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Household Adoption of Water-Efficient Equipment: The Role of Socio-Economic Factors, Environmental Attitudes and Policy

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Abstract

Using unique survey data of 10,000 households from 10 OECD countries, we identify the driving factors of household adoption of water-efficient equipment by estimating Probit models of a household's probability to invest in such equipment. The results indicate that the adoption of water-efficient equipment is the most strongly affected by ownership status, by being metered and charged a volumetric charge on water consumption, and by behavioural factors. Environmental attitudes are strong predictors of adoption of water-efficient equipment, with a marginal effect that exceeds ownership status in some cases. In terms of policy, we find that households that were both metered and charged for their water individually had a much higher probability to invest in water-efficient equipment compared to households that were not charged for their water.

Keywords: attitudes; metering; residential water use; technology adoption

JEL codes: D12; O33; Q25; Q58

1. Introduction

Water scarcity is a global environmental problem. Even countries with abundant water supply face constraints in providing clean drinking water because of water contamination from pollution that raises the costs of water treatment. Although industry and agriculture represent the bulk of water demand, the percentage of domestic use in overall water consumption ranges from 10-30% in developed countries. Given the high costs of developing new water supply projects, we observe an increased reliance on demand side management (DSM) policies, i.e., price and non-price policies designed to promote water conservation in the residential sector.

Pricing policies have received much attention by economists who consider the price to be the best instrument to induce water conservation because the welfare loss of water restrictions usually exceeds that of a price increase (Woo, 1994; Roibás, García-Valiñas and Wall, 2007; Grafton and Ward, 2008). However, because residential water demand is known to be price inelastic, managers of water utilities have often preferred to impose restrictions on water use instead of imposing higher prices. They argue that water restrictions would place a lower burden on poorer households than price increases and would guarantee an immediate response in the case of severe and unexpected water shortages. Another type of non-price policy, that has been given little attention by economists (mainly because of lack of appropriate data), is to promote installation of water-efficient devices in residential housing. There is little data on adoption of water-efficient equipment, and with the exception of Renwick and Archibald (1998) we are not aware of any previous study that has studied adoption on a household level. The purpose of this article is to fill this gap by studying the adoption of water-efficient devices using unique survey data from around 10,000 households in ten OECD countries.

Several countries or regions have promoted rebate programs for the installation of water-efficient technologies, among them California and Australia. Severe droughts between 1985 and 1992 in California called for continued conservation and various measures were undertaken by local water agencies including low-flow toilet rebate programs and distribution of free plumbing retrofit kits.[1] The government of Victoria (Australia) currently offers rebates for a series of water-efficient products, including rainwater tanks, dual flush toilets, and water

[1] In 2007, California became the first US state to mandate the installation of high efficiency toilets (dual or single flush), a requirement that will be phased in beginning January 2010.

efficient shower heads.[2] Installation of water-efficient devices is seen as an effective manner of inducing water conservation for several reasons: first, water consumed through both indoor and outdoor appliances (e.g., showers, toilets, washing machine, sprinklers) represents a significant share of households' daily water use in developed countries: for example in France, it is estimated that on average, more than two third of water consumed daily is used for hygienic purposes (39%), toilets (20%) and cleaning dishes (10%).[3] In Australia in 2001, residential water use was split as follows: kitchen (8%), laundry (13%), toilets (15%), bathroom (20%) and outdoors (44%).[4] In Spain, showering and toilet flushing account for almost 60% of total indoor water use, whereas the irrigation of private gardens accounts for a third of total annual household water consumption (Sauri, 2003). Second, the reduction potential of water saving fixtures is now well acknowledged: among other examples, a water-efficient washing machine may use only one-third the water of an inefficient model, an old-style single-flush toilet could use up to 12 litres of water per flush, while a standard dual flush toilet uses just a quarter of this on a half-flush, and a standard showerhead may use up to 25 litres of water per minute whereas a water-efficient showerhead might use as little as seven litres per minute.[5] Third, policies to promote installation of water-efficient devices are likely to be more politically acceptable than price increases or policies imposing water restrictions. Finally, another reason why adoption of water efficient equipment is a potentially interesting policy tool is the pervasive role of habits in human behaviour (Thøgersen and Ölander, 2002) which may make other forms of non-price policies, such as public information campaigns, yield little effect.

