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A Double-hurdle Approach for Estimation of Bottled Water Demand under Consumer Environmental Attitudes and Water Conservation Policies

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Summary:
Despite the efforts of public authorities to supply drinking water that meets higher quality standards, averting behaviors and particularly the demand for bottled water experiences tremendous growth. In this paper, we explore some determinants of bottled water demand. Because bottled water is a good that poses negative environmental externalities, we aim at exploring the role of environmental attitudes and behaviors. Moreover, given that bottled water and tap water could be either complementary or substitutes, we also analyze the impact of several pricing and non-pricing policies related to its efficient management. A double-hurdle approach is proposed to model separately individuals' decision about whether to consume bottled water and their level of consumption. Using a comprehensive dataset from two cities in southern Spain facing severe water scarcity, we find that deteriorated quality, perception about more frequent interruptions of the service and higher prices may be giving rise to increased demand for bottled water, while promoting environmental habits and affecting consumer's perception regarding water price could reduce it. Our results show that not modeling properly the relationship between the two different decisions would lead to misleading conclusions.

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A Double-hurdle Approach for Estimation of Bottled Water Demand under Consumer Environmental Attitudes and Water Conservation Policies

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Abstract

Despite the efforts of public authorities to supply drinking water that meets higher quality standards, averting behaviors and particularly the demand for bottled water experiences tremendous growth. In this paper, we explore some determinants of bottled water demand. Because bottled water is a good that poses negative environmental externalities, we aim at exploring the role of environmental attitudes and behaviors. Moreover, given that bottled water and tap water could be either complementary or substitutes, we also analyze the impact of several pricing and non-pricing policies related to its efficient management. A double-hurdle approach is proposed to model separately individuals' decision about whether to consume bottled water and their level of consumption. Using a comprehensive dataset from two cities in southern Spain facing severe water scarcity, we find that deteriorated quality, perception about more frequent interruptions of the service and higher prices may be giving rise to increased demand for bottled water, while promoting environmental habits and affecting consumer's perception regarding water price could reduce it. Our results show that not modeling properly the relationship between the two different decisions would lead to misleading conclusions.

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1.Introduction

Over the last decades, there has been an increased concern by public authorities to supply water that meets higher quality standards. However, although both the quality of the water provided from the tap and access to safe drinking water have substantially improved (UN, 2015), bottled water industry continues to experience immense growth. Only in the US, consumption of bottled water has almost doubled in the past ten years and now-a-days exceeds 11 billion gallons per year.[1] Actually, bottled water is already the second largest category (after carbonated soft drinks) in terms of volume sold by the beverage industry and the fastest-growing one, expected to become the first in the coming year (Beverage Marketing Corporation, 2016).

In environmental terms, the use of bottled water entails great social costs. According to the International Bottled Water Association (2015), the amount of water needed to obtain one liter of bottled water amounts to 1.32 liters, contributing to the depletion of aquifers and spring waters. In addition, most plastic bottles are discharged after use into landfills (Arnold and Larsen, 2006), filling them with residuals that are for the most part non-biodegradable. Finally, energy needs associated with bottling and transport significantly add to environmental footprint, with a range of 5.6 to 10.2 Megajoules per a liter (MJ/l) of bottled water produced as opposed to up to 2000 times less (0.005 MJ/l) needed to produce the same amount of tap water (Gleik and Cooley, 2009). Accordingly, in a context of expanded demand with negative environmental externalities, understanding its drivers emerges as a key objective for adequate management and control policies. In this sense, the use of appropriate methodological approaches proves crucial in undertaking precise diagnoses about the effectiveness and consequences of those policies.

In parallel, water resources are becoming increasingly scarce. In fact, water scarcity is expected to be one of the major challenges to humankind in the future (World Economic Forum, 2017), placing efficient management of water resources as a paramount concern in the agenda of world leaders. Under this scenario, policy guidance points at the containment of demand by formulating both pricing and non-pricing incentives. Pricing interventions are mainly directed to raising prices and designing pricing schemes that foster efficient water consumption (Olmstead et al. 2007). Particularly, steeper pricing structures such as the ones in Increasing Block Rates (IBRs) are increasingly common (Olmstead et al. 2007). On the other hand, non-pricing instruments include mainly imposing restrictions on water use and promoting efficient water consumption by either influencing individual's attitudes and behaviors or fostering the installation of water saving technologies.

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[1] 1 cubic meter = 264 gallons.

Within this context, our objective in this paper is twofold. First, we aim at exploring several features in the demand for bottled water that have not been studied before. Regarding environmental attitudes, some papers have aimed at analyzing the influence of environmental concern on the decision to consume bottled water (Johnstone and Serret, 2012). However, existing research claims that there exist a substantial gap between people's attitudes towards the environment and their actual behaviors (Blake, 1999). Moreover, the literature has identified two distinct classes of environmental behaviors entailing different levels of sacrifice on the part of the individual, efficiency or one-shot behaviors - i.e. installation of certain technologies addressed at saving resources-, and curtailment behaviors - i.e. daily habits or sacrifices- (Stern and Gardner, 1981). In this paper, we go one step further and use a wider range of variables related to both environmental concerns and consumer behavior. This will allow us to further disaggregate the analysis in order to account for the different levels of individual pro-environmental involvement. This is important in terms of public policy, as policies aimed at fostering concern usually differ from the ones promoting behavioral change (Stern and Gardner, 1981). And the same applies to interventions tackling promotion of efficiency and curtailment behaviors.

Similarly, we want to explore the influence of several pricing and non-pricing water management policies that may potentially be affecting bottled water demand. With respect to water rationing, given that drinking water is a human necessity, interruptions of the service could be expected to trigger the need to purchase and keep water bottled. Likewise, the price paid for tap water may affect bottled water demand, namely, tap and bottled water could be either complementary or substitute goods. If households that are charged a higher price for tap water tend to demand more bottled water, the environmentally desirable effects of reducing residential water demand by increasing tap water prices may be well offset by the environmental costs of bottled water. It could also be the case that the perception of tap water price by the consumer, rather than the actual price, may be affecting bottled water. In that case, costs and environmental externalities derived from bottled water consumption should be considered in cost-benefit analyses leading to the pertaining public policies related to both network investment and pricing and non-pricing approaches for water conservation.

Our second contribution refers to adequately modeling a demand equation for bottled water. One important issue when dealing with certain averting expenditures, and particularly bottled water consumption, is the high percentage of households that do not consume any amount. Zero consumption may arise for several reasons. Infrequency of purchase is a usual one. However, given that drinking water is a necessity, it does not seem to apply to the consumption of this particular commodity. The two other common sources, non-participation and corner solutions are more likely to be occurring instead. It may be that some individuals are simply non-consumers of bottled water, that is, that they decide not to "participate" in the market for bottled water for several reasons, but if those reasons were not present (e.g. environmental believes), they would consume a positive amount. Corner solutions, on the other hand, arise from the consumer's utility-maximizing decision not to consume at all, given their budget constraint. This is an important distinction, as econometric modeling strategies will vary according to the economic interpretation placed on those observed zeros. Until now, the majority of existing studies on this issue have focused only on studying the decision or probability to consume bottled water, treating it as a dichotomous variable, without modeling the actual quantity consumed. In the infrequent occasions in which expenditures have been explored, they usually have been investigated through the use of Heckman selection models (Jakus, 2009; Lloyd-Smith et al. 2016) or similar approaches (Yoo and Yang, 2000), assuming selection bias derived from the decision to participate in the market (non-participation hypothesis). However, the fact that zeros can also arise from corner solutions has been neglected. In this paper, we use a double hurdle approach to model bottled water demand under both corner and non-participation hypotheses and we discuss the different methodological approaches that can be used based on the assumptions we place on the data generating process. Finally, we propose an empirical strategy in order to test the specification and distributional assumptions underlying them and choose among specifications. Our methodological approach can also be extended to other averting expenditures posing similar problems derived from zero consumption.

To meet our objectives, we use data from a 2014 household survey conducted in the towns of Baza and Guadix, in the province of Granada, Spain. Baza and Guadix are located in the Guadalquivir River basin, which is under extreme water stress according to the European Environmental Agency (2012). Efficient management of water resources gets special attention from policy-makers in this region. The fact that Spain is the fourth largest consumer of bottled water per capita in Europe and the ninth in the world (Beverage Marketing Company, 2013) makes it an interesting setting for our study. Furthermore, and relevant for the purpose of this study, our database includes a wide range of questions on environmental attitudes and behaviors as long with questions about consumer's perception on price and the occurrence of interruption in the service. Information on tap water price can also be derived from the sample.

The remainder of the paper is structured as follows. Section 2 presents an overview of the state of the art on the determinants of the adoption of averting behaviors and bottled water consumption. In section 3, our model of bottled water demand is outlined. The data and methodological approach proposed for the empirical analysis are described in Section 4. Section 5 presents the results and the pertaining robustness checks, and Section 6 concludes with a discussion.

2. Literature Review

Averting behaviors have been a long-standing matter of study. The existence of consumer's defensive responses to potential environmental or health impacts of pollution was acknowledged earlier in the literature. First attempts to provide a consistent theoretical framework of averting behaviors were developed (Courant and Porter, 1981; Harford, 1984; Gerking and Stanley, 1986; Smith and Desvouges, 1986; Bartik, 1988). Since then, numerous efforts have been made towards a more thorough understanding of the determinants of these decisions and some methods have been suggested for the estimation of the benefits of an improved environmental quality and the mitigation of the effects of pollution (which is reviewed below).

