This is a pre-print version of *Garrone*, *P.*, *Grilli*, *L.*, & *Marzano*, *R.* (2020). *Incentives to water conservation under scarcity:* Comparing price and reward effects through stated preferences. *Journal of Cleaner Production*, 244, 118632. The final authenticated version is available online in https://doi.org/10.1016/j.jclepro.2019.118632.

1

26

Incentives to water conservation under scarcity: 2 comparing price and reward effects 3 through stated preferences 4 5 Paola Garrone, Politecnico di Milano 6 Luca Grilli, Politecnico di Milano 7 Riccardo Marzano, Sapienza Università di Roma 8 9 **Abstract** 10 Focusing on two different European institutional contexts, a stated preference approach is 11 adopted to elicit the willingness to save water under three alternative incentive policies: a water 12 price increase, monetary reward, and symbolic prize. In addition, two water scarcity scenarios, a 13 'critical' and a 'regular' scenario, are devised to analyze how information on water scarcity 14 moderates the effect of incentives. Empirical results show that users become sensitive to 15 monetary incentives (while they remain insensitive to non-monetary ones) when water is scarce. 16 Batteries of pre-tests on the sample and robustness checks on the results strengthen the reliability 17 of our findings and partially circumvent concerns related to the use of a stated preference 18 approach. The study adds to the literature on the efficacy of economic incentives in the water 19 sector and the role of local factors in explaining water users' response. 20 21 22 JEL classification: Q21; Q25; Q28; L95; D12 23 24 Keywords: economic incentives; water conservation; water scarcity; demand management strategies; stated preferences; individual behavior 25

1. Introduction

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

The European Environment Agency reports that many European regions are increasingly experiencing water stress conditions.¹ Although water scarcity is not on average severe in Europe, pressure on freshwater resources is a concern for the population residing in the European Mediterranean region and the densely populated river basins. Further deterioration of the balance between water supply and demand in Europe can be expected in the long term because of climate changes and urbanization.² Likewise, in the United States, the Environmental Protection Agency reports that water managers in 40 out of 50 states expect water shortages in some areas of their territories under average conditions over the next 10 years.³ Policy makers are increasingly relying on demand side management mechanisms, namely, regulatory measures and economic incentives, to attain water conservation (Renwick & Green, 2000). However, the empirical evidence on the incentive policies that are most effective for different types of water consumers in different scenarios is fragmented and ambiguous (Beecher & Gould, 2018). This article studies how consumers respond to different economic incentives. First, it stresses the importance of understanding, in more detail, the potential of price as a means of inducing water conservation behavior, compared with alternative mechanisms, namely, monetary rewards and symbolic prizes. Second, it investigates whether users' response to conservation incentives varies according to water scarcity conditions. More specifically, it draws on two surveys of water users in Switzerland and Spain and explores the individuals' willingness to engage in water saving actions under hypothetical incentive policies and water scarcity scenarios. The study relies on a stated preference approach to elicit the willingness to save water among a sample of households. The respondents received

different treatments, in terms of economic incentives, and were exposed to different water scarcity scenarios, as their district was or was not reported to experience a severe water shortage.

Stated preferences are increasingly being used to estimate preferences over nonmarket goods and goods not yet available in markets (Pondorfer et al., 2018). Although both stated and revealed preferences have their own pros and cons (e.g., Champ et al., 2003), a research design based on stated preferences allows mitigating, at least partially, some critical concerns that may misleadingly influence the estimates of incentive effects. First, through this method, the typical information gap about price (or an alternative economic incentive) structure, which has been found to affect water consumers, is largely mitigated. Second, and more important, incentives can be randomly assigned to water users, namely, without any ex-ante information regarding their potential response in terms of water conservation, making the investigated treatment effect truly exogenous. Additionally, a battery of pre-tests on the sample and robustness checks on the results is conducted to strengthen the reliability of the findings and partially circumvent concerns related to the use of a stated preference approach (see subsections 3.4 and 4.1 for details).

The empirical analyses consider three alternative incentive policies: a water price increase, a monetary incentive consisting of a voucher, and a symbolic prize represented by a badge. The voucher and the badge are awarded to households that stand out as water savers in their neighbourhood. In addition, two water scarcity scenarios are devised: a 'critical' and a 'regular' scenario. The combination of the two treatment levels, i.e., incentives and scarcity, allows testing hypotheses about users' reaction to monetary and non-monetary incentives possibly moderated by a negative shock to the water supply.

The findings confirm the reluctance of individuals to change their consolidated habits of water use. However, results support the claim that water users become sensitive to monetary incentives

(while remaining insensitive to non-monetary incentives) when they believe that their community is threatened by severe water supply shortages.

The remainder of the article is organized as follows. Section 2 reviews the literature on resource conservation behavior by focusing on the use of economic incentives and formulates the research hypotheses. Section 3 describes the survey administration, presents the data, and illustrates how a potential problem of sample self-selection bias has been tackled. Section 4 presents the main results and robustness checks performed to support the empirical findings. Section 5 concludes and discusses the implications of the findings.

2. Literature review and research hypotheses

82 The literature has studied resource conservation behavior extensively (Wang et al., 2019).

83 Incentive mechanisms have been mainly studied in the context of energy conservation, in part

because of the longer experience with policy experiments in that sector, whereas their application

in the water sector has received increasing attention only more recently.

Abrahamse et al. (2005) surveyed experimental and empirical studies and suggested that monetary rewards in combination with feedbacks could induce households to reduce energy consumption, but the effect is generally short-lived. Delmas et al. (2013) conducted a meta-analysis of field trials and found that the provision of information on monetary savings or expenses is counter-productive, likely due to pro-social behavior crowding out or the paucity of incentives. Other studies have focused on dynamic pricing programs, and have covered various designs of time-of-use prices, critical peak prices, and rebate schemes (Faruqui & Sergici, 2010). They all converge to show that consumers do respond to extrinsic monetary incentives, with the effect varying greatly according to the size of the measure and the contextual conditions, which should warn policy makers against generalizing the results (Ito et al., 2018).

In the water sector, the effectiveness of economic incentives as demand management policies has mainly been investigated by assessing whether and to what extent price increases lead to water saving. Most of this literature has found that residential water demand is price inelastic (Marzano et al., 2018). The reasons for this empirical finding remain elusive, but a few issues have emerged. First, many studies have not considered the dynamics of users' response, although price elasticity has been estimated to be higher in the long run (Nauges & Thomas, 2003). Second, water users might not be able to respond to prices because they lack adequate price information (Wichman, 2017). Understandable and informative water bills can produce a positive effect on price elasticity (Gaudin, 2006). Although this information gap can hardly be completely filled, it is likely to be mitigated due to the adoption of advanced meters and other technologies (Rougé et al., 2018). Third, another issue concerns the potential endogenous nature of the relationship between price elasticity and tariff schemes (Olmstead et al., 2007). Structural estimates of water demand under non-linear prices show that household price elasticity is contingent on the water utility's choice of price structure (Lopez-Nicolas et al., 2018). This result seems to suggest that utilities could modify consumers' responsiveness to prices, even in the short term, provided that they are able to select the appropriate pricing strategy.

96

97

98

99

100

101

102

103

104

105

106

107

108

109

110

111

112

113

114

115

116

117

118

119

The literature on the effects in the water sector of demand management mechanisms that are alternative to price is scarce and has mainly focused on use restrictions (Castledine et al., 2014) and prescriptions (Wichman et al., 2016). More recently, studies have investigated the impact of information campaigns on water saving behavior (London et al., 2018; Torres & Carlsson, 2018). In particular, pricing mechanisms have not been compared with other monetary incentives (i.e. rewards) and non-monetary incentives (i.e. symbolic prizes).

