(k)</sup>	USA	CVM	USD 209	WTP for groundwater protection plans (the description of plans emphasizes the uncertainty of their success).
Sun, Bergstrom and Dorfman (1992) <sup>(l)</sup>	USA	CVM	USD 769 – USD 1388	WTP to support a program for preventing groundwater pollution from agriculture pesticides and fertilizers (program described as able to definitely keep groundwater below EPA's health advisory levels for drinking and cooking).
Whitehead (2006) <sup>(m)</sup>	USA	CVM	USD 24 – USD 322	WTP to make sure that water quality in the Neuse River is safe enough for fishing, swimming, and drinking treated water from the River.



Notes:

GDP deflator taken from: <http://data.worldbank.org/indicator/NY.GDP.DEFL.KD.ZG>

(a) Abdalla, Roach and Epp (1992) estimate WTP for reducing the contaminating pollutant (per- and trichloroethylene) to the public drinking water standard levels (in a south-eastern Pennsylvania community, USA). The data was collected with a mail survey.

(b) Dupont (2005) uses surveys on quality perceptions of municipally supplied tap water after the shock following the widespread illnesses caused by the presence of bacteria in drinking water.

(c) Laughland et al. (1996) estimate WTP for reducing the contaminating pollutant (the parasite *Giardia lamblia*) to the public drinking water standard levels in the USA. They use a telephone survey.

(d) Adamowicz, Dupont, Krupnick, Zhang (2011) search to provide the most robust estimates for the willingness to pay for reducing risks of microbial/cancer illness and deaths in a public drinking water context by comparing and evaluating results from various methods and model specifications. These estimates are developed from an extensive internet-based stated preference survey conducted across Canada during the summer of 2004. The focus of the survey was to examine the public's willingness to trade-off longer term cancer illness and death risks from some forms of public water supply treatments against the more immediate risks of microbial illness and death. They calculate mean WTP for the same benchmark improvement in a water treatment program, i.e., a program with 15,000 fewer microbial illnesses, 10 fewer microbial deaths, 10 fewer cancers deaths, and 50 fewer cancer illnesses.

(e) Benson (2006) uses a CV survey in order to measure the benefits of improved water quality in the Opequon watershed (an area of Virginia, USA). This area is classified as impaired due to violation of bacteria standards. For in-state water quality improvements, the question was phrased using local taxes as the payment vehicle. For out-of-state water quality improvements, the question was phrased using a one-time donation to a hypothetical clean-up fund as the payment vehicle.

(f) Crutchfield, Cooper and Hellerstein (1997) use CV to value the reduction of nitrate levels in drinking water to safe levels and to completely nitrate-free levels in four regions of the US.

(g) Jordan and Elnagheeb (1993) do CV on a sample of respondents in Georgia, USA, (mail survey) to value the increase above their normal bill that households would pay for a nitrate reduction in groundwater (the main source of drinking water in the region).

(h) Luzar and Cosse (1998) use data collected from a CV survey (by mail) of rural residents (USA). The region experienced water quality problems due to the production requirements for specialized crops such as rice (irrigated rice). Individuals were presented with a hypothetical market for changes in water quality and were asked to disclose the dollar amount they would be willing to pay annually for a change in water quality.

(i) McConnell and Rosado (2000) estimate the benefits of a discrete improvement in tap water quality in Espírito Santo, Brazil, from households' use of different types of water filters.

(j) Poe and Bishop (1999) provide information on the actual nitrate levels in the groundwater to respondents in an area in Wisconsin (where groundwater is the sole drinking water source) and use CV to value a 25% decrease in their exposure levels.

(k) Schultz and Lindsay (1990) elicit household total WTP for a hypothetical groundwater protection plan in the USA. They use a CV survey (by mail) during the summer of 1988. The payment vehicle was an increase in property taxes.

(l) Sun, Bergstrom and Dorfman (1992) use CV (by mail) to estimate the WTP to reduce pesticide and nitrate contamination of groundwater on a sample of households in southwest Georgia, USA.

(m) Whitehead (2006) estimates the WTP for improved water quality in North Carolina, USA. The author use a stratified random sample telephone survey of landowners from the 12 counties of the upper, middle, and lower Neuse River Basin.

**Table 2. Respondents' opinion about quality and safety of their tap water**

<b>Country</b>	<b>% of respondents satisfied with their tap water</b>	<b>% of dissatisfied having taste concern</b>	<b>% of dissatisfied having health concern</b>	<b>% of respondents drinking tap water</b>
<b>High quality tap water countries</b>				
The Netherlands	95	63	31	91
Sweden	92	68	24	95
Norway	90	67	29	97
<b>Medium quality tap water countries</b>				
The Czech Republic	72	52	39	75
Australia	71	55	42	83
France	70	59	37	63
Canada	67	43	56	67
Italy	56	33	61	39
<b>Low quality tap water countries</b>				
Korea	30	11	86	39
Mexico	21	5	92	19

**Table 3. Estimation results from the interval models –  
Model on the pooled data and separate models for Italy, Korea and Mexico.**