The underlying idea is that households undertake averting behaviors to produce a certain level of quality of the environmental goods they consume, or as referred to by Bartik (1988) "the quality of their personal environment". Thus, the decision to undertake an environmental defensive behavior (or the intensity of those averting behaviors) is expected to depend on the pre-existing quality of environmental conditions faced by consumers. For example, Courant and Porter suggest the use of measures of air quality in order to obtain the WTP for a marginal improvement in the level of air quality. In this line, Bartik (1988) also uses objective measures of environmental quality to assess the benefits for non-marginal (i.e. large) reductions in pollution. Some other models make similar assumptions in the case of water quality (Harrington et al. 1989; Abdalla et al. 1992; Laughland et al. 1996).

However, consumer judgement about environmental quality and harmful environmental risks has extensively been found to depart from rationality (Slovic, 1987, Simon, 1955, Arrow, 1992, Kahneman 1982). Therefore, if the individual cannot be assumed to be perfectly rational and to have perfect information, choice of averting behaviors are expected to be made instead on the basis of the perceived environmental quality. Um et al. 2002 extend Bartik's model to incorporate the effect of perceived tap water quality, finding that the conventional models based on objective measures of quality are often of limited application in explaining consumer actual averting choices. In their study, households were more likely to take averting actions, including consuming bottled water, the poorer their perception of tap water quality was. Yoo (2003) and Janmaat (2007) find analogous results in relation to bottled water consumption. On the other hand, several studies find no statistically significant influence of perceived water quality on the decision to consume bottled water (Larson and Gnedenko 1999; Yoo and Yang, 2000; Doria, 2009). Therefore, the averting measures related to water consumption are often the consequence of an insufficient quality of the water directly supplied from the tap. An inadequate tap water quality has been found to affect's consumer's utility either indirectly through the existence of health risks or directly by means of other non-health related aspects.

Health risks have been long recognized as one of the main reasons for households undertaking averting behavior. Given that, as with environmental quality, households may not be perfectly capable of assessing the health risks they are exposed to (Slovic, 1987), subjective measures of health risks are usually employed in empirical works. Several papers have empirically explored the influence of perceived health risks on averting behaviors, providing mixed evidence. While some find that health risk perceptions do not have an influence on the averting behaviors undertaken in response to hazardous substances in water (Janmaat, 2007), others do find a significant positive effect (Bontemps and Nauges, 2015). With respect to the use of bottled water, Jakus (2009) finds that perceived risk had a positive impact on bottled water consumption. He used data from four regions of the United States with levels of exposure to arsenic in tap water, which was higher than the allowed in the new federal standard. Johnstone and Serret (2012) also confirm that concern about health risks have a positive impact on drinking bottled water, analyzing a sample of over 10,000 households from 10 OECD countries. Similarly, the presence of individuals belonging to vulnerable populations (e.g. young children, elderly people or individuals with poor health status) has been acknowledged to generate risk aversion, sometimes triggering the decision to consume bottled water (Zivin et al 2011, Yoo and Yang, 2000) or water-related averting behaviors in general (Abdalla et al 1992).

Non-health related aspects of tap water quality involve mainly organoleptic (aesthetic) characteristics such as taste, odor (mainly chlorine), color and turbidity (i.e the extent to which water has particles in suspension). Research suggests that these sensorial characteristics are at least as important as consumer's health risks perception when deciding on whether or not to undertake averting actions related to drinking water (Abrahams et al. 2000; Jakus et al. 2009). A poor perception about organoleptics has been systematically found to increase the likelihood of the household's choice to consume bottled water (Abrahams et al 2010; Yoo, 2003; Doria, 2009; Jakus et al 2009; Johnstone and Serret, 2012).

Additional consideration would be whether households have any previous experience with violations in health-related parameters involving water contamination (Abrahams et al 2010) or past unpleasant episodes with respect to organoleptic characteristics (Dupont et al. 2010, Janmaat, 2007, Um et al 2002). Finally, some aspects related to the perceived quality of the service have also been considered. For instance, Doria (2009) includes satisfaction with tap pressure, finding no significant influence on the propensity to consume bottled water.

Concerning environmental attitudes, it is reasonable to believe that consumer behavior will adjust to people's beliefs and concerns towards environmental degradation (Kollmuss and Agyeman, 2002). Since bottled water poses a number of significant environmental negative externalities, it can be expected that consumers also adjusted their demand to their attitudes towards the environment. However, research on the relationship between environmental concerns and behaviors states that environmental concern does not always translate into the corresponding pro-environmental actions (Blake, 1999). This gap between people's attitudes towards the environment and their actual behavior, known as the "value-action gap" or concern-action paradox, has been long acknowledged and extensively studied (Blake, 1999; Kollmuss and Agyeman, 2002). Furthermore, the literature has identified two differentiated categories of pro-environmental behaviors according to the different levels of sacrifice they demand from the individual, that is, efficiency and curtailment behaviors (Hayes, 1976). Efficiency or one-shot behaviors refer to the adoption of technologies that conserve certain natural resources (e.g. water or energy) within the household. For instance, some efficiency behaviors related to water would involve the installation of water-saving devices on taps or the purchase of electrical appliances (i.e. dishwashers or washing machines) that optimize water consumption. On the other hand, curtailment refers to frequently repeated actions or sacrificial habits that imply a modification in the way people use these resources. Some examples of these types of behaviors include trying to reduce the duration of the showers or waiting until the dishwasher and washing machine are full before operating them. Therefore, the main difference between both types of behaviors is that while using water-saving technologies does not demand any sacrifice on behalf of the individual, apart from the initial economic cost of installing water-saving devices, having to renounce to a long shower or closing the tap when not in use entails sacrifices in daily life (Stern and Gardner, 1981). As far as the demand for bottled water is concerned, to our knowledge only one attempt has been made in order to ascertain the impact of environmental concern (Johnstone and Serret, 2012)[2] and neither the existence of the abovementioned paradox nor the distinction between different types of behaviors have been previously explored.

With respect to the link between tap water prices and bottled water consumption, to our knowledge this relationship has not been previously explored, mainly because of the difficulty in finding microeconomic data that simultaneously contains information on expenditures, prices and quantities consumed for bottled and tap water by the same household. Only a few papers have attempted to link tap water prices with a decision to avert to bottled water consumption. For instance, Johnstone and Serret (2012) explore the impact of being charged on a marginal basis in the propensity to consume bottled water, finding no significant effect. Um et al 2002 analyze the influence of

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[2] However, it is limited to including a variable to indicating the "importance of solid water issues relative to other eight environmental concerns". Moreover, it only studies the influence of this variable on the propensity to consume bottled water, against both the decision and quantities purchased considered in this study.

average price of tap water on undertaking the decision to consume bottled water. They also find that tap water price does not affect the probability of the household to avert to consuming bottled water. However, none of these works explore the influence of tap water price on bottled water quantity consumed, thus not being able to elicit the existence of substitution or complementarity patterns. Moreover, our paper also aims at exploring the role of price perception, that is, whether more than actual price, it is the way in which households perceive that price what may be driving bottled water consumption.

With respect to the socio-demographic variables, income is usually considered a determinant. Bottled water is expected to be a normal good, so higher-income households are expected to both show higher probability of purchasing bottled water (Larson and Gnedenko, 1999; Johnstone and Serret, 2012; Bontemps and Nauges, 2015) and higher level of demand, although some papers find no significant influence of the income variable (Smith and Desvouges, 1986). Similarly, education is usually included as a proxy for household's knowledge and empirical evidence on its expected sign is mixed. While some find that bottled water consumption increases with education level (Jakus et al. 2009) others do find the opposite effect (Janmaat, 2007) and some elicit no significant relationship (Um et al. 2012). The time that household members have been living in town (Janmaat, 2007; Johnstone and Serret, 2012) and the household size are also usually considered with mixed evidence (Johnstone and Serret, 2012; Yoo and Yang, 2000).

3. The Model of Bottled Water Consumption

Departing from the existing literature, our model addresses several features that have not been sufficiently studied in previous work. First, we analyze the role of both environmental attitudes and behaviors. For this purpose, we use an aggregate index based on individual responses to a series of statements assessing their environmental concerns, which accurately measure attitudinal factors. In addition, we incorporate some variables related to environmental behaviors in order to account for the different levels of individual's environmental involvement (efficiency and curtailment actions) and their effects on the quantity of bottled water consumed. Although promoting efficient behaviors within the household has usually proved to exhibit more potential for natural resource's conservation than fostering curtailment behaviors (Stern and Gardner, 1981), containment of bottled water consumption is inherently a behavior of curtailment type. There does not exist an efficient technology that allows households to reduce its consumption without reducing utility. Thus, it is possible that even when environmental concern doesn't affect bottled water consumption habits, individuals that are already undertaking some environmental habits extend it to other pro-environmental behaviors (e.g. restricting their bottled water consumption). In the same manner, individuals already undertaking a higher level of commitment or sacrifice may find it easier to carry out other behaviors, implying similar levels of sacrifice. This has important implications in terms of public policy, since interventions that promote concern are different from those encouraging behavioral change. Likewise, strategies fostering efficiency and curtailment behaviors are rather dissimilar. As for concern promoting, policies normally involve information campaigns aimed at raising awareness. On the other hand, in the case of behaviors of the one-shot or efficiency class, policy interventions could range from subsides that reduce the cost of purchasing efficient technologies to the design of labeling systems that correctly signal appliance level of efficiency or improving the diffusion of innovation through social networks (Stern and Gardner, 1981; Darley, 1977). Contrarily, promoting the adoption of certain curtailment or sacrificial habits demands a substantially more complex approach involving factors such as generating commitment or leading to changes in social norms (Kollmuss and Agyeman, 2002).