Although residential water demand has been found to be price inelastic, pricing mechanisms are expected to impact, at least to some extent, water consumption. Theoretically, alternative

- 120 economic incentives are likely to induce water saving behaviors in water users as well.
- 121 Accordingly, the first initial hypothesis is as follows:
- H1a. Increasing the water price has a positive effect on water savings.
- *H1b. Offering monetary rewards to water savers has a positive effect on water savings.*
- H1c. Awarding symbolic prizes to water savers has a positive effect on water savings.
 - Water scarcity may play a key role in shaping water consumption (Prediger et al., 2014) and water users' responsiveness to incentives (Krause et al., 2003). Aside from 'other-regarding' opportunity costs (Pfaff at al., 2015), which can contribute to water savings regardless of the adoption of demand management strategies, scarcity may act as a focusing device that makes individuals more reactive to economic incentives (Garrone et al., 2019). First, social recognition can be a powerful trigger, especially in contexts where the applauded behavior is more relevant from a social point of view, i.e. in geographical areas where water supply is relatively scarcer. Second, self-esteem from the assimilation of the normative signal of what constitutes desirable societal behavior conveyed by the regulating institution can be a critical psychological mechanism behind the positive interaction between scarcity and the use of economic incentives on water savings (Narloch et al., 2012). Accordingly, we posit the second hypothesis as follows:
- H2a. Water scarcity strengthens the positive effect of a price increase on water savings.
- *H2b.* Water scarcity strengthens the positive effect of a monetary reward on water savings.
- *H2c.* Water scarcity strengthens the positive effect of a symbolic prize on water savings.

3. Methods

3.1. Administration and samples of the surveys

Two surveys were conducted: the first in Switzerland and the second in Spain.

The Swiss survey was administered in Ticino, an Italian-speaking canton, between October 15 and November 31, 2015. The target population comprised customers of Società Elettrica Sopracenerina (SES), a utility that provides a bundle of services, including electricity distribution and smart meter installation.⁴ A letter was sent by SES to its customers inviting them to fill in a questionnaire by using a link to a web platform. The letter was bundled with the electricity bill invoice. SES actively promoted participation in the survey by raffling three mini iPads. A total of 462 filled in questionnaires were obtained.

The Spanish survey was administered in Valencia between April 1 and June 30, 2016. The target population comprised EMIVASA customers; EMIVASA manages the water supply and provides drinking water to the city of Valencia. In the same manner as in the Swiss case, the questionnaire was made available on a web platform. To engage customers, EMIVASA used e-mails in addition to a call center campaign and promotion through radio/press. At the end of the survey administration process, 295 observations were obtained.

Canton Ticino and Valencia were selected because they represent geographical contexts characterized by different water availability and water consumption attitudes. Although water is generally abundant in Ticino, Valencia suffers from frequent droughts due to climate conditions. Moreover, although the metropolitan area of Valencia is largely urbanized, Canton Ticino remains mostly a rural area. As a consequence, different water consumption attitudes should be expected.

Both surveys undertook a pilot pre-test phase during which questionnaires were submitted to students not involved in the project. Moreover, two focus groups using members of the targeted populations were held to calibrate survey and item response rates and conduct preliminary statistical tests on the investigated hypotheses (Johnston et al., 2017).

3.2. Dependent variable, treatments, and additional information on respondents

Each respondent was asked if he/she was willing to engage in water saving actions, which were the same for all the respondents. The study focuses on the willingness to reduce the duration of showering for three reasons. First, showering has often been reported as being one of the most water consuming actions in a house, accounting for a residential water consumption share that ranges from 19% to 25% (see Energy Saving Trust, 2013). Second, unlike irrigation, or the use of washing machines and dishwashers, showering is under the full control of each individual household member. Therefore, the willingness to reduce irrigation by one member of a household may not be relevant if he/she is not the person who makes the decision about how often and for how long the garden should be watered. Third, unlike the use of the lavatory (which competes with the shower as the largest water consuming action in a household), the use of water to shower is fully adjustable by each individual. The question about shower time reduction allowed the respondents to select their answers from four possible time reduction options: 0, 1–2, 3–4, >4 minutes.

Respondents were randomly assigned to 3 x 2 alternative treatment groups that resulted from the combination of incentives with water availability scenarios (Appendix B). Each sample received two incentive treatments (i.e. *price increase* and *symbolic prize* in Switzerland; *price increase* and *monetary reward* in Spain) and included a *control* group.⁵ Additionally, the respondents could have been exposed to either a *critical* scarcity scenario, framed as a severe water shortage in the district, or a *regular* supply. Treatments were randomized across respondents to avoid bias due to correlation among cross-treatment responses, thus ruling out the common method variance concern, frequently mentioned when using data collected from a survey instrument (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Table 1 shows the distribution of respondents across treatments in the two samples. The *pricing* treatment consists of an increase in the semestral water bill by 40 Swiss Francs (CHF) in Switzerland and a bimonthly increase by 20 Euros (EUR) in Spain (see Appendix A for details on the calibration of treatments). The *symbolic reward* treatment (tested in Switzerland only) consists in the households that obtained high water savings being awarded a "Best friend of environment" badge to be put on display in the town. The *monetary reward* treatment (tested in Spain only) is a EUR 20 voucher to be redeemed in the user's supermarkets/shopping malls of choice. Both in Switzerland and Spain, the residual group works as a *control* group and includes respondents not exposed to any incentive. Appendix B reports the wording of the survey treatments.⁶

[Insert Table 1 about here]

The questionnaires asked respondents to provide additional information prior to exposure to one of the six scenarios. Accordingly, the first part of the survey encompasses four sections: Demographics,⁷ House Data,⁸ Water Use,⁹ and Environmental Status.¹⁰ This information allowed checking the sample representativeness against secondary data on targeted populations. Demographic characteristics are also used to control for sample heterogeneity.

3.3. Descriptive statistics

Regarding the respondents in the Swiss sample, the majority are male (59.1%), the most populated age range is 41–50 (16.7%), respondents younger than 30 (3%) and older than 70 (7.6%) are included, and a higher education level was observed compared with the average education level of the Ticino population. Specifically, 137 respondents out of 462 (29.7%) have a university degree compared with approximately 7% of Ticino residents. Conversely, only

1.52% of the Swiss respondents have their final leaving certificate that is below the apprenticeship qualification, compared with 31% of the Ticino population. Similar to the Swiss sample, in the Spanish sample, male respondents (67.9%) exceed female respondents, and the most populated age range is 41–50 (24.1%). The Spanish respondents are more educated than the Swiss respondents as the majority have a university degree (66.9%). Notably, because in the regression models the demographic characteristics of the respondents are controlled for, stratification based on gender, age, and/or education does not cause problems of consistency (see Wooldridge, 1999). Additional details on the sample descriptive statistics are reported in Appendix C.

On average, the respondents take 5.17 showers per week in Ticino and 5.29 in Valencia. In both samples, some respondents do not take showers because they prefer to take baths. The maximum reported number of showers per week is 8. The shower times range from 4 to 21 minutes, with a mean value of 6.58 minutes in Ticino and 7.59 minutes in Valencia (see Appendix C for further details).