	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>
	<b>Pooled data</b>	<b>Italy</b>	<b>Korea</b>	<b>Mexico</b>
Variables <sup>a</sup>	Coef. <sup>b</sup> (std error)	Coef. (std error)	Coef. (std error)	Coef. (std error)
constant	-8.333*** (1.883)	-15.685*** (5.288)	-0.914 (2.838)	1.545 (4.382)
<b><i>Economic variables</i></b>				
rev_cat1 (reference)	-	-	-	-
rev_cat2	1.477** (0.579)	0.540 (1.703)	2.069** (0.933)	2.613** (1.237)
rev_cat3	2.335*** (0.565)	1.999 (1.640)	2.040** (0.898)	2.160* (1.158)
rev_cat4	1.810*** (0.542)	1.046 (1.725)	2.071** (0.825)	2.799*** (0.949)
rev_cat5	-1.668 (1.190)	-2.046 (2.823)	-4.823** (2.224)	-0.913 (2.189)
<b><i>Demographic variables</i></b>				
i_female	-1.367*** (0.382)	-2.971*** (1.014)	-0.748 (0.605)	-0.660 (0.768)
age	-0.052*** (0.014)	-0.070** (0.034)	0.012 (0.022)	-0.013 (0.034)
i_pgrad	1.167* (0.644)	1.410 (1.811)	1.541 (1.033)	0.437 (1.146)
<b><i>Attitudinal characteristics</i></b>				
index_env_concern	0.827** (0.369)	1.417 (1.024)	-0.030 (0.587)	-0.443 (1.085)
i_member_orga	1.889*** (0.582)	3.453** (1.645)	1.777** (0.838)	1.254 (1.211)
i_time_orga	1.499** (0.616)	2.478 (1.722)	0.457 (1.281)	2.136** (0.945)
notrust_gov	-0.191 (0.144)	-0.322 (0.386)	0.128 (0.213)	-0.039 (0.294)
<b><i>Respondent's opinion</i></b>				
i_taste_concern	4.805*** (1.214)	16.119*** (4.412)	-0.036 (2.106)	2.641 (2.870)
i_health_concern	5.621*** (1.181)	17.222*** (4.385)	0.177 (1.918)	4.899** (2.406)
<b><i>Country dummies</i></b>				
i_Australia (reference)	-	-	-	-
i_Canada	1.754* (1.051)	-	-	-
i_Czech	4.865*** (1.071)	-	-	-
i_France	-0.766 (0.981)	-	-	-
i_Italy	3.920*** (0.848)	-	-	-
i_Korea	2.675*** (0.869)	-	-	-

i_Mexico	7.470*** (0.887)	-	-	-
i_Netherlands	-2.094 (1.842)	-	-	-
i_Norway	0.921 (1.616)	-	-	-
i_Sweden	0.715 (2.130)	-	-	-
Ln( $\sigma$ )	2.174*** (0.020)	2.325*** (0.047)	1.863*** (0.043)	2.220*** (0.034)
Test of global significance	LR Chi2(22) = 411.48 p-value = 0.0000	LR Chi2(13) = 53.80 p-value = 0.0000	LR Chi2(13) = 33.08 p-value = 0.0017	LR Chi2(13) = 27.85 p-value = 0.0095
Number of observations	2 741	538	575	706
Number of censored observations	1 150	243	211	169

a) The prefix i\_ indicates a 0/1 variable.

b) \*, \*\*, \*\*\* indicate significance at the 10%, 5%, and 1% level, respectively.

**Table 4. Estimated marginal effects (pooled sample)**

Variable <sup>a</sup>	Marginal effect <sup>b</sup>
<i><b>Economic variables</b></i>	
rev_cat1 (reference)	-
rev_cat2	0.312**
rev_cat3	0.509***
rev_cat4	0.387***
rev_cat5	-0.318
<i><b>Demographic variables</b></i>	
i_female	-0.276***
age	-0.010***
i_pgrad	0.242*
<i><b>Attitudinal characteristics</b></i>	
index_env_concern	0.166**
i_member_orga	0.398***
i_time_orga	0.313**
notrust_gov	-0.038
<i><b>Respondent's opinion</b></i>	
i_taste_concern	1.144***
i_health_concern	1.378***
<i><b>Country dummies</b></i>	
i_Australia (reference)	
i_Canada	0.374
i_Czech	1.160***
i_France	-0.150
i_Italy	0.904***
i_Korea	0.590***
i_Mexico	1.961***
i_Netherlands	-0.393
i_Norway	0.191
i_Sweden	0.147

a) The prefix i\_ indicates a 0/1 variable.

b) \*, \*\*, \*\*\* indicate significance at the 10%, 5%, and 1% level, respectively.

**Table 5. Annual WTP estimates (in percentage of the water bill)  
Pooled data and Italy, Korea and Mexico**

Country	Median water bill	Mean WTP	Median WTP	Min WTP	Max WTP
Pooled data	185.28	7.79	7.57	4.18	12.96
Italy	200.00	8.67	8.62	3.60	14.42
Korea	86.75	5.80	5.79	3.46	7.96
Mexico	74.11	10.19	10.26	6.88	12.98

**Table 6. Annual WTP estimates, 2008 EUR (or USD) –  
Estimation sample and restricted sample**

Sample	WTP Estimation sample	WTP Restricted sample
Pooled data	14.03 (22.45)	14.14 (22.62)
Italy	17.25 (27.6)	17.49 (27.98)
Korea	5.02 (8.03)	5.08 (8.13)
Mexico	7.60 (12.16)	7.68 (12.29)

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