A second feature of the model is the analysis of whether there is an influence of the price paid for tap water on the quantity of bottled water consumed, that is, whether or not tap and bottled water may be complementary or substitute goods. Bottled water can be on average up to 1,000 times more expensive than tap water (Hu et al. 2011). Therefore, it would be expected that in order for consumers to divert from tap to bottled water, the perceived difference in utility from the two choices should be sufficiently large in order to compensate for the observed difference in price. However, it is possible that factors other than mere prices may also be affecting consumer's behavior. The way in which decisions are framed has long been acknowledged to affect consumer's choices, entailing a source of cognitive bias that usually leads to non-optimal decision-making. Particularly, ease of computation or information processing has been found in affecting people's judgments (Tversky and Kahneman, 1973; Thomas and Morwitz, 2009). For the issue at hand, it has important implications, as in most regions in the world, prices for bottled and tap water are expressed in rather different units. For example, in Spain, tap water prices are usually shown in €/m^3 in tariff reports and water bills,[3] while bottled water is priced on the basis of €/litter. When expressed in their usual units, figures paid for both goods are actually rather similar, which makes it extremely more difficult for the consumer to compare prices. Research has proved that when pricing decisions are more computationally complex, consumers tend to judge price differences between two products to be smaller than they actually are (Thomas and Morwitz, 2009). Thus, the actual influence of tap water price on bottled water consumption could be greater than it would initially be expected if the consumer exhibited a perfectly rational behavior. In addition, empirical evidence on water tariffs shows that in most cases information on tariff structure is vague (Nieswiadomy and Molina, 1989; Nataraj and Hanneman, 2011; Pérez-Urdiales et al. 2015) and consumers find it difficult to understand complex pricing and commonly used non-linear pricing structures (Nieswiadomy and Molina, 1989; De Bartolome, 1995).

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[3] One cubic meter = 1,000 liters.

Consequently, it could also be the case that perception of the tap water price[4] by the consumer, rather than the actual price, may be affecting bottled water demand.

A third feature of our model stems from the fact that our database allows us to test the influence of interruptions in tap water supply. Supply cuts can take place mainly for two reasons: (1) network overload (i.e. excess demand) or breakdown and (2) the implementation of certain policies involving supply cuts with the objective of reducing demand (Olmstead and Stavins, 2009). Since drinking water is a human necessity, the reliability of the service is very likely to affect the decision to consume bottled water.

3.1. Model

With the context discussed above, we distinguish between two decisions undertaken by households. First a decision to move to bottled water consumption, and second, a decision on how much bottled water to consume, as is expressed by the two equations below:

$$S = f(\mathrm{s, e, p, c}) \qquad (1)$$

$$Y = g(\mathrm{s, e, p, c}) \qquad (2)$$

where S is a dichotomous variable, reflecting whether or not the household consumes bottled water, and Y is the bottled water consumption (quantities purchased). s is a vector of variables including socioeconomic variables and variables related to organoleptics and tap water quality, e is a vector of environmental variables concerning attitudes and behaviors, p is a vector including tap water price related variables, and c is a vector of variables related to interruptions in the service. The methodology used to model these decisions and all the variables included in the study is explained in the next section.

Our expectations with respect to the variables, based on previous work, are provided below. A bad perception on both organoleptic and quality are presumed to lead to a higher probability of consuming bottled water, while the effect on the quantities is not clear. Pro-environmental attitudes and behaviors should be expected to reduce the propensity to consume bottled water, and, when the households have decided to consume, based on any other circumstance, it is also expected that environmentally friendly households try to reduce their actual consumption as much as possible. With respect to price, some substitution patterns could occur between bottled and tap water, that is, price of tap water and household's perception about that price are expected to affect the decision on the consumed quantity. Interruptions in the service are predicted to affect the decision to consume, since frequent cuts may trigger the need to purchase and keep water bottled. The level of disruption caused is more related to the length in time and other features of those cuts, and could affect both the decision to consume and the quantity to be consumed.

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[4] Whether it is or not perceived as expensive.

4. Data, Variables and Empirical Methodology

4.1 Data, Sample and Variables

This study uses data from a household survey conducted in the towns of Baza and Guadix, in the province of Granada (Spain). Baza and Guadix are two towns in southern Spain with a population of 20,668 and 18,928 inhabitants respectively (INE, 2015a), located nearly 50 km apart from each other and served by two different utilities. Water supply originates mainly from snowmelt in the Sierra Nevada mountains, where the highest peak of the Iberian Peninsula is located and part of the supply being abstracted from several local springs. In general, objective water quality parameters are rather good and above the official standards[5]. Violations of health related water parameters in this area are rare (only one episode in 2008 is recorded and it was due to torrential rains). However, service interruptions due to network overload are not so uncommon, taking place mainly in the summer. In peak times, during holidays, nearly 28,000 and 23,000 additional residents are added to the regular population of Baza and Guadix, respectively (MHAP, 2016), creating excess demand.

The area of study exhibits certain characteristics that make it an interesting setting for this study. In their last available study about the global market in 2014, the Beverage Marketing Corporation rated Spain as the 4th largest per capita consumer of bottled water in Europe and the 9th in the world in total consumption (Beverage Marketing Company, 2014). Furthermore, Spain is a country subject to either water stress or severe water stress throughout the most part of its territory (European Environmental Agency, 2012). The towns of Baza and Guadix are located in the Guadalquivir River Basin, a basin under severe water stress (European Environmental Agency, 2012), that has long suffered from water scarcity problems and whose situation is expected to worsen in the future. These circumstances have made water management a paramount issue of concern in the region.

The survey was implemented by a market research consulting company (Ipsos) in 2014 and administered on a population of 10,062 households in Baza and 9,704 in Guadix (MHAP, 2016), from which a representative sample of 594 households (305 in Baza and 289 in Guadix) was extracted. Sampling was performed with proportional quotas to stratum size, according to gender and age. Questionnaire development included the use of several focus groups and a pilot study/pre-test. Interviewers were instructed/trained before the

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[5] Values of objective water quality parameters from the last chemical analysis performed can be provided by the authors upon request.

interview was launched and careful instructions were incorporated into the questionnaire on what information should be conveyed and how responses should be gathered. The survey was administered door-to-door with a response rate of 80%. According to interviewers, respondents had, on average, a very good attitude towards the interview.[6] With respect to the information included in the survey, this database contains a broad set of perceived water quality indicators, as well as usual socioeconomic controls. Furthermore, interestingly for the purpose of this study, a wide range of questions on environmental attitudes and behaviors and information on consumption for bottled and tap water is included. Tap water prices paid by the household can also be obtained from the questionnaire, and a question on residential water price perception is included. In addition, information on household perception on interruptions of the service was gathered. Appendix 1 contains a further description of the construction of the variables.

Descriptive Statistics

Table 1 depicts the definition and main descriptive statistics of the variables included in the study. With respect to our dependent variables, 32.2% of the households report purchasing bottled water on a regular basis, while mean bottled water consumption is 4.33 liters per week. However, this mean includes households that do not consume bottled water at all. Among those households that purchase a positive amount of bottled water, a mean value of 13.7 liters per week is consumed. Figure 2 shows the distribution of the variable for those households that report consuming bottled water. Mean household size of 2.95 is in line with the census mean for Spain of 2.51 members (INE, 2015b). A 7.2% of the households have at least one child less than 2 years old. Mean household income lies within the range of 1,801 - 2,100€ per month, slightly lower than the census mean of 2,174€ in Spain (INE, 2015b)[7].

With respect to organoleptics, household perception is quite good. In a range of 1 to 5 (5 reflecting poor perception on organoleptics), color is the best perceived (1.509); the worst perception corresponding to taste (1.74). Smell would lie in the middle with a rating of 1.55. In the same vein, consumers are on average more than satisfied with the quality of tap water (4.027 out of 5). As for interruptions in the service, cuts are perceived to be relatively infrequent (between 0 and 3 during the summer), although the level of disruption caused by them is on average high (4.214 out of 5).

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[66] They were rated by the interviewers an average of 4.51 in a scale from 1 (Very bad attitude) to 5 (very good attitude)

[7] This is not surprising as Andalucía, the region of Spain where Baza and Guadix are located, is one of the poorest Autonomous Communities in Spain.

The variables related to the environmental value-action gap deserve a more detailed analysis. With respect to environmental attitudes, as we can see, individuals report, on average, being quite concerned about environmental degradation (3.9 out of 5). Moreover, a high percentage of households report practicing water saving. 97.2% report waiting until the washing machine and dishwasher are full before operating them; 93.6% try to turn off taps when not in use while shaving or brushing their teeth and 92.8% report reducing the duration of their showers. In fact, almost all the households in the survey put into practice at least one of these curtailment behaviors (99.6%).[8] However, as depicted in Figure 3, the level of environmental concern does not seem to make a difference in relation to the involvement in water-saving habits (curtailment behaviors). Those households whose environmental concern is above average have similar values compared with the ones below average, and correlation between environmental concern, and the number of water-saving practices that the household performs is substantially low (12.81%). With respect to behaviors of the "one-time" or efficiency type, these percentages are relatively lower, with 61.6% of the households in the sample having water-saving technologies installed in the house. Correlation of this variable with the level of environmental concern is also very low (6.56%) and the percentage of households seems to be similar independently of whether the level of concern of the household is over the sample mean or not (Figure 3). As the 'value-action' gap literature asserts, the correlation between environmental concern and behavior in our sample seems weak. Moreover, support for the different types of behaviors is substantially diverse, suggesting that the processes generating them may differ. In this context, a further level of disaggregation of the variables related to environmental attitudes and behaviors could improve our understanding of environmental related processes and thus yield more accurate policy recommendations.

4.2. Empirical Methodology

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[8] This holds even if we restrict more the definition of environmentally concern. For individuals that report more than 4.5 as average environmental concern, these percentages suffer only from little variation (slight increase).