When using stated preferences, precautions are required to deal with systematic upward biased results due to the differences between how individuals behave in real life and the responses to hypothetical questions (Blumenschein et al., 2008). Pollowing Champ et al. (1997), the 'hypothetical bias' in the Swiss survey is alleviated by using follow-up questions aimed at assessing the respondents' certainty level about the provided answers related to the willingness to undertake water saving actions. Responses to hypothetical willingness to reduce the shower time are divided considering two degrees of certainty: 'probably sure' and 'definitely sure'. Having this self-assessed certainty level at our disposal, the shower time reduction variable is operationalized in two different ways. The first way contemplates the use of the variable as reported by the respondents, namely, without considering the self-reported certainty level. In the

second approach, mildly positive responses, namely, responses reporting only a probable willingness to engage in a reduction in the shower time, are treated as negative responses (i.e. responses reporting an unwillingness to engage in a reduction in shower time). This approach has been proved effective in removing hypothetical bias in both laboratory and field experiments (Blumenschein et al., 1998). However, in the Spanish survey, under the guidance of EMIVASA managers and their specific recommendations, no follow-up questions were included. This (expost rational) choice was deemed necessary to limit the required filling time of questionnaires and raise as much as possible the response rate. Of course, this choice came at the cost that in such a case it is impossible to control for the aforementioned hypothetical bias.

Since discrete options of a shower time reduction were available, some reference values had to be chosen in order to treat the variable as if it is continuous. Thus, 1–2 minutes is transformed into 1.5 minutes, 3–4 into 3.5, and >4 into 5. Of course, 0 requires no transformation. The mean shower time reduction in Switzerland changes from 2.12 minutes, when using the first operationalization, to 0.59 minutes, when using the second one. The only available measure of shower time reduction in the Spanish case has a mean value of 2.25 minutes, which is similar to the mean value of the same variable in Switzerland.

3.4. Sample self-selection problem

Sample self-selection is a common problem when using surveys. Respondents' observable characteristics and unobservables can differ from the remainder of the targeted population. Dealing with differences in observables is straightforward. As above mentioned, controlling for those characteristics in the regression models is the solution. Conversely, when self-selection is based on unobservables, concerns may arise if those unobservables may affect the treatment effects. In our case, respondents may be more environmentally friendly or sensitive to water

efficiency than the remainder of the residents. Thus, respondents could react to economic incentives to a greater or lesser extent than the rest of the population.

In this section, evidence that the self-selection problem is unlikely to impair our results is provided. To this aim, a twofold strategy is adopted. First, a supplementary sample of respondents located in Valencia who did not self-select in the survey is used. They were reached by phone and asked a limited subset of questions about their relationship with water and water efficiency issues.¹³ Their answers to questions related to social norms, behaviors and beliefs are not statistically different from those given by the core sample. Second, using data available for the Spanish case study, it can be shown that the survey respondents' water consumption distribution is not statistically different from that of the rest of the population.

Table 2 reports the results of ordinary least squares (OLS) estimations of four regression models, which differ in the dependent variables: (i) the extent to which the respondent feels that it is expected of him/her to save water (social norms); (ii) the extent to which the respondent is confident that he/she would be able to save water if he/she wanted to (behavioral control); (iii) the respondent's willingness to engage in everyday actions to save water over the next 6 months (behavioral intention); (iv) the extent to which the respondent agrees with the statement that a way of preventing water exhaustion is by using it only when absolutely necessary (beliefs). The first three dependent variables are measured on a 5-point scale, ranging from 'completely disagree' to 'completely agree'. The last one uses a 4-point scale.

Depending on the measure considered, the phone sample includes 188 or 189 individuals, the survey sample consists of 290 respondents for whom all demographic characteristics are observed. The results show that the responses from the survey respondents are not statistically different from those of the phone respondents, thus suggesting that the 'self-reported' behavioral

control and intention, beliefs, and perceived social norms are not dissimilar for the two groups, that is, self-selection is less likely.¹⁴

[Insert Table 2 about here]

Another concern with the use of self-reported subjective measures is that respondents who are less sensitive to water efficiency issues may be more prone to exaggerating their sensitiveness than truly water-concerned individuals. To partially circumvent this issue, the water consumption data of the Spanish survey respondents were compared with those of a far larger sample of randomly selected Valencian users; to distinguish the two, the latter is labelled as 'representative sample': more than 10,000 metered households, whose water consumption readings relative to 2015 are available. Moreover, data pertaining to almost every survey respondent relative to the same period are also available. Figure 1 depicts the Kernel estimates of the two sample distributions of the average daily water consumption, which, as can be observed, are very similar.

[Insert Figure 1 about here]

[Insert Table 3 about here]

To statistically test the equality of the two sample distributions, Panel A of Table 3 shows the descriptive statistics of the daily water consumption for the two samples. The mean and median values are very close and the mean values are not statistically different. Moreover, Panel B of Table 3 shows the results of the Kolmogorov-Smirnov test (K-S test). The K-S test is a nonparametric test of the equality of continuous, one-dimensional probability distributions. The K-S test rejects the hypothesis that the two sample distributions differ.

The two pieces of evidence provided (comparison of self-reported sensitiveness to water efficiency between survey respondents and phone respondents; comparison of water consumption

patterns) suggest that there are no reasons to believe that the respondents may have self-selected in the core surveys on the basis of their sensitiveness to water efficiency issues.

3.5. Models

302

303

304

To test the hypotheses formulated in Section 2, the following models are estimated through OLS:

Showertime reduction =
$$\beta_0 + \beta_1 Pricing + \beta_2 Symbolic + \beta_3 Scarcity + \beta_4 (Pricing *$$

307
$$Scarcity$$
) + $\beta_5(Symbolic * Scarcity) + \gamma_k X_k + \varepsilon$ (1)

Showertime reduction =
$$\delta_0 + \delta_1 Pricing + \delta_2 Monetary + \delta_3 Scarcity + \delta_4 (Pricing * \delta_1 Pricing * \delta_2 Monetary + \delta_3 Scarcity + \delta_4 (Pricing * \delta_3 Pricing * \delta_4 Pricing * \delta_5 Pri$$

$$Scarcity) + \delta_5(Monetary * Scarcity) + \theta_k X_k + \epsilon$$
 (2)

- where X_k is a vector of respondent controls and ε and ε are the errors terms specific to each model. The model in Equation (1) is estimated using observations from the Swiss survey because we can test the effect of the symbolic prize in Switzerland only. Likewise, the model in Equation (2) is estimated using observations from the Spanish survey, as we can test the effect of the
- 313 (2) is estimated using observations from the Spanish survey, as we can test the effect of the
- 314 monetary reward in Spain only.
- Hypothesis H1 is supported if β_1 and δ_1 (H1a), β_2 (H1c), and δ_2 (H1b) are positive and
- statistically significant. Hypothesis H2 is supported if β_4 and δ_4 (H2a), β_5 (H2c), and δ_5 (H2b)
- 317 are positive and statistically significant.
- To strengthen the reliability of our results, we estimate the same models as reported in
- Equations (1) and (2) through GOLOGIT and interval regression (see subsection 4.1). Their
- 320 specifications require a different operationalization of the dependent variable. When estimating
- 321 the GOLOGIT models, we use a categorical variable to measure the shower time reduction,
- whereas when estimating the interval regression models, we create two variables containing the
- lower and upper endpoints of the shower time reduction categories.

4. Results

Columns (1–6) of Table 4 present the results of the OLS estimations with robust standard errors obtained using the Swiss sample. Columns (1–3) report the estimates obtained using the *shower* time reduction as reported by the respondents, without considering the self-reported certainty level. Columns (4–6) report the results robust to hypothetical bias (Champ et al., 1997).

The estimates that refer to specifications that include only the treatment dummies are reported in columns (1) and (4). The respondents' shower habits, namely, number of showers per week (*Showers*) and shower time (*Showertime*), are considered in columns (2) and (5). Additional respondent-specific controls, namely, gender (*Female*), age (Age), age-squared (Age^2), education level (*Education*), and a set of job category dummies are also added to columns (3) and (6).

[Insert Table 4 about here]

The coefficients of the treatment dummies are not statistically significant in any of the six specifications. This finding suggests that the consumers' willingness to reduce their shower time is not associated per se with the price increase or the symbolic prize. According to these results, Hypotheses H1a and H1c are rejected by the Swiss sample.