In this article, we study the factors driving adoption of four types of water-efficient devices: (1) water-efficient washing machines, (2) low volume or dual flush toilets, (3) water flow restrictor taps or low flow shower heads, and (4) water tanks to collect rainwater. The dataset that we use has several features that make it quite unique: its scope (ten countries including water-abundant countries such as Canada and Norway and water-scarce countries such as Australia and Mexico) guarantees a high heterogeneity in socioeconomic and demographic characteristics of the households surveyed but also in their relationship to water in general. This large coverage also provides a large variation in terms of pricing schemes across the ten countries and we will be able to assess the effect of water charges and water metering on

[2] Further details can be found at the following address: http://www.ourwater.vic.gov.au/saving/home/rebates.
[3] Source: http://www.cieau.com.
[4] Source: Water Services Association of Australia, at http://www.wsaa.asn.au.
[5] Source: http://www.waterrating.gov.au.

households' use of water-efficient devices, something that was not doable in studies focusing on a unique region or country. Finally, the dataset contains attitudinal and behavioural variables that measure respondents' opinions about the environment in general and their behaviour in relation to environmental preservation. van den Bergh (2008), in a survey of residential water and energy use as well as generation of waste and recycling, notes that very little attention has been paid to the influence of attitudes, perceptions and values on household environmental behaviour. Another contribution of this paper is to fill this gap by measuring the effect of attitudinal and behavioural variables on the probability of households to adopt water-efficient devices. The findings of this study should be informative for water authorities and policy makers that wish to induce adoption of water-efficient equipment.

In Section 2, we discuss the main demand side management (DSM) policies that have been in use in the water sector. We also review the few empirical studies that exist on their effectiveness. In section 3, we propose a literature review that allows us to identify the important factors to take into account in our econometric models of adoption of water-efficient devices. Section 4 presents the data along with some descriptive statistics. In Section 5, we discuss the model and the corresponding estimation results. Section 6 concludes.

2. Urban water demand side management policies

Basically, policymakers can choose between two types of DSM policies: price policies and non-price policies, the latter including for example water restrictions on specific uses (such as irrigation or car washing), information and education campaigns to encourage water conservation, and rebates for adoption of water-efficient technologies. The choice of price or non-price instruments for water demand management has been at the core of a debate among economists and policy makers about both the effectiveness of alternative policy instruments in inducing efficient water use and their equity implications for residential users. While economists generally advocate higher residential water prices as a means of reducing demand, others argue that non-price policies constitute the only viable means to reduce residential demand. The main argument is that water being a basic need and water demand being usually found price inelastic, then allocating it on the basis of price may place a larger cost burden on poorer and larger households.[6] However, econometric studies indicate that the welfare loss of water service interruption usually exceeds that of a price increase (see Woo, 1994, using data from Hong-Kong; Roibás, García-Valiñas and Wall, 2007, using data from Seville, Spain; and Grafton and Ward, 2008, using data from Australia).

The role of subsidies or campaigns promoting the use of water-efficient devices has been less studied, mainly because of lack of appropriate data. Exceptions are Renwick and Archibald (1998) and Renwick and Green (2000) that analyze data on California's experience with such policies during severe drought episodes at the end of the eighties, Campbell, Johnson and Hunt Larsen (2004) on DSM policies in Arizona, and Kenney et al. (2008) on household data from Colorado.

Using household data from two communities in California (Santa Barbara and Goleta), Renwick and Archibald (1998) find that restrictions imposed on the use of irrigation water had a significant and positive effect on the probability of using an efficient landscape irrigation technology but also on the number of indoor water-efficient equipments used by households. The latter effect is somehow surprising and may reflect the difficulty to separately identify the effect of one particular instrument when several policies are put in place simultaneously. They also find a strong and significant positive effect of the marginal price for water and of the low-flow toilet and showerhead subsidy program on the number of such equipments in the household. These results seem to contradict the findings of Syme, Nancarrow and Seligman (2000) who, in a survey of the research on attitudes and water conservation, concluded that monetary savings are not a large factor in water conservation (at least as long as water is underpriced), and that subjective norms or other socially motivated values are more important in strengthening behavioural intentions to conserve water. Apart from that survey and the econometric analysis of Renwick and Archibald (1998), and as far as we know, the effect of the price of water on installation of water-saving devices has never been studied. A price increase (or an expected price increase in the future) could however be one motive for investing in water-efficient devices since the use of water appliances has a direct impact on the water bill when households are charged for water.[7] All other things being