In this section, we aim at modeling the demand for bottled water. The first issue that we must deal with is that the sample contains a high percentage of households reporting of not consuming bottled water (67.8%). As referred in the introduction, zero consumption may arise from several reasons. Because infrequency of purchase is unlikely in the context of our study, we will examine corner and non-participation hypotheses. In order to model it, we depart from a generic double-hurdle approach (Jones, 1989) in which consumers are presumed to pass two hurdles before observing a positive consumption. First, they decide on whether or not to consume a certain amount of bottled water (choosing bottled water as their averting behavior) and, once they have decided to consume, they determine the quantity to be consumed.

Analytically speaking, consumers are assumed to display a latent utility derived from participating in the market (in this case, the market for bottled water). If that utility is positive, they will decide to purchase certain amount in the market, otherwise they won't.

$$Participation\ equation\text{: } S = \gamma Z + \nu \qquad (3)$$

Because we do not observe utility, we can only observe whether they have actually participated or not in the market, reflected in a binary choice variable.

$$D = \begin{cases} 1, & s > 0 \\ 0, & s \leq 0 \end{cases} \qquad (4)$$

Once consumers have decided to consume bottled water, they will decide in the second stage on how much to consume. Thus, the main equation of interest is:

$$Intensity\ equation\text{: } \quad Y^{*} = \beta X + u \qquad (5)$$

where ν and u are assumed to have a bivariate normal distribution with zero means, standard deviations σ_u and σ_v, and correlation ρ. Z and X are the covariates affecting each decision. As we will explain below, estimation methods will vary according to the assumptions placed on the relationship between the two decisions (joint distribution of the errors) and the process that generates the data (observability rule).

When corner solutions are encountered, values within a certain range are observed as a single value (Greene, 2012). Particularly for the case considered here, when consumers underlying utility derived from consuming bottled water is negative ($Y* \leq 0$), their utility-maximizing decision will be not to consume:

$$Observed\ consumption\text{: } Y = Y* \ when\ Y^{*} > 0\ (D = 1), \qquad Y = 0\ otherwise\ (6)$$

Estimation under this type of censoring of the dependent variable was addressed by Tobin (1958) using a mixture of discrete and continuous distributions. However, one drawback of Tobit models (as they are usually referred) is that they estimate only one set of coefficients, implying that the variables in the model affect both the decision to consume and the consumption choice in the same direction. In our setting, this premise may be too restrictive, as there are reasons to believe that the group of factors that influence the choice of bottled water over other averting behaviors related to water consumption are different from the ones that determine the quantity eventually consumed. In order to account for this possibility, we use a more flexible model proposed by Cragg (1971), which allows the participation and intensity equations to be independent and governed by different mechanisms, yielding two different sets of estimations. Thus, in Cragg's models, independence of the disturbance terms (u and v) is assumed ($\rho = 0$) and the participation and consumption equations are estimated respectively by means of a probit and a truncated regression.

When $\gamma = \beta / \sigma_v$ and provided that the same set of regressors is used for both equations, Cragg's specification will collapse to Tobit (Greene, 2012). A likelihood ratio test on this restriction proposed by Lin and Schmidt (1984), can be used to choose between Cragg's and Tobit (both) specifications.

On the other hand, when non-participation is suspected as the underlying process generating zero consumption, Heckman selection models are to be applied. In this case, consumption will only be observed when the individuals pass the participation rule ($d = 1$), that is, once they have chosen bottled water as their averting behavior:

$$Observed\ consumption\text{: } Y = d\ Y* \quad (7)$$

Under this scenario, the final observed consumption could be biased if there were unobserved factors affecting both the decision to consume and the quantity actually consumed. Therefore, under Heckman models, dependence of the disturbance terms (u and v) is presumed in order to account and correct for the possibility of the existence of selection bias. Parameters in the system can be estimated through either Full Information Maximum Likelihood (FILM) or two-step estimation (Heckman, 1979) and, after the estimation, the independence assumption is tested by means of a LR test. If both errors are found to be correlated, selection bias is present in our sample and OLS would yield inconsistent estimates. However, in the case of $\rho = 0$, independence of the two decisions can be assumed and two-part models in which a probit and OLS equations are estimated separately for each decision, have proved more efficient. When $\rho = 0$, a Vuong test for non-nested models to test for the truncated normal against the lognormal specifications allows us to discern between the Cragg's and Heckman[9] specifications (Wooldridge, 2010).

Moreover, when using Heckman selection models, in order for the system to be properly identified, Z must contain at least one regressor, also known as *exclusion*

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[9] This is true when log(y) is effectively treated as the dependent variable.

restriction, that must belong to the participation equation while being exogenous to the consumption decision, and thus not included in *X*.

Finally, in order to determine the magnitude of the response of the variable of interest under a change in one of the independent variables, marginal effects should be obtained. Here, we are interested in predicting unconditional marginal effects, that is, the potential change in bottled water consumption that could be achieved through a public policy affecting one of the independent variables. In the case of Heckman models, unconditional partial effects can be interpreted directly from the estimation results. However, in Cragg's approach, obtaining unconditional marginal effects requires some extra calculations of marginal impacts:

$$\frac{\partial E[y|Z,X]}{\partial x_j} = \gamma_j \phi(Z\gamma)[X\beta + \sigma\lambda(X\beta/\sigma)] + \Phi(Z\gamma)\, \beta_j[1 - \lambda(X\beta/\sigma)\{X\beta/\sigma + \lambda(X\beta/\sigma)\}]$$

where ϕ is the normal density function, Φ is the normal distribution function and $\lambda\,(X\beta/\sigma) = \phi(X\beta/\sigma)/\ \Phi(X\beta/\sigma)$ is the Inverse Mills Ratio (IMR).

Endogeneity

Another issue that should be addressed is that in our model two variables are suspected of being endogenous: the index on water saving habits and the price structure. Water saving habits could be expected to be jointly determined with bottled water consumption if there are some unobservable factors other than environmental concern in our included regressors that foster both the decision to consume bottled water and to reduce tap water consumption by performing certain saving habits. With respect to the price variable, the municipalities included in our sample apply tariffs for tap water that take the form of Increasing Block Rates (IBRs). This implies that price will increase with consumption. In this context, price is predicted to be endogenous to water demand (Olmstead and Stavins, 2007). Because bottled water demand is closely related to the household decision on tap water consumption, it is expected that there will be unaccounted factors affecting both price for tap water and our dependent variable -bottled water consumption- . In order to account for endogeneity in the framework of selection models, Wooldridge (2010) proposes a two-step approach in which a Probit model is estimated for the selection indicator, including all exogenous variables (i.e. instruments for the endogenous regressor, exogenous regressors in the intensity equation and exclusion restrictions) and then the IMR is computed and included in a 2SLS estimate of the structural equation (equation of interest). Because standard errors are incorrect when the IMR coefficient is statistically different from zero, bootstrapping should be applied (Wooldridge, 2010).

For corner solution models (Tobit and Cragg's), a control function approach is used. In a first step, the endogenous variable is regressed on the exogenous regressors and the set of instruments and the residuals are retrieved. Estimated residuals are included in the models' equations. The inclusion of this error term in the equations of interest corrects for endogeneity, the test for the significance of the error term becomes a test for endogeneity. Similarly as in selection models, the inclusion of a generated regressor coming from a previous estimation is addressed using bootstrapping.

A final issue is finding valid and relevant instruments. As common practice, we use the set of all the possible marginal prices for each block as instruments for average price of tap water (Olmstead, 2009). With respect to the index reflecting water habits, we use several questions reflecting household's concern and willingness to act related particularly with efficient and sustainable use of water resources and supply networks (see Appendix 2). These variables are expected to be correlated with the household's decision on performing water saving habits while not affecting demand for bottled water.

5. Results

Results of the different estimated models are reported in Table 2. Because some households were not able to report their water bill, the variable *averageprice* suffers from a significant number of missing values (134). For that reason, we first estimate a model with all the variables excluding *averageprice*, and then we model the relationship with the price variable *averageprice* (Table 7).

First, models with endogenity correction for waterhabitindex were run. Tests for validity, relevance of the instruments and endogeneity are reported in Table 3. In the Heckman model, since the second stage is a 2SLS, validity and relevance of the instruments are confirmed by a Sargan test of overidentifying restrictions and an F-test of excluded instruments (Bound, Jaeger and Baker, 1995) respectively. However, Hausman test for endogeneity fails to be rejected, indicating that there is no need to instrument. In the case of the Craggit model, as proposed by Wooldridge (2010), an F-test of exclusion of instruments is performed[10], confirming instruments' validity. An F-test on the first stage regression indicates also relevance. Nevertheless, the t-test on the coefficient of the estimated residual

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[10] After running the structural equation with the control function (residual from the first stage) included, instrumental variables should not belong to the structural equation. Under that logic, the structural equation with endogeneity correction is run (including all instruments except for one) and an F-test on those instruments is conducted. In order for those instruments to be valid, they should not be jointly significant in an F-test of exclusion of instruments. The test is invariant to the choice of excluded instrument (Wooldridge, 2010)

is not rejected, also pointing out to endogeneity correction for this variable not being necessary. Because tests indicate that waterhabitindex is exogenous and instrumenting would come at the cost of efficiency of the estimations, models without endogeneity correction are finally performed.

In the Heckman specification, *Childrenlessthan2* is used as an exclusion restriction. Having children less than two years old is expected to affect the likelihood of purchasing bottled water, but not necessarily the amount finally consumed. As expected, in Table 2 we can see that it is a significant determinant in the participation equation (Heckman model). However, when the intensity equation is estimated separately (OLS), it can be observed that it does not affect the quantity finally consumed, thus posing an adequate exclusion restriction.

Heckman model yields a ρ of 0.614. However, a direct test for the existence of the selection effect (ρ =0) cannot be rejected, implying independent errors. A likelihood ratio test for the independency of both equations also cannot be rejected, favoring the estimation of a separate Probit model for the participation equation and a regression model on the intensity decision against the Heckman specification.