To compute the effects of the incentive treatments under the water scarcity scenario, the direct and cross-term coefficients must be summed. The table at the bottom reports the marginal effects of *Pricing* and *Symbolic* incentive treatments considering the scarcity scenario. The results show that the bill increase leads to a statistically significant shower time reduction when coupled with water scarcity (in the case when the hypothetical bias has been ruled out completely). The predicted shower time reduction ranges from 0.41 to 0.46 minutes, depending on the specifications, and it is statistically significant at the 10% level. Since the Swiss respondents

reported an average shower time of 6.58 minutes, a shower time reduction between 6.2% and 7.0% could be obtained. Therefore, Hypothesis H2a is supported by the Swiss sample.

The symbolic incentive, by contrast, continues to be ineffective at increasing water savings for showers, even under severe water scarcity conditions. Notably, the prediction of shower time reduction when the respondents face both scarcity and the possibility of being awarded a badge if they engage in water saving actions is not statistically different from zero. Therefore, since Hypothesis H2c can be tested only through the Swiss sample, we conclude that it is rejected.

Columns (7–9) of Table 4 show the results using the Spanish sample. As above mentioned, the hypothetical bias cannot be dealt with in this case, as no follow-up questions were available. However, since the results presented in columns (4-6) show that statistical significance is strengthened by controlling for the hypothetical bias, it can be expected that the Spanish results would be conservative. Moreover, when the *symbolic prize* treatment is replaced with the *monetary reward*, the stand-alone coefficients of the treatment dummies are not statistically significant in any of the three specifications. According to these results, H1a and H1b are rejected by the Spanish sample.

The interaction term between *Monetary* and *Scarcity* is positive and statistically significant at the 10% level in the most thorough specification. Regarding the marginal effects of *Pricing* and *Monetary* incentive treatments under the scarcity scenario, the estimates show that the bill increase leads to a statistically significant *shower time reduction* under water scarcity. The most thorough specification (column 9) produces a predicted *shower time reduction* of 0.58 minutes, statistically significant at the 5% level. Since Spanish respondents reported an average shower time of 7.59 minutes, a 7.6% reduction in shower time could be obtained. Thus, Hypothesis H2a is supported by the Spanish sample.

Unlike the *symbolic incentive*, the *monetary reward* is effective at reducing the shower time under a water scarcity scenario. The predicted *shower time reduction* is estimated to be 0.50 minutes and to be statistically significant at the 10% level. Because Hypothesis H2b is tested in only Spain, it can be concluded that it is supported.

4.1. Robustness checks

In this subsection, the preceding analyses have been extended with additional tests to support the causal interpretation of the previously described findings.

As mentioned in Section 2, it was necessary to rely on an *ad-hoc* transformation to convert the four discrete shower time reduction options into a pseudo-continuous variable that would allow the OLS to be adopted. In doing so, the continuous and unobservable latent variable *Showertime Reduction** (whose values determine the observed discrete responses coded as our original variable *Showertime Reduction Option*) is forced to be discretely distributed with the mass points corresponding to the four values taken on by our *Showertime Reduction* variable, that is, the one that is used throughout the analyses. Although this approach is convenient and commonly adopted, the artificial discrete distribution and OLS estimation may affect our results.

To cope with this issue, the same models presented in Table 4 (columns 6 and 9) are reestimated by adopting the generalized ordered logit (GOLOGIT) estimator, in which the dependent variable is the categorical *Showertime Reduction Option*, coded as 1 = 0 minutes, 2 = 1-2 minutes, 3 = 3-4 minutes, 4 = >4 minutes. ¹⁶ Panel A of Table 5 presents the marginal effects on the probability of belonging to each category, i.e., each possible outcome, after the GOLOGIT estimations.

[Insert Table 5 about here]

Consistently with the results in Table 4, when the bill increase is coupled with water scarcity, the probabilities of occurrence of the responses in which the most dramatic reduction in terms of shower time is contemplated also goes up. Notably, when respondents face the hypothesis of a bill increase in a water scarcity scenario, the probability of outcome #4 (>4 minutes) increases by 15.3% in Switzerland (statistically significant at the 5% level) and by 6.9% in Spain (statistically significant at the 10% level). Additionally, a 10.9% increase is observed in the probability of outcome #3 (3–4 minutes) in Spain. Likewise, the probabilities of outcome #1 (no reduction at all) vary by -15.2% in Switzerland and -7% in Spain, and both cases are statistically significant at the 10% level. There is also a 10.8% reduction in the probability of outcome #2 (1–2 minutes) in Spain.

The *symbolic prize* effect keeps being not significant, whether alone or coupled with water scarcity. By contrast, the effect of the *monetary reward* exhibits the same pattern described for the *price* effect. When water is scarce, the probabilities of the first two outcomes (no reduction whatsoever and 1–2 minutes) decrease by 6.9% and 10.7%, statistically significant at the 10% and 5% levels, respectively. Conversely, the probabilities of the two most demanding outcomes (3–4 minutes and >4 minutes) increase by 10.8% and 6.8%, statistically significant at the 5% and 10% levels, respectively.

Panel B of Table 5 shows the results of estimating the same specifications through interval regression, another commonly adopted method to cope with interval data. Signs and statistical significance of the marginal effects are unaffected by the change in the estimation approach.

Another concern with the results shown in Table 4 is that we can measure the extent to which respondents are willing to reduce shower time only as long as they have reported their shower habits. Respondents could have chosen not to provide information about their body cleansing habits, or not answer shower-related questions because they usually take baths. In this case, our

estimates can be biased upward or downward, depending on the reasons that prevent respondents from providing relevant information.

Panel C of Table 5 reports the results of using Heckman models to control for selection in the pool of respondents who provide information about the willingness to reduce shower time. Two alternative exclusion restrictions are adopted for the Swiss and Spanish samples. When considering the Swiss data, they are the number of bathtubs and the number of shower stalls in the house, which are correlated with a respondent's likelihood of taking showers, but are unlikely to affect their willingness to reduce their shower time. When considering the Spanish data, because no information is available about the presence of water consuming elements and appliances in the house, the frequency of bathing is employed.

Similar to the baseline results reported in Table 4, the marginal effects of the bill increase under water scarcity range from 0.43 minutes of shower time reduction in Switzerland to 0.57 minutes in Spain, and both are significant at the 10% level. By contrast, the effect played by the *monetary reward* seems to lose statistical significance. On the basis of these findings, it can be concluded that controlling for selection concerns does not alter the effect of an increase in the water bill on the willingness to reduce the shower time.

4.2. Heterogeneity across water bills

As mentioned in Section 3, *pricing* treatments comprise a CHF 40 biannual bill increase in Switzerland and a EUR 20 bimonthly bill increase in Spain for all respondents. Thus, the pricing treatment ultimately depends on the current average water bill each respondent pays. The unitary price increase exhibits within-case heterogeneity and is greater for consumers with lower bills. For this reason, it is interesting to estimate the pricing effect for different classes of water

consumers separately. To capitalize on the diverse information available on the two samples, the heterogeneity of the pricing effect is analyzed using different strategies for the two locations.

In Switzerland, a survey question that asked respondents to provide an appraisal of how much they pay biannually for their water bill is exploited. Since only a subsample of the respondents replied to the question, and they were not required to provide the actual amount of the water bill, these water bill appraisals are used to predict the water bill class of the full sample of respondents. To this aim, an ordered probit model is estimated, in which the dependent variable is the respondent's water bill appraisal. The independent variables are the household size, the number of fixtures in the house (bathrooms, bathtubs, taps, washing machines, and dishwashers), the presence of water consuming elements (garden area, houseplants, balcony plants, swimming pool) and a set of municipality dummies.¹⁷

Once each respondent has been placed in his/her own water bill class, the model reported in Table 4 (column 6) is estimated for the two extreme water bill classes (<100 CHF and >200 CHF) separately. Only the marginal effects of the two treatments (*pricing* and *symbolic prize*) on the shower time reduction under scarcity are reported. The estimates of the source model are available upon request. The results are shown in columns (1) and (2) of Table 6.