[6] The average own price elasticity is -0.51 in industrialized countries (Espey, Espey and Shaw, 1997). See also Arbués-Gracia, García-Valiñas and Martínez-Espiñeira (2003), Dalhuisen et al. (2003), Ferrara (2007), or Worthington and Hoffman (2008) for comprehensive reviews of residential water demand estimation.

[7] Even if water demand has been found inelastic to price in the bulk of water demand studies, household water use, in all cases, do respond significantly to price variation, though in a moderate manner (residential demand

equal, Renwick and Archibald (1998) show that the use of one low-flow toilet decreases household water use by 10% while the use of one low-flow showerhead results in a 8% decrease in household water consumption. Water-efficient irrigation technologies reduce water use by 11%; traditional irrigation techniques, on the other hand, increase water usage by 9%.

Renwick and Green (2000) use aggregate data on the water agency level to study residential demand in eight Californian water agencies over the 1989-1996 period.[8] Six types of DSM policies were implemented at that time: public information campaigns, low-flow toilet rebate programs, distribution of free plumbing retrofit kits, water rationing/allocation policies, restrictions on certain types of water use, and San Francisco Water District's compliance affidavit policy. Their findings suggest that more stringent mandatory policies were more effective in reducing water use than voluntary measures: water rationing and use restrictions were found to induce a reduction of 19 and 29% respectively while public information campaigns and retrofit subsidies were found to reduce average household use by 8 and 9% respectively. These figures indicate the average effectiveness of various DSM instruments. However in such situations where each water agency uses a combination of instruments, the contribution of each type of instrument to the overall reduction in water use is difficult to assess.

Kenney et al. (2008) provide more recent evidence of the impact of rebate programs for the installation of water-efficient devices. In an analysis of household data from Colorado over the period 1997-2005, they show that rebates to indoor water-efficient equipment, such as low-flow toilets and water-efficient washing machines, reduced household water demand by 10%.

Campbell, Johnson and Hunt Larsen (2004) study the impact of regulation and non-price conservation programs undertaken by the city of Phoenix, Arizona, during the period 1990-1996. They found a water reduction of 3.5% from regulation imposing the installation of low-flow fixtures and devices, but increases in water use from free retrofit device kits (to the order

being price inelastic is a technical definition meaning that a one-percent increase in price results in a less than one-percent decrease in consumption). For comprehensive reviews, see Arbués-Gracia, García-Valiñas and Martínez-Espiñeira (2003), or Worthington and Hoffman (2008).

[8] San Francisco Water District, Marin Municipal Water District, Contra Costa Water Agency, East Bay Municipal Utility District, City of San Bernardino, City of Santa Barbara, Los Angeles Department of Water and Power, and City of San Diego.

of 3.8-4.6%). Another policy had similar devices installed on personal house visits with person-to-person communication and it obtained significant savings between 2.4 and 6.4%. The result may depend on the difference between receiving equipment for free and actually installing it. Nevertheless, the results of Campbell, Johnson and Hunt Larsen (2004) raise the issue of a possible rebound effect, i.e., an increase in water use following the installation of water-efficient equipment. This issue has been much studied in analyses of household adoption of energy-efficient equipment, where it indicates the possible increase in consumption following a reduction in the effective price of energy services brought about by energy efficiency improvements (Khazzoom, 1980). Recent evidence seems to indicate that the rebound effect on energy use is limited: 0-15% on data from the Netherlands (Berkhout, Muskens and Velthuijsen, 2000), 0-6% on data from Sweden (Brännlund, Ghalwash and Nordström, 2007) whereas Japanese household data indicate a rebound effect of the magnitude of 27% (Mizobuchi, 2008).[9] A significant part of potential savings