Results for the Tobit and Cragg's model are also reported. A likehood ratio test (Lin and Schmidt, 1984), for the restriction of Tobit model yields a value of 28.7, rejecting the null hypothesis that $\gamma = \beta/\sigma_v$ at a 1% level, and thus favoring Cragg's more flexible specification against Tobit. Finally, a Vuong test for non-nested models to compare the lognormal and truncated specifications is performed. With a value of -0.146 and a p-value of 0.010, the Vuong test is rejected at the 1% level, implying that Cragg's model should be preferred to its Heckman's counterpart, and thus favoring the hypothesis of corner solution being the process governing observed zero consumption. Therefore, Cragg's specification will be our final modelling choice. In any case, results are found to be very robust across the various econometric specifications (See Table 2).

In order to study the magnitude of the effect of those variables on both the probability to consume and the quantity of bottled water consumed, marginal effects are computed. For the intensity equation, we report unconditional marginal effects (Table 4) accounting for the total potential effect (that is, both the direct effect on quantity and the indirect effect through the change in the probability to consume) on bottled water consumption that could be achieved through a change in each of the independent variables. For the standard errors to be valid, we estimate them using bootstrapping (Wooldridge, 2010).

We find that, as expected, some factors such as lower quality perception of the water from the tap increase the probability of drinking bottled water, while not affecting the quantity eventually consumed. This suggests that characteristics related to water quality tend to affect more the decision to use bottled water as an averting behavior rather than the amount consumed, once the individual decides to purchase bottled water. Although perceived taste is not significant in any of the equations when estimated separately, the joint marginal effect on quantity is significant, suggesting that targeting this variable is also expected to affect bottled water consumption.

We also find that households with children that are less than two years old report a higher probability (12.2%) of choosing to consume bottled water. This result is in line with previous literature (Yoo and Yang, 2000) and seems to indicate that when households display a higher level of risk aversion, their propensity to consume bottled water is also higher. The length that the consumer has been living in the same town seems to lead to a decreased probability of purchasing bottled water. This is usually explained by the fact that familiarity with the water system has also been found to reduce risk perception (Slovic, 2000) and with time people get accustomed to the organoleptic characteristics of tap water (Doria, 2010). Quantity, however, seems to be explained better by household size, that is, as expected, bottled water consumption is predicted to increase with the number of members in the household. Finally, related to the perception of the quality of the service, contrary to what was expected, a higher satisfaction with wastewater treatment is associated with a higher probability of consuming bottled water.

With respect to the variables related to interruptions in the service, as we expected, a perception by the household that supply cuts are more frequent leads to a higher probability to purchase bottled water as a means to avoid lack of water, while not affecting the level of consumption. A marginal increase in this indicator is expected to increase the probability of purchasing bottled water by up to 10.7%. However, the length and frequency of disruption does not seem to affect neither the probability to consume nor the quantity to be consumed of bottled water.

As for the analysis of the environmental paradox, our results show that environmental concern does not translate into a reduction in either the probability to consume bottled water nor the quantity consumed. Likewise, the fact that individuals carry on behaviors of the "efficient" type, that is, one-time behaviors such as installing certain types of water saving devices, does not seem to affect bottled water consumption or the level of consumption. However, we do observe that those individuals that consistently undertake a higher number of daily saving habits, also show both a lower probability of choosing to consume bottled water and a lower quantity consumed. Thus, our results seems to suggest that individuals showing a higher level of commitment towards environmental degradation in their daily lives are more prone to carry out other behaviors entailing similar levels of sacrifice in order to reduce their environmental impact. Actually, the joint effect of this variable is the most sizeable one, with a marginal increase in this indicator predicting to reduce water consumption by 3.04 liters per week (A 22% of average consumption).

Finally, price perception is found to affect bottled water consumption. Our results suggest that households that do perceive tap water as more expensive tend to consume more bottled water. Since it has been proved (Nieswiadomy and Molina, 1989; De Bartolome, 1995) that consumers have problems in understanding water tariffs, it may be that if water from the tap is perceived as more expensive they assess the opportunity cost of diverting drinking bottled water as being smaller.

Robustness Checks

In order to evaluate the robustness of the estimations, Tables 5 and 6 show respectively step-wise estimations by groups of variables for the participation and intensity equations of our final model choice (Cragg's Tobit specification). Moreover, in a previous section, robustness across methodological specifications was also shown.

Models with Tap Water Price

Results of the models including the price variable (*averageprice*) and addressing its likely endogeneity are reported in Table 7. The estimated coefficient for the Inverse Mills Ratio is negative and significant in the intensity equation of the selection model, suggesting that the selection effect should be accounted for. In the presence of a selection bias, independence of the disturbance terms should not be assumed, and therefore Heckman's specification should be preferred to its Cragg's counterpart.

As for endogeneity of the price variable, for it to be corrected the set of instruments must be valid and relevant. Because in a second step of the selection model we use 2SLS, a Sargan test of overidentifying restrictions is performed. With a value of 0.26316 (p=0.8767), Sargan test cannot be rejected, indicating that the set of instruments is valid. Results for the first stage estimations are also included in Table 7. Following Bound, Jaeger and Baker (1995), relevance of the instruments is confirmed by the rejection of the F-test of excluded instruments on the set of instrumental variables. Finally, a Hausman test for endogeneity is also rejected at the 10% level, recommending the use of endogeneity correction.

With respect to our variable of interest, our results show that bottled water demand reacts to the price of water tap. In order to understand the magnitude of the effect, elasticities are computed from the estimated coefficients, yielding a positive and significant cross-price elasticity of 10.72. That is, a 1% increase in the average price for tap water is expected to increase bottled water demand by up to 10.72%, implying that bottled and tap water would be substitute goods.

6. Conclusions

Bottled water consumption has grown exponentially during past years in many parts of the world (Beverage Marketing Corporation, 2014; 2016), generating significant negative environmental externalities. For the regulation of this phenomenon, it is essential to have an accurate understanding of the factors driving demand and the possible effects of certain public policies on such determinants.

Using a comprehensive dataset from two cities in southern Spain, which suffer severe water scarcity, we find that a perception by the household on interruptions being more frequent increase the probability of diverting to bottled water consumption, while higher price paid for the water from the tap is related to higher levels of consumption, with cross-price elasticity of bottled and tap water being positive and significant. Our results reveal that neither environmental concern nor behaviors of the one-shot type are predictors of a reduced bottled water consumption. However, those individuals that more consistently maintain behaviors of curtailment type seem to show both a lower probability to divert to bottled water and lower levels of consumption, with the magnitude of this effect being the most sizable one among the variables considered in our study. In addition, some of the distributional methodological assumptions previously imposed in the literature prove to be restrictive and not always supported by our data.

Therefore, our results suggest that public policies aimed at promoting environmental habits can prove very successful in containing bottled water demand. They seem to indicate that pricing and non-pricing policies related to the efficient management of water resources may result in environmentally undesirable effects derived from an increase in bottled water demand. Consequently, accounting for those environmental costs seem necessary for an accurate assessment of the environmental effects of water conservation policies. An important conclusion is that special attention should be paid to the modeling strategy, as improper modeling of the relationship between the two different bottled water consumption decisions would lead to misleading conclusions. The methodological approach used in this paper could also be extended to other averting behaviors with problems derived from zero expenditures.

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Table 1: Descriptive statistics and definition of the variables

Set of variables	Variable	Description	N	Mean	SD	Min	Max
Dependent variables	Bottledwater	Household reports consuming bottled water on a regular basis (Dummy)	528	0.322	0.468	0	1
	Quantity	Bottled water consumption (in liters per week)	528	4.333	7.748	0	48
Socioeconomic	Municipio	Household is located in Baza (Dummy)	528	0.496	0.501	0	1
	HholdIncome	Household income (Ordinal)	528	6.417	3.677	1	14
	NoEduc	Respondent has not completed any formal education level (Dummy).	528	0.0473	0.213	0	1
	BasicEduc	Respondent has completed elementary education(Dummy).	528	0.348	0.477	0	1
	SecondaryEduc	Respondent has completed secondary education (Dummy).	528	0.303	0.460	0	1
	HighEduc	Respondent has completed university studies either degree, master or PhD (Dummy).	528	0.301	0.459	0	1
	Length	Length of time that the respondent has been living in the town (Years).	528	35.55	19.85	1	86
	Hsize	Household size (Number of members in the household).	528	2.955	1.157	1	6
	Childrenlessthan2	The household reports having members under 2 years old (Dummy).	528	0.0720	0.259	0	1
Water quality and service perception	Quality	Satisfaction with water quality 1 (very unsatisfied) - 5 (very satisfied).	528	4.027	1.109	1	5
	Serviceperc	Satisfaction with wastewater service. 1 (very unsatisfied) - 5 (very satisfied).	508	3.415	1.178	1	5
Organoleptics	Color	Respondent perceives that water is not clear 1 (totally disagree) to 5 (totally agree).	528	1.509	0.893	1	5
	Smell	Respondent perceives that water has some odor 1 (totally disagree) - 5 (totally agree).	528	1.555	0.878	1	5
	Taste	Respondent perceives that water has some taste 1 (totally disagree) - 5 (totally agree).	523	1.740	1.064	1	5
Interruptions	Cutfreq	Incidence of water supply cuts realized during the summer by the respondent 0 (never) - 5 (very frequently, more than 10 times)	528	1.246	0.508	1	4