[Insert Table 6 about here]

As expected, the pricing effect in the scarcity scenario is higher for respondents who pay a smaller water bill and fades as the water bill increases. The predicted shower time reduction for the smallest consumers reaches 0.51 minutes, and this effect is statistically significant at the 10% level. The largest consumers seem to be insensitive to the pricing treatment, even under water scarcity. The *symbolic prize* treatment continues to be ineffective in reducing shower time, regardless of the water consumption class.

The heterogeneity of the incentive effects is even more pronounced in the Spanish case study. Here, as real consumption data (the same data used in Table 3) were available, the *pricing* and the *monetary incentive* effects are estimated for the smallest water users, belonging to the first quartile, and the largest water users, belonging to the fourth quartile (columns 3 and 4 of Table 6). The smallest users are willing to reduce shower time by 1.28 minutes when the price increases under water scarcity, and this reduction is statistically significant at the 5% level. Under the same water availability conditions, they are also very sensitive to the *monetary reward* and are willing to reduce shower time by 1.59 minutes, statistically significant at the 1% level. As in the Swiss case, the effectiveness of the two economic incentives diminishes when the largest water users are considered.

5. Conclusion

This study analyzes the effectiveness of different demand-side management mechanisms that utilities may activate to induce consumers to save water and investigates to what extent these mechanisms interact with water availability, a central characteristic of the context in which water utilities operate. Specifically, the study relies on two surveys on water users in Switzerland and Spain and adopts a stated preferences approach. Three alternative incentive policies are considered, i.e. *price*, *monetary*, and *symbolic rewards*, and their link to consumers' savings in two different water scarcity scenarios, i.e. 'critical' and 'regular', is observed. The results, which have proved rather stable to a series of controls and robustness checks, can be summarized as follows. First, at a general level, the findings confirm the reluctance of individuals to change their consolidated habits in terms of water use. Although this result is certainly not new, given that a consistent body of empirical literature has documented the inelasticity of residential water demand to price, it brings a new perspective: this unresponsiveness is not confined to price but

also invests other possible monetary and non-monetary incentives. Moreover, and more importantly, it cannot be imputed to an information gap on the pricing level potentially suffered by users.

However, consumers are not *always* unresponsive to water prices. First, they cease to resist changes and become sensitive to a price increase when they believe that severe water supply shortages threaten their community. In this scenario, consumers reduce water use. Notably, *pricing* turns out to be an effective mechanism to induce savings under water scarcity in both geographical contexts (Switzerland and Spain). Moreover, although the *symbolic prize* incentive is not effective, irrespective of consumers' water availability scenario, the *monetary* reward, i.e., the voucher, is likely to induce virtuous behavior provided that the consumers face water scarcity conditions. Second, the responses to price and monetary incentives under scarcity conditions are heterogeneous. The relative effect is more pronounced for consumers who consume less and pay smaller bills.

This study is not free from limitations. First, it focuses on a specific water use: showering. Although the choice has been extensively justified in Section 3.2, the results cannot be automatically generalized to other water uses. Second, the focus on a single water use makes computation of implied price elasticity by using the treatment effects estimated through our analyses difficult. However, to compare the results with the literature, an attempt has been made to calculate a local price elasticity (see the results of this computation in footnote 15).

Despite these unavoidable limitations and caveats, the findings of this study are relevant to environmental and ecological economics literature and water policy debate. First, the findings depict a more nuanced picture than usual regarding the interplay between symbolic and market mechanisms, at least for water use. Individuals care about the social costs of their consumption choices only in the presence of strong rivalry in consumption (i.e. shortage in water supply), and

only when the information on scarcity is transmitted through a proper market signal, namely, the price or the amount of the monetary reward. When the message about the social urgency of inducing water savings is delivered to the community through alternative *symbolic* mechanisms, the credibility of the message appears to be undermined or even overlooked. In other words, the analyses confirm that a monetary incentive, e.g. a price increase and a monetary reward, can still deliver the appropriate signals about the resource cost to society. However, the effect holds only if consumers know about a scarcity problem. It could be speculated that the price increase is not effective if consumers attribute such a scarcity to other reasons (e.g. inefficiency in water management).

Second, regulators should know that fixed price and monetary incentives may jeopardize water uses of smaller consumers, who are also likely to be lower-income households. Further analyses are necessary to investigate the effect of incentives that vary across consumption classes. Additionally, regulators who decide to adopt demand-side policies should consider accompanying mechanisms that shield water users from possible inequitable consequences of the economic incentives, e.g. rebates for lower-income or smaller users.

Overall, the results indicate the extreme difficulty experienced by any mechanism to produce water savings when community members are not pressed to activate virtuous behavior. Water is a necessity good and is generally low-priced compared with other (unregulated) services in many modern, advanced economies. As long as the price of water increases but remains within a reasonable range, consumers are highly unlikely to respond to a pricing stimulus.

Acknowledgements

The research for this paper was funded by the European Union research project FP7-ICT-619172

SmartH2O: an ICT Platform to leverage on Social Computing for the efficient management of

Water Consumption.

534 References

- 535 1) Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention
- studies aimed at household energy conservation. Journal of Environmental
- 537 *Psychology*, 25(3), 273-291.
- 538 2) Beecher, J., & Gould, T. (2018). Pricing wastewater to save water: Are theory and practice
- transferable? *Utilities Policy*, *52*, 81-87.
- 3) Blumenschein, K., Johannesson, M., Blomquist, G.C., Liljas, B. and O'Conor R.M. (1998).
- Experimental results on expressed certainty and hypothetical bias in contingent valuation.
- *Southern Economic Journal*, *65*(1), 169–177.
- 543 4) Blumenschein, K., Blomquist, G. C., Johannesson, M., Horn, N., & Freeman, P. (2008).
- Eliciting willingness to pay without bias: evidence from a field experiment*. *The Economic*
- 545 *Journal*, 118(525), 114-137.
- 546 5) Castledine, A., Moeltner, K., Price, M. K., & Stoddard, S. (2014). Free to choose: Promoting
- conservation by relaxing outdoor watering restrictions. Journal of Economic Behavior &
- 548 *Organization*, 107, 324-343.
- 549 6) Champ, P. A., Bishop, R. C., Brown, T. C., & McCollum, D. W. (1997). Using donation
- mechanisms to value nonuse benefits from public goods. Journal of Environmental
- *Economics and Management, 33*(2), 151-162.
- 552 7) Champ, P. A., Boyle, K. J., & Brown, T. C. (2003) A primer on nonmarket valuation.
- Dordrecht: Kluwer Academic Publishers, 2003.
- 554 8) Delmas, M. A., Fischlein, M., & Asensio, O. I. (2013). Information strategies and energy
- conservation behavior: A meta-analysis of experimental studies from 1975 to 2012. Energy
- 556 *Policy*, *61*, 729-739.
- 557 9) Energy Saving Trust (2013). At home with water. London: EST, 2013.
- 558 10) Garrone, P., Grilli, L., & Marzano, R. (2019). Price elasticity of water demand considering
- scarcity and attitudes. *Utilities Policy*, 59, 100927. https://doi.org/10.1016/j.jup.2019.100927
- 560 11) Gaudin, S. (2006). Effect of price information on residential water demand. Applied
- 561 *Economics*, 38(4), 383-393.
- 562 12) Ito, K., Ida, T., & Tanaka, M. (2018). Moral suasion and economic incentives: Field
- experimental evidence from energy demand. American Economic Journal: Economic Policy,
- 564 *10*(1), 240-67.