	Cutdisruption	Supply cuts caused inconvenience to respondent 1 (a few)-5 (a lot).	528	4.214	0.959	1	5
Environmental variables	Envconcernavg	Respondent average value reported in a set of environmental attitudes (see Appendix 1 for further explanation).	528	3.940	0.512	1.50	5
	Envworried	Respondent environmental concern is over the mean of the sample (Dummy).	528	0.540	0.499	0	1
	Watereff	The household has installed some water saving devices on taps, showers or cisterns (Dummy).	528	0.616	0.487	0	1
	filling_dishwasher	Respondent reports waiting until the dishwasher and washing machine are full before operating them (Dummy).	499	0.972	0.165	0	1
	Closing_taps	Respondent reports closing the tap while brushing their teeth or shaving (Dummy).	528	0.936	0.246	0	1
	Reducing_showers	Respondent reports trying to reduce the duration of his/her shower (Dummy).	528	0.928	0.2587	0	1
	Waterhabitindex	Index indicating number of water conservation habits held by the respondent (Count).	528	2.78	0.48	0	3
Price variables	Priceperception	Respondent's perception of water tap price 1 (very cheap) – 5 (very expensive).	513	3.780	0.834	1	5
	Marginalprice	Marginal price per cubic meter of tap water at the mean point of the range in which the household reports to consume (€/m^3).	394	0.883	0.293	0.25	1.110

Table 2. Heckman selection (FILM), Two-part, Tobit and Cragg's model estimations (N=493. Censored= 332)

	Heckman		OLS	Tobit	Cragg	
VARIABLES	Participation	Intensity			Participation	Intensity
Municipio	-0.225	0.0339	0.0816	-1.776	-0.228	2.518
	(0.146)	(0.100)	(0.0965)	(1.996)	(0.145)	(1.709)
Childrenlessthan2	0.455*		-0.0669	4.160	0.435*	-0.643
	(0.245)		(0.135)	(3.216)	(0.254)	(2.362)
Length	-0.0108***	-0.00425	-0.00257	-0.150***	-0.0109***	-0.0288
	(0.00380)	(0.00269)	(0.00250)	(0.0527)	(0.00379)	(0.0450)
Hholdincome	-0.00687	-0.00907	-0.00877	-0.230	-0.00707	-0.357
	(0.0214)	(0.0130)	(0.0135)	(0.284)	(0.0209)	(0.246)
Hsize	-0.0417	0.185***	0.187***	0.817	-0.0360	3.405***
	(0.0600)	(0.0365)	(0.0380)	(0.815)	(0.0596)	(0.720)
BasicEduc	0.0254	0.129	0.167	-0.0632	-0.0105	3.283
	(0.363)	(0.263)	(0.271)	(5.115)	(0.359)	(5.076)
SeconEduc	0.170	0.251	0.253	3.003	0.154	5.256
	(0.374)	(0.276)	(0.289)	(5.305)	(0.370)	(5.341)
Higheducation	0.0818	0.104	0.130	1.624	0.0635	3.263
	(0.386)	(0.277)	(0.286)	(5.415)	(0.380)	(5.315)
Color	0.159	-0.00158	-0.0255	1.862	0.148	-0.796
	(0.0970)	(0.0610)	(0.0600)	(1.279)	(0.0963)	(1.044)
Smell	0.0842	0.00276	-0.00382	1.047	0.0872	0.729
	(0.0989)	(0.0536)	(0.0548)	(1.264)	(0.0955)	(0.965)
Taste	0.141*	0.0768*	0.0518	2.144**	0.121	1.148
	(0.0780)	(0.0433)	(0.0406)	(0.990)	(0.0753)	(0.718)
Quality	-0.317***	-0.112**	-0.0558	-3.985***	-0.315***	-0.931
	(0.0769)	(0.0550)	(0.0400)	(0.983)	(0.0761)	(0.718)
Serviceperc	0.102	0.00571	-0.0186	1.117	0.114*	-0.328
	(0.0647)	(0.0410)	(0.0373)	(0.850)	(0.0649)	(0.666)
Cutfreq	0.346**	0.0241	-0.0271	3.813**	0.381***	-0.760
	(0.148)	(0.0867)	(0.0784)	(1.844)	(0.147)	(1.376)
Cutdisruption	0.0525	-0.00908	-0.0217	0.488	0.0541	-0.223
	(0.0733)	(0.0439)	(0.0441)	(0.987)	(0.0731)	(0.813)
Envconcernavg	0.305	0.118	0.0433	3.925	0.303	0.250
	(0.255)	(0.180)	(0.177)	(3.458)	(0.246)	(3.169)
Envworried	-0.120	0.0361	0.0761	-0.373	-0.115	2.083
	(0.231)	(0.152)	(0.157)	(3.156)	(0.227)	(2.803)
Watereff	-0.0427	-0.000460	-0.000347	-0.123	-0.0465	0.226
	(0.148)	(0.0983)	(0.102)	(2.043)	(0.148)	(1.827)
Waterhabitindex	-0.429**	-0.361**	-0.299**	-7.319**	-0.422**	-6.192**
	(0.208)	(0.144)	(0.143)	(2.852)	(0.206)	(2.599)
Priceperception	-0.0100	0.110**	0.118**	0.636	-0.00102	1.746*
	(0.0860)	(0.0522)	(0.0536)	(1.161)	(0.0853)	(0.969)
Constant	-1.363	1.006	1.527*	-23.75	-1.433	-4.188
	(0.276)	(0.272)	1.527*	15.51***	(1.213)	(15.60)
ρ	0.614					
	(0.439)					
Σ	-0.672***				7.779963***	
	(0.140)				(0.5984736)	
LR test of independent equations	χ_1^2= 1.08 (0.2977) [a]					

Standard errors in parentheses.

Notes: *, ** and *** denote 10%, 5%, and 1% significance levels, respectively.

a. P-value.

Table 3. Tests for endogeneity, validity and relevance for Heckman selection (FILM) and Cragg's model estimations with endogeneity correction for the variable waterhabitindex.

Tests	Heckman	Tests	Cragg	
			Participation	Intensity
Hausman	0.02 (0.8951)	T-test on the included residual	-0.44 (0.663)	1.13 (0.257)
Sargan test	0.1914 (0.6618)	F-test of exclusion of instruments	0.761 (0.6835)	0.743 (0.6897)
F-test of excluded instruments (First stage 2SLS)	15.50 (0.0014)	F-test (First stage)	3.00 (0.0305)	

p-values are reported in parentheses

Table 4. Marginal Effects for the Cragg's model estimations.

VARIABLES	Marginal effects	
	Participation	Intensity (Unconditional)
Municipio	-0.0638819	-0.2073927
	(0.0404749)	(0.7594287)
Childrenlessthan2	0.1219732*	1.417454
	(0.0651619)	(1.030329)
Length	-0.0030683***	-0.0466816***
	(0.0009935)	(0.0180355)
Hholdincome	-0.0019846	-0.1132304
	(0.0054422)	(0.101826)
Hsize	-0.0100926	0.7046737**
	(0.0171237)	(0.3108281)
BasicEduc	-0.0029481	0.7668188
	(0.0863704)	(2.175619)
SeconEduc	0.043138	1.845703
	(0.1146203)	(2.508469)
Higheducation	0.0178282	1.030414
	(0.1038933)	(2.320931)
Color	0.0416047	0.3420471
	(0.0288384)	(0.5051409)
Smell	0.0244638	0.4946904
	(0.0303447)	(0.56174)
Taste	0.0340424	0.7211814**
	(0.0268369)	(0.3493412)
Quality	-0.0883292***	-1.368968
	(0.0297569)	(0.3534333)
Serviceperc	0.0318698	0.3311705
	(0.0207237)	(0.2342998)
Cutfreq	0.1069017*	1.194052
	(0.0591058)	(0.8170846)
Cutdisruption	0.0151802	0.1412496
	(0.0268184	(0.3591169)
Envconcernavg	0.0849113	1.157794
	(0.0731812)	(1.155939)
Envworried	-0.0321705	0.0954011
	(0.0640323)	(0.9549162)
Watereff	-0.0130449	-0.1129135
	(0.0382911)	(0.617297)
Waterhabitindex	-0.1182606**	-3.045422***
	(0.0487385)	(1.009367)
Priceperception	-0.0002867	0.4243339
	(0.0262441)	(0.4545721)

Standard errors in parenthesis are computed using bootstrapping with 100 iterations.

Notes: *, ** and *** denote significance at 10%, 5%, and 1% significance levels, respectively.

Table 5. Robustness checks. Participation equation of the final chosen model (Cragg's Tobit)