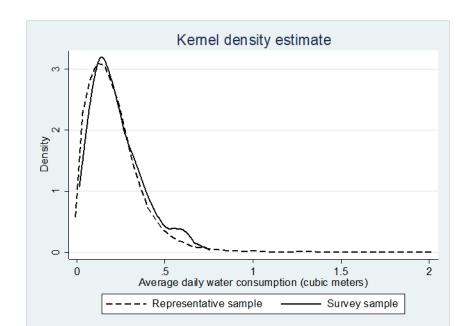
- 565 13) Johnston, R. J., Boyle, K. J., Adamowicz, W., Bennett, J., Brouwer, R., Cameron, T. A.,
- Hanemann, W. M., Hanley, N., Ryan, M., Scarpa, R., Tourangeau, R., & Vossler, C.A.
- 567 (2017). Contemporary guidance for stated preference studies. *Journal of the Association of*
- *Environmental and Resource Economists*, 4(2), 319-405.
- 569 14) Krause, K., Chermak, J. M., & Brookshire, D. S. (2003). The demand for water: Consumer
- response to scarcity. *Journal of Regulatory Economics*, 23(2), 167-191.
- 571 15) Landon, A. C., Woodward, R. T., Kyle, G. T., & Kaiser, R. A. (2018). Evaluating the efficacy
- of an information-based residential outdoor water conservation program. *Journal of Cleaner*
- 573 *Production*, 195, 56-65.
- 16) Lopez-Nicolas, A., Pulido-Velazquez, M., Rougé, C., Harou, J. J., & Escriva-Bou, A. (2018).
- Design and assessment of an efficient and equitable dynamic urban water tariff. Application
- to the city of Valencia, Spain. *Environmental Modelling & Software*, 101, 137-145.
- 577 17) Marzano, R., Rougé, C., Garrone, P., Grilli, L., Harou, J. J., & Pulido-Velazquez, M. (2018).
- Determinants of the price response to residential water tariffs: Meta-analysis and beyond.
- *Environmental Modelling & Software*, 101, 236-248.
- 18) Narloch, U., Pascual, U., & Drucker, A. G. (2012). Collective action dynamics under external
- 581 rewards: experimental insights from Andean farming communities. World
- 582 Development, 40(10), 2096-2107.
- 583 19) Nauges, C., & Thomas, A. (2003). Long-run study of residential water
- consumption. *Environmental and Resource Economics*, 26(1), 25-43.
- 585 20) Olmstead, S. M., Hanemann, W. M., & Stavins, R. N. (2007). Water demand under
- alternative price structures. Journal of Environmental Economics and Management, 54(2),
- 587 181-198.
- 588 21) Pfaff, A., Vélez, M. A., Ramos, P. A., & Molina, A. (2015). Framed field experiment on
- resource scarcity & extraction: Path-dependent generosity within sequential water
- appropriation. *Ecological Economics*, *120*, 416-429.
- 591 22) Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method
- 592 biases in behavioral research: a critical review of the literature and recommended remedies.
- 593 *Journal of Applied Psychology*, 88(5), 879-903.

- 594 23) Pondorfer, A., & Rehdanz, K. (2018). Eliciting Preferences for Public Goods in
- Nonmonetized Communities: Accounting for Preference Uncertainty. Land Economics,
- 596 *94*(1), 73-86.
- 597 24) Prediger, S., Vollan, B., & Herrmann, B. (2014). Resource scarcity and antisocial
- behavior. *Journal of Public Economics*, 119, 1-9.
- 599 25) Renwick, M. E., & Green, R. D. (2000). Do residential water demand side management
- policies measure up? An analysis of eight California water agencies. Journal of
- *Environmental Economics and Management, 40*(1), 37-55.
- 602 26) Rougé, C., Harou, J.J., Pulido-Velazquez, M., Matrosov, E.S., Garrone, P., Marzano, R.,
- Lopez-Nicolas, A., Castelletti, A., Rizzoli, A.-E., 2018. Assessment of smart-meterenabled
- dynamic pricing at the utility and basin scales. Journal of Water Resources Planning and
- 605 *Management*, 144(5), 04018019.
- 606 27) Torres, M. M. J., & Carlsson, F. (2018). Direct and spillover effects of a social information
- campaign on residential water-savings. Journal of Environmental Economics and
- 608 *Management*, 92, 222-243.
- 609 28) Wang, F., Peng, X., Wei, R., Qin, Y., & Zhu, X. (2019). Environmental behavior research in
- resources conservation and management: A case study of Resources, Conservation and
- Recycling. *Resources, Conservation and Recycling*, 141, 431-440.
- 612 29) Wichman, C. J., Taylor, L. O., & Von Haefen, R. H. (2016). Conservation policies: Who
- responds to price and who responds to prescription? *Journal of Environmental Economics*
- 614 and Management, 79, 114-134.

- 615 30) Wichman, C. J. (2017). Information provision and consumer behavior: A natural experiment
- 616 in billing frequency. *Journal of Public Economics*, 152, 13-33.
- 617 31) Wooldridge, J. M. (1999). Asymptotic Properties of Weighted M-estimators for variable
- probability samples. *Econometrica*, 67(6), 1385-1406.

Figures

Figure 1 - Water Consumption Distributions – Survey Sample vs. Representative Sample in Spain



625 **Tables**

627

Table 1 - Treatments

Panel A: Swiss survey			
	Wate	r availability scen	arios
Incentives	Scarcity	Regular	TOTAL
Pricing	82	86	168
Symbolic reward	68	82	150
Control	79	65	144
TOTAL	229	233	462

Panel B: Spanish survey

	scenarios

Incentives	Scarcity	Regular	TOTAL
Pricing	53	47	100
Monetary reward	46	49	95
Control	48	52	100
TOTAL	147	148	295

Table 2 - Survey vs. Phone Samples - Spanish Survey

Social norms, beliefs, and behaviors				
	Social	Behavioral	Behavioral	Beliefs
	norms	Control	intentions	Bellets
	(1)	(2)	(3)	(4)
Respondent in the survey sample	-0.1173	0.1396	0.1156	0.0269
	(0.0935)	(0.1112)	(0.0900)	(0.0695)
Respondent controls	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Survey sample	290	290	290	290
Phone sample	189	188	188	189
Total observations	479	478	478	479

Table 3 - Survey Sample vs. Representative Sample in Spain

		Obs	Mean	Median	Sd	Max	Min
Survey sample		275	0.2269	0.1901	0.1481	0.7530	0.0149
Representative sample		10,076	0.2299	0.1830	0.2945	9.4940	0.0110
D:00	-0.0029						
Difference	(0.0178)						

Panel B: Two-sample I	Kolmogorov-Smirnov test
-----------------------	-------------------------

D	p-value	Exact
0.0205	0.799	
-0.0589	0.156	
0.0589	0.312	0.284
	-0.0589	0.0205 0.799 -0.0589 0.156