VARIABLES	Model 1 (Socioeconomic)	Model 2 (+ Water quality)	Model 3 (+ Interruptions)	Model 4 (+Environment)	Model 5 (+Price perception)
Municipio	-0.333***	-0.322**	-0.293**	-0.247*	-0.228
	(0.120)	(0.134)	(0.136)	(0.143)	(0.145)
Childrenlessthan2	0.438**	0.538**	0.520**	0.462*	0.435*
	(0.223)	(0.246)	(0.250)	(0.249)	(0.254)
Length	-0.0125***	-0.0102***	-0.00995***	-0.0106***	-0.0109***
	(0.00328)	(0.00364)	(0.00366)	(0.00373)	(0.00379)
Hholdincome	-0.0294*	-0.0222	-0.0114	-0.00631	-0.00707
	(0.0172)	(0.0191)	(0.0198)	(0.0206)	(0.0209)
Hsize	-0.0124	-0.0332	-0.0471	-0.0422	-0.0360
	(0.0520)	(0.0573)	(0.0580)	(0.0592)	(0.0596)
BasicEduc	0.0653	0.0779	0.0847	-0.0209	-0.0105
	(0.315)	(0.357)	(0.358)	(0.356)	(0.359)
SeconEduc	0.217	0.231	0.225	0.112	0.154
	(0.325)	(0.365)	(0.368)	(0.366)	(0.370)
Higheducation	0.327	0.215	0.234	0.0861	0.0635
	(0.331)	(0.373)	(0.375)	(0.374)	(0.380)
Color		0.167*	0.144	0.153	0.148
		(0.0916)	(0.0936)	(0.0954)	(0.0963)
Smell		0.0717	0.0633	0.0638	0.0872
		(0.0933)	(0.0937)	(0.0938)	(0.0955)
Taste		0.134*	0.126*	0.124*	0.121
		(0.0737)	(0.0738)	(0.0749)	(0.0753)
Quality		-0.322***	-0.319***	-0.311***	-0.315***
		(0.0737)	(0.0744)	(0.0758)	(0.0761)
Serviceperc		0.0981	0.118*	0.116*	0.114*
		(0.0615)	(0.0628)	(0.0637)	(0.0649)
Cutfreq			0.289**	0.331**	0.381***
			(0.140)	(0.145)	(0.147)
Cutdisruption			0.0739	0.0674	0.0541
			(0.0705)	(0.0718)	(0.0731)
Envconcernavg				0.348	0.303
				(0.243)	(0.246)
Envworried				-0.130	-0.115
				(0.223)	(0.227)
Watereff				-0.0909	-0.0465
				(0.147)	(0.148)
Waterhabitindex				-0.344*	-0.422**
				(0.193)	(0.206)
Priceperception					-0.00102
					(0.0853)
Constant	0.108	0.379	-0.368	-1.576	-1.433
	(0.368)	(0.559)	(0.706)	(1.159)	(1.213)
Observations	528	503	503	503	493
Log-likelihood	-865.12747	-783.29806	-780.59767	-772.90769	-762.65091
Sigma	8.227525***	8.138906***	8.117013***	7.854181***	7.779963***
	(0.6376958)	(0.6430355)	(0.6399216)	(0.6061813)	(0.5984736)

Standard errors in parentheses.

Notes: *, ** and *** denote 10%, 5%, and 1% significance levels, respectively.

Reported likelihood refers to the joint estimation of the two equations in the model (Probit and truncated regression)

Table 6. Robustness checks. Intensity equation of the final chosen model (Cragg’s Tobit).

VARIABLES	Model 1 (Socioeconomic)	Model 2 (+ Water quality)	Model 3 (+ Interruptions)	Model 4 (+Environment)	Model 5 (+Price perception)
Municipio	3.589**	3.754**	3.383**	2.769	2.518
	(1.580)	(1.621)	(1.674)	(1.716)	(1.709)
Childrenlessthan2	-1.399	-1.125	-0.805	-1.068	-0.643
	(2.364)	(2.421)	(2.439)	(2.367)	(2.362)
Length	-0.0395	-0.0194	-0.0158	-0.0236	-0.0288
	(0.0429)	(0.0448)	(0.0448)	(0.0447)	(0.0450)
Hholdincome	-0.158	-0.267	-0.290	-0.294	-0.357
	(0.222)	(0.243)	(0.245)	(0.244)	(0.246)
Hsize	3.296***	3.298***	3.388***	3.623***	3.405***
	(0.695)	(0.728)	(0.738)	(0.723)	(0.720)
BasicEduc	2.854	4.804	4.353	2.756	3.283
	(5.026)	(5.283)	(5.300)	(5.107)	(5.076)
SeconEduc	3.051	5.900	5.680	3.920	5.256
	(5.115)	(5.457)	(5.488)	(5.328)	(5.341)
Higheducation	2.113	3.831	3.382	1.336	3.263
	(5.137)	(5.386)	(5.392)	(5.230)	(5.315)
Color		-0.542	-0.396	-0.569	-0.796
		(1.054)	(1.063)	(1.051)	(1.044)
Smell		0.572	0.469	0.756	0.729
		(0.987)	(1.001)	(0.982)	(0.965)
Taste		0.760	0.777	1.129	1.148
		(0.723)	(0.721)	(0.723)	(0.718)
Quality		-0.999	-1.033	-1.219*	-0.931
		(0.733)	(0.734)	(0.711)	(0.718)
Serviceperc		-0.333	-0.250	-0.321	-0.328
		(0.691)	(0.701)	(0.674)	(0.666)
Cutfreq			-1.146	-1.122	-0.760
			(1.381)	(1.380)	(1.376)
Cutdisruption			0.138	-0.102	-0.223
			(0.809)	(0.819)	(0.813)
Envconcernavg				-0.414	0.250
				(3.192)	(3.169)
Envworried				2.842	2.083
				(2.804)	(2.803)
Watereff				-0.0183	0.226
				(1.827)	(1.827)
Waterhabitindex				-6.108**	-6.192**
				(2.530)	(2.599)
Priceperception					1.746*
					(0.969)
Constant	0.520	1.048	5.267	5.267	-4.188
	(5.675)	(7.076)	(14.83)	(14.83)	(15.60)
Observations	528	503	503	503	493

Standard errors in parentheses.

Notes: *, ** and *** denote 10%, 5%, and 1% significance levels, respectively

Table 7. Estimates of Heckman selection model with IV and Cragg's model with control function approach to correct for price endogeneity (N=379. Censored= 252).

	Heckman with IV			Cragg with CFA		
VARIABLES	Participation	First stage 2SLS	Intensity 2SLS	First stage	Participation	Intensity
Municipio	4.778	0.129	-6.445**	0.110	-0.788	-13.86
	(699.5)	(0.164)	(2.752)	(0.0876)	(0.738)	(9.848)
Childrenlessthan2	0.678**				0.654**	0.782
	(0.287)				(0.288)	(2.722)
Length	-0.0167***	1.72e-05	-0.0628**	7.77e-05	-0.0162***	-0.0417
	(0.00430)	(0.000538)	(0.0274)	(0.000267)	(0.00429)	(0.0401)
Hholdincome	-0.0246	-0.000307	-0.126	-0.000227	-0.0117	-0.388*
	(0.0256)	(0.00184)	(0.125)	(0.00156)	(0.0252)	(0.221)
Hsize	-0.0787	0.00933*	-0.144	0.00953**	-0.165*	1.270
	(0.0731)	(0.00541)	(0.372)	(0.00445)	(0.0920)	(1.000)
BasicEduc	0.217	-0.0397**	3.814**	-0.0405	0.339	17.87**
	(0.496)	(0.0194)	(1.845)	(0.0279)	(0.551)	(6.939)
SeconEduc	0.213	-0.0395**	4.441**	-0.0402	0.392	19.18***
	(0.507)	(0.0195)	(1.968)	(0.0288)	(0.556)	(6.938)
Higheducation	0.211	-0.0290	3.267*	-0.0297	0.315	14.43**
	(0.516)	(0.0214)	(1.776)	(0.0295)	(0.550)	(6.638)
Color	0.0935	0.000245	0.514	1.02e-05	0.0960	-1.924*
	(0.117)	(0.00828)	(0.826)	(0.00757)	(0.117)	(1.065)
Smell	0.150	0.00681	-0.0666	0.00625	0.105	0.870
	(0.111)	(0.00753)	(0.963)	(0.00733)	(0.113)	(0.992)
Taste	0.0922	0.00292	0.126	0.00261	0.0905	0.628
	(0.0868)	(0.00402)	(0.631)	(0.00575)	(0.0870)	(0.661)
Quality	-0.315***	-0.0133	-1.068*	-0.0124**	-0.302***	0.000395
	(0.0892)	(0.0105)	(0.595)	(0.00560)	(0.117)	(1.133)
Serviceperc	0.0829	0.00154	0.369	0.00130	0.0973	-0.707
	(0.0760)	(0.00542)	(0.385)	(0.00466)	(0.0763)	(0.595)
Cutfreq	0.357**	0.0122	-0.00759	0.0110	0.286*	-2.057
	(0.170)	(0.0144)	(0.930)	(0.0103)	(0.164)	(1.378)
Cutdisruption	0.0938	0.0102	-0.410	0.00988*	0.0384	-1.851*
	(0.0879)	(0.00625)	(0.500)	(0.00535)	(0.0984)	(1.013)
Envconcernavg	0.320	0.0182	-1.294	0.0169	0.226	-1.896
	(0.310)	(0.0241)	(1.440)	(0.0182)	(0.325)	(3.193)
Envworried	-0.0771	0.0246	-0.0613	0.0248	-0.213	0.698
	(0.276)	(0.0195)	(1.411)	(0.0169)	(0.300)	(3.215)
Watereff	0.00535	0.0111	-0.747	0.0110	-0.0332	-2.612
	(0.177)	(0.0133)	(0.878)	(0.0106)	(0.184)	(1.769)
Waterhabitindex	-0.390	-0.0265	0.316	-0.0250*	-0.333	0.173
	(0.267)	(0.0204)	(1.303)	(0.0135)	(0.305)	(3.708)
Priceperception	-0.0210	-0.000676	0.679	-0.000395	0.0277	2.140**
	(0.0993)	(0.00870)	(0.535)	(0.00607)	(0.0984)	(0.834)
Averageprice	-0.0854		47.01**		3.508	112.5
	(0.943)		(20.83)		(5.747)	(79.56)
IV1	-57.66	-1.155		-0.936		
	(7,972)	(1.864)		(1.081)		
IV2	17.99	-0.0633		-0.141		
	(1,056)	(0.634)		(0.131)		
IV3	3.512*	0.273**		0.261***		

	(1.901)	(0.114)		(0.0974)		
IMR		0.00490	-1.202***			
		(0.0407)	(0.340)			
Residual					-4.399	-97.18
					(5.883)	(78.44)
Constant	-5.010	0.841***	-31.30*	0.8615***	-4.537	-95.47
	(1,015)	(0.248)	(17.82)	(0.1431553)	(5.206)	(68.12)
Σ					6.280***	
					(0.488)	
Sargan test		χ^2_2= 0.26316				
		(0.8767)				
F-test of excluded instruments		$F_{(3,355)} = 2.78$				
		(0.041)				
Hausman test.		χ^2_1= 3.40				
.		(0.0651)				

Standard errors in parenthesis are computed using bootstrapping with 100 iterations.

Notes: *, ** and *** denote 10%, 5%, and 1% significance levels, respectively.

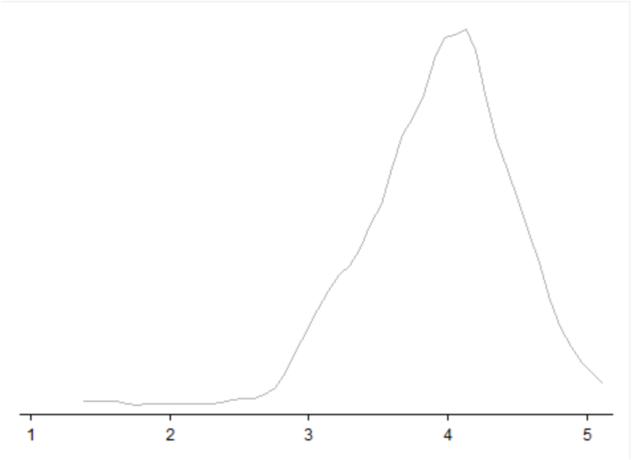

Figure 1: Distribution of the variable envconcernavg
(Respondent average value in a set of questions on environmental attitudes. See Appendix 1).

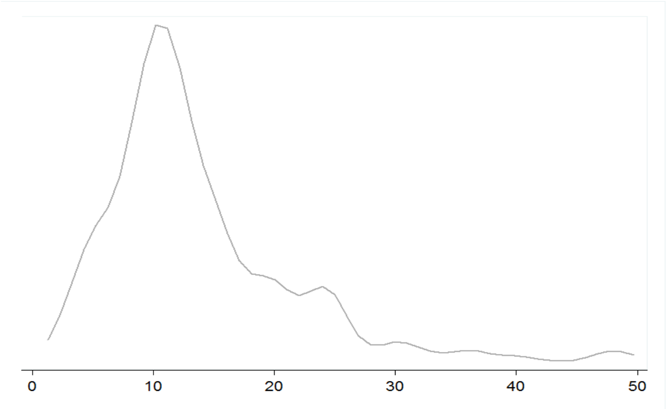

Figure 2: Distribution of bottled water demand in liters per week

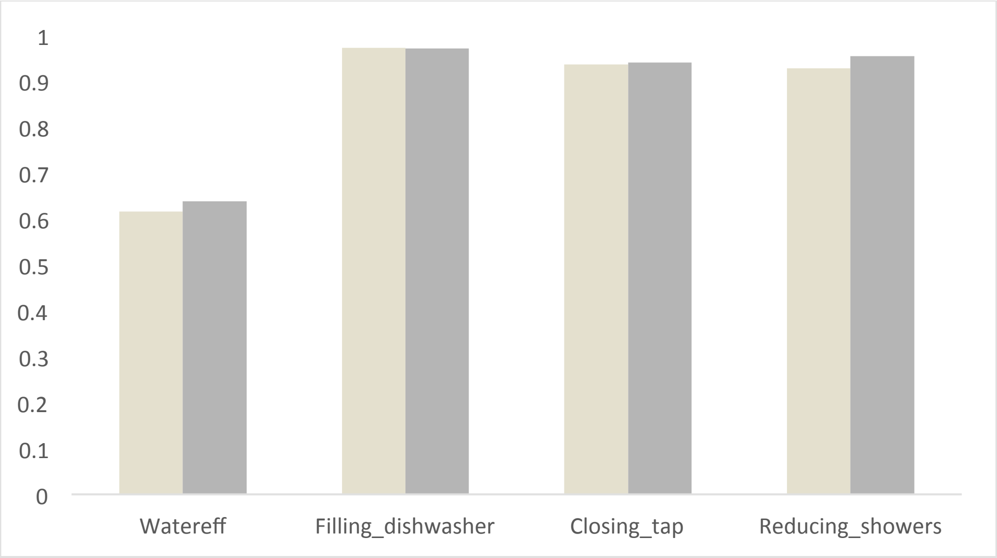

Figure 3: Share of households whose concern is below (light grey) and above (dark grey) average that perform certain water saving behaviors.

Appendix 1: Definition of Variables

Our variables are defined as follows. Household monthly income (*Hholdincome*) is measured as an ordinal variable taking 14 possible values, ranging from 0€ to more than 3,900€ in intervals of 300€. Since households very rarely feel comfortable with stating their income, interviewers were instructed to show a card with a different color for each range of income and the interviewee had to say which color represent their household income level.

As for education, we include dummies indicating respectively whether the household head has not completed any formal education level (*NoEduc*) or has completed either basic education (*BasicEduc*), secondary (*SecondEduc*), or any kind of university degree (*HighEduc*).

The length of time in years that the respondent has been living in town (*Length*) and the number of members living in the household (*Hsize*) are also considered.

In order to account for the influence of the presence of individuals belonging to vulnerable populations we include a dummy variable reflecting whether there are some children under 2 years old living in the household (*Childrenlessthan2*).

With respect to organoleptics, consumer perceptions about color, taste and smell are considered. Households were asked, respectively, to which degree they agree that the water is clear as opposed to having some color (*Transparency*), having some taste (T*aste*) or some odour (*Smell)*. Household perception of these aesthetic characteristics had to be rated from 1 (strongly disagree) to 5(strongly agree). The variable reflecting transparency was afterwards recoded (and renamed as C*olor*) so that the highest value always reflects a poor perception on organoleptics. In the same fashion, perception of water quality is included using an ordinal variable (*Quality*). For this purpose, households had to report their degree of satisfaction with water quality, ranging from 1 (very dissatisfied) to 5 (very satisfied).

In order to analyze the effect of supply interruptions, we include two variables: *Cutfreq* reflects the frequency or incidence of disruption events from 1 (never) to 5 (very frequently, more than 10 times per year). The inconvenience caused to the household may vary according to the length of time of those supply interruptions. Given that households cannot manage without drinking water during long periods of time, bottled water demand may be affected in different intensities, depending on whether the interruptions are shorter or longer. To measure this, the respondent was asked to report the level of inconvenience that these incidents (C*utdisruption*) have caused the household, ranging from 1 (very little) to 5 (a lot).

With respect to environmental variables, we include proxies for environmental concern and behaviors. As for behavior, both improved efficiency and curtailment actions are considered. Environmental attitudes are measured through a set of questions designed to evaluate environmental concern. The respondent agrees with certain statements related to their perception of current environmental problems (The statements are included at the end of this Appendix) from 1 (strongly disagree) to 5 (strongly agree). Some of the values were recoded so that 5 always reflect the highest level of environmental concern. A mean of the values given by the respondent was then calculated and used as a proxy for their level of concern (*Envconcernavg*). When the household did not provide an assessment on a particular statement, it was recoded as a missing value and not considered in the computation of the mean. As depicted in Figure 1, the distribution of this variable is right-skewed and, on average, households report to have a high level of concern about environmental problems (3.94 out of 5). For this reason, in addition to the average, we decide to include a dummy, indicating whether the household's level of environmental concern is above average, that is whether they are relatively more concerned than average about the environment (*Envworried*).

Behaviors of the efficiency type are considered through a binary variable reflecting whether the households have water-saving technologies installed either in taps, flush toilets or showers (*Watereff*). As for curtailment behaviors, we include household's reported level of involvement in several environmental habits related to water use, particularly whether (1) they wait until the dishwasher and washing machine are full before starting them (*Fill_dishwasher*), (2) they close the tap when not in use, while brushing their teeth, shaving or washing hands (*Closing_tap*), and (3) if they try to reduce the duration of their showers (*Reduce_showers*). With these behaviors we construct an index of household's level of involvement in curtailment behavior, based on how many of these habits the household puts into practice (W*aterhabitindex*). The aim of this variable is, therefore, to measure the level of consistency of the household in their commitment to perform water-saving behaviors.

Tap water price variables are constructed using both information in the sample and the official tariffs published by the city council. Because it is usually very difficult for consumers to know their exact water payments, in order to facilitate the household giving an answer, water expenditures were recorded using ranges. Therefore, the mean point of each range was taken when computing the average (*Averageprice*). With respect to household's perception of tap water price (*Priceperception*), individuals were requested to assess how they perceived the price, and this ranged from 1(very cheap) to 5 (very expensive).

Finally, our dependent variables are respectively a dichotomous variable indicating whether or not the household reports using regularly bottled water as main source of drinking water (*Bottledwater*), and a variable reflecting quantities of bottled water consumed per week in liters (*Quantitybottledwater*).

Set of question to evaluate the level of environmental concern.

1) I am concerned about future generations when I think of the environmental situation we are going to leave them with.
2) If society continues to carry on a consumerist lifestyle, we are heading towards an environmental disaster.
3) When I watch or read the news about environmental problems, I feel shamed or raged.
4) The great majority of Spanish people do not act in an environmentally responsible manner.
5) The limits to economic growth in the industrialized world have already been reached or they will be reached soon.
6) In my opinion, environmental problems are being very overstated by the advocate of ecologist movements.
7) It is clear that now-a-days politicians are doing very little for the protection of the environment.
8) In order to protect the environment, we must all be willing to change our current lifestyle.
9) Some measures aimed at protecting the environment should be applied, although it could lead to job losses in the economy.

Appendix 2: Set of questions used as instruments for the index on water-saving habits.

1. Do you think that, as it is proposed by EU Norms, your municipality should take steps towards a more efficient and sustainable use of water resources and, particularly, towards reducing network losses?
2. Do you have an approximate idea about the percentage of water network losses in your municipality?
3. Would you be willing to pay an extra amount in your water bill to act more decisively in order to improve the current state of the supply networks?