Table 4 - OLS Estimates – Swiss and Spanish Surveys

Dependent variable: Sho	wertime redi	uction							
			Switz	erland				Spain	
•	Or	riginal respon	ises	Uncerta	in positive re	esponses			
				treated	as negative re	esponses			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pricing	-0.0044	-0.0893	-0.1035	0.1481	0.1089	0.1477	-0.0390	-0.0712	0.0967
	(0.2452)	(0.2312)	(0.2482)	(0.1825)	(0.1832)	(0.1861)	(0.3064)	(0.3024)	(0.3046)
Symbolic	-0.1052	-0.1619	-0.1606	0.2088	0.1870	0.2305			
	(0.2461)	(0.2380)	(0.2529)	(0.1767)	(0.1744)	(0.1797)			
Monetary							-0.4117	-0.4075	-0.2430
							(0.2988)	(0.2863)	(0.2920)
Scarcity	0.3342	0.2756	0.3317	0.1633	0.1376	0.1872	0.1469	0.1567	0.1620
	(0.2380)	(0.2304)	(0.2352)	(0.1826)	(0.1794)	(0.1816)	(0.3021)	(0.2911)	(0.2815)
Pricing*Scarcity	-0.1009	0.0218	-0.0395	0.2653	0.3148	0.3078	0.4708	0.5179	0.4847
	(0.3431)	(0.3264)	(0.3401)	(0.3038)	(0.2996)	(0.3073)	(0.4277)	(0.4224)	(0.4117)
Symbolic*Scarcity	0.3612	0.3406	0.2491	-0.0309	-0.0369	-0.1768			
	(0.3605)	(0.3366)	(0.3431)	(0.2954)	(0.2919)	(0.2960)			
Monetary*Scarcity							0.7367*	0.8346**	0.7470*
							(0.4244)	(0.3994)	(0.4016)
Shower habit controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Respondent controls	No	No	Yes	No	No	Yes	No	No	Yes
Marginal effects									
Pricing under scarcity	-0.105	-0.068	-0.143	0.4134*	0.4237*	0.4555*	0.4317	0.4468	0.5814**
	(0.240)	(0.231)	(0.241)	(0.2429)	(0.2401)	(0.2534)	(0.2984)	(0.2963)	(0.2823)
Symbolic under scarcity	0.256	0.179	0.088	0.1778	0.1501	0.0537			
	(0.263)	(0.240)	(0.249)	(0.2367)	(0.2321)	(0.2418)			
Monetary under scarcity							0.3250	0.4271	0.5041*
							(0.3014)	(0.2853)	(0.2899)
Observations	375	375	362	375	375	362	267	267	266

^{*} and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 5 - Robustness checks

Panel A: GOLOGIT				Panel B: Interval regression	n models	
Marginal effects on the p	robabili	ty of the outcome		Marginal effects on the Sho	owertime reductio	n
		Switzerland	Spain		Switzerland	Spain
	•	(1)	(2)		(1)	(2)
Pricing under scarcity	0	-0.1521*	-0.0697*	Pricing under scarcity	1.4197*	0.6486**
		(0.0784)	(0.0358)		(0.7346)	(0.2790)
	1-2	0.0626	-0.1082**	Symbolic under scarcity	0.2522	
		(0.0606)	(0.0544)		(0.7812)	
	3–4	-0.0633	0.1091**	Monetary under scarcity		0.5816**
		(0.0591)	(0.0524)			(0.2930)
	>4	0.1528**	0.0687*			
		(0.0648)	(0.0375)	Respondent controls	Yes	Yes
Symbolic under scarcity	0	-0.0438				
		(0.0748)		Observations	362	266
	1–2	0.0253				
		(0.0433)				
	3–4	0.0144		Panel C: Heckman selection	n models	
		(0.0249)		Marginal effects on the Sho	owertime reductio	n
	>4	0.0040			Switzerland	Spain
		(0.0071)		-	(1)	(2)
Monetary under scarcity	0		-0.0691*		0.4252*	0.5696*
			(0.0359)	Pricing under scarcity	(0.2565)	(0.3173)
	1–2		-0.1066**	G 1 1: 1 :	0.0730	
			(0.0540)	Symbolic under scarcity	(0.2411)	
	3–4		0.1081**	16		0.4942
			(0.0523)	Monetary under scarcity		(0.3174)
	>4		0.0676*			
			(0.0375)	Respondent controls	Yes	Yes
Respondent controls		Yes	Yes	Observation	443	274
Observations		362	266	Selected	359	251

^{*} and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 6 - Effects across Consumption Levels

Marginal effects				
	Switzerland		Sp	ain
	Smallest consumers	Largest Consumers	Smallest consumers	Largest consumers
	(1)	(2)	(3)	(4)
Pricing under scarcity	0.5064*	-0.0136	1.2824**	0.3655
	(0.2986)	(0.7405)	(0.5433)	(0.7166)
Symbolic under scarcity	0.0299	0.1100		
	(0.2652)	(0.6062)		
Monetary under scarcity			1.5945***	0.5901
			(0.6044)	(0.6431)
Observations	191	52	57	78

^{*, **} and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

FOOTNOTES

- 645 ¹ EEA, 2017. Use of freshwater resources. European Environment Agency (retrieved from
- 646 http://www.eea.europa.eu/data-and-maps/indicators/use-of-freshwater-resources-2 on 29
- 647 September 2018)

- ² See Water Scarcity & Droughts in the European Union (retrieved from
- 649 http://ec.europa.eu/environment/water/quantity/scarcity_en.htm.on 29 September 2018)
- 650 ³ GAO, 2014. Supply Concerns Continue, and Uncertainties Complicate Planning. United States
- 651 Government Accountability Office (retrieved from
- 652 https://www3.epa.gov/watersense/pubs/supply.html on 29 September 2018).
- ⁴ The Swiss survey administration relied on SES because the utility was a partner of a broader
- research project aimed at understanding and modelling consumers' behavior and predicting how
- 655 consumers' behavior can be influenced by various water demand management policies. In
- addition to being an electricity provider, SES is the universal provider of the water metering
- service in the targeted area; thus, there are no concerns related to the consistency between the
- targeted population and the aim of the survey.
- ⁵ The decision to test only two incentive policies per survey was made in order to minimize the
- 660 risk of having a number of observations per treatment that would not have allowed reliable
- estimations. Ex-post, given the response rates, we can say that it was a justified choice.
- 662 ⁶ Pricing treatments in the two case studies (and the monetary reward in Spain) were devised by
- considering the actual water tariffs in the two locations to make them as comparable as possible.
- Respondents were asked to state their gender, age, level of education, and internet use along
- with basic information about their household (number of adults/children, job category of the
- 666 principal breadwinner).
- ⁸ Respondents were asked to provide information on their residence (property type, tenure) and its
- equipment, in terms of fixtures and fittings (bathrooms, taps/sinks, bathtubs, shower stalls,
- washing machines, dishwashers) and water consuming elements (houseplants, plants on the
- 670 balcony, garden area, swimming pool).
- 671 ⁹ Respondents were asked to estimate their households' daily water consumption and the total
- 672 semester water bill to compare their household's water consumption with that of similar
- 673 households in the area and to guess what activity consumes the most water per month. Regarding 674 water use habits, respondents were invited to provide information on the frequency of their
- water use nabits, respondents were invited to provide information on the frequency of them
- showers and baths on a weekly basis, their shower time, time pattern of washing machine use,
- 676 frequency of watering (plants and garden area), and garden irrigation times.
- 677 Respondents were asked to rate their personal environmental attitudes and provide information
- about their most recent exposure to informational campaigns (e.g. government messages on the
- media, TV and newspaper ads) on water conservation issues.
- 680 ¹¹ See the Institute of Statistics of Canton Ticino (USTAT): http://www4.ti.ch/dfe/dr/ustat/chi-
- siamo/lufficio (retrieved on 28 September 2018).
- 682 ¹² Within the family of Stated Preference method, we consider a contingent behaviour approach.

- The Supplementary sample and related questionnaire served goals other than those of this article. No questions were asked about the respondents' water use habits or willingness to undertake water saving actions.
- We re-estimate models whose results are reported in Table 2 through ordered probit. The two samples continue to be not statistically different along the four dimensions at the 5% significance level.
- Although the results cannot be directly translated in terms of price elasticity, if we assume that i) our average respondent is representative of the population from which he/she was drawn; ii) the price effect on water saving from the shower time reduction can be generalized to other water uses, we can get an estimate of the price elasticity ranging from 7%/77%=0.09 to 7%/ 42%= 0.17, computed using the incentive magnitude reported in the appendix.
- 694 ¹⁶ We use GOLOGIT rather than an ordered logit because the Brant test presents that the parallel regression/proportional odds assumption (that must hold so that an ordered logit estimates could be reliable) is not met.
- of fixtures and water consuming elements is justified by the water tariff structure commonly adopted in Ticino, which entails a fixed part computed on the basis of the house endowment in terms of fixtures and the presence of gardens and swimming pools. Because the water tariffs in Switzerland are set by the municipalities, the set of municipality dummies controls for heterogeneity at a municipality level.

704 **Appendices**

- 705 Appendix A Treatment calibrations
- 706 Appendix B Survey treatments
- 707 Appendix C Additional descriptive statistics

Appendix A – Treatments calibration

To calibrate our monetary treatments, we simulated a typical water bill for a Ticino household by using information collected by interviewing local water managers and data from the local Statistic Office (USTAT).

714715 We assume

- We assumed 182 days per semester and an average number of equivalent inhabitants per household of 2.2 (USTAT data). We use a typical volumetric rate for residential users in Ticino, 0.8 CHF/mc. Assuming that the individual water consumption in Ticino ranges from 162 to 300 litres/day-equivalent inhabitant, we compute the variable part of the semester water bill in Ticino, which should range from 52 (i.e. 162*2.2*182/1,000*0.8) to 96 (i.e. 300*2.2*182/1,000*0.8) CHF/semester-household. The fixed part is assumed to range between 40 and 76 CHF/semester-
- household (data from local water managers estimates).
 The previous computations led to an overall water bill increasing from 92 (52+40) to 172 (76+96) CHF/semester-household.

- Therefore, the magnitude of our treatment can be estimated to be
- Average: from 40/172 = 23.26% to 40/92 = 43.48%
 - Marginal: from 40/96 = 41.66% to 40/52 = 76.92%

729 The same approach was used to calibrate the incentives in the Spanish case.

Appendix B – Survey treatments

Spanish survey

Treatment	Water availability	Wording
Pricing	Regular	Assume that your water supplier measures household water consumption through smart meters. In addition, your water supplier increases the bimonthly water bill by 20€ for households who do not undertake water saving actions.
Monetary reward	Regular	Assume that your water supplier measures household water consumption through smart meters. In addition, your water supplier rewards water saving actions each two months by awarding the households reaching highest water savings a 20€ voucher to be redeemed in your preferred supermarket/shopping mall.
Control	Regular	Assume that your water supplier measures household water consumption through smart meters.
Pricing	Scarcity	Assume that your water supplier measures household water consumption through smart meters and your district is facing a severe water supply issue/water shortage. In addition, your water supplier, in order to deal with the water supply issue/water shortage, increases the bimonthly water bill by 20€ for households who do not undertake water saving actions.
Monetary reward	Scarcity	Assume that your water supplier measures household water consumption through smart meters and your district is facing a severe water supply issue/water shortage. In addition, your water supplier, in order to deal with the water supply issue/water shortage, rewards water saving actions each two months by awarding the households reaching highest water savings a 20€ voucher to be redeemed in your preferred supermarket/shopping mall.
Control	Scarcity	Assume that your water supplier measures household water consumption through smart meters and your district is facing a severe water supply issue/water shortage.

Please keep the scenario you have just read in mind, and answer to the following question: How much are you willing to reduce your shower time?

More than 4 minutes
3-4 minutes at most
1-2 minutes at most
I am not willing to
I don't know

738 Swiss survey

Treatment	Water availability	Wording
Pricing	Regular	Assume that your water supplier measures household water consumption through smart meters. In addition, your water supplier increases the biannual water bill by 40CHF for households who do not undertake water saving actions.
Symbolic reward	Regular	Assume that your water supplier measures household water consumption through smart meters. In addition, your water supplier rewards water saving actions by awarding the households reaching highest water savings a "Best friend of environment" badge which will be advertised in your town.
Control	Regular	Assume that your water supplier measures household water consumption through smart meters.
Pricing	Scarcity	Assume that your water supplier measures household water consumption through smart meters and your district is facing a severe water supply issue/water shortage. In addition, your water supplier, in order to deal with the water supply issue/water shortage, increases the biannual water bill by 40CHF for households who do not undertake water saving actions.
Symbolic reward	Scarcity	Assume that your water supplier measures household water consumption through smart meters and your district is facing a severe water supply issue/water shortage. In addition, your water supplier, in order to deal with the water supply issue/water shortage, rewards water saving actions by awarding the households reaching highest water savings a "Best friend of environment" badge which will be advertised in your town.
Control	Scarcity	Assume that your water supplier measures household water consumption through smart meters and your district is facing a severe water supply issue/water shortage.

Please keep the scenario you have just read in mind, and answer to the following question: How much are you willing to reduce your shower time?

More than 4 minutes
3-4 minutes at most
1-2 minutes at most
I am not willing to

744	How would you assess the degree of certainty of your previous answer?						
		Probably sure Definitely sure					

$\label{eq:Appendix} \textbf{Appendix} \ \textbf{C} - \textbf{Additional descriptive statistics}$

Table C1 - Respondents

Panel A: S	wiss survey									
	Gen	der	Education							
Age	Female	Male	Doctoral	University	Professional	High	Apprenticeship	Lees than	Others	Total
Age			degree	degree	degree	School	apprenticeship			
≤ 20	4	3	0	0	0	2	2	1	2	7
21-30	18	11	0	17	2	4	6	0	0	29
31-40	35	47	1	34	8	15	23	0	1	82
41-50	53	77	4	28	24	28	39	2	5	130
51-60	40	53	1	22	13	15	40	0	2	93
61-70	30	47	4	19	19	11	21	1	2	77
71-80	7	32	4	3	6	6	14	2	4	39
> 80	2	3	0	0	0	3	1	1	0	5
TOTAL	189	273	14	123	72	84	146	7	16	462

Panel B:Spanish survey

	Ger	ıder					Education				
A ===	Female	Male	Doctoral	Master or	Bachelor or	Higher	Lower	Higher	Lower	Primary	Total
Age			degree	equivalent	equivalent	Post-sec	Post-sec	secondary	secondary	School	
≤ 20	0	0	0	0	0	0	0	0	0	0	0
21-30	9	8	0	10	2	1	2	2	0	0	17
31-40	27	40	5	36	13	8	3	1	1	0	67
41-50	34	70	8	38	29	6	5	9	8	1	104
51-60	17	52	1	23	15	2	3	12	9	4	69
61-70	5	22	1	6	5	2	5	3	2	3	27
71-80	1	5	0	1	1	1	1	1	1	0	6
> 80	0	0	0	0	0	0	0	0	0	0	0
TOTAL	93	197	15	114	65	20	19	28	21	8	290

Panel A and B illustrate the distribution of respondents by gender and education along the columns and by age ranges along the rows, as indicated by the respondents in Switzerland and Spain, respectively.

1 Table C2 - Shower Habits and Willingness to Save

 Shower time reduction

Panel A: Swiss survey						
	Obs	Mean	Median	Sd	Max	Min
Showers per week	380	5.172	6.500	2.184	8	0
Shower time	375	6.584	8.000	2.940	21	4
Shower time reduction	375	2.121	1.500	1.418	5	0
Shower time reduction (uncertain responses to 0)	375	0.593	0	1.241	5	0
Panel B: Spanish survey						
	Obs	Mean	Median	Sd	Max	Min
Showers per week	293	5.285	6.500	2.386	8	0
Shower time	293	7.587	8.000	3.261	21	4

Panel A and B illustrate the descriptive statistics relative to the number of showers per week, the shower time and the shower time reduction as indicated by the respondents in Switzerland and Spain, respectively.

2.245

1.500

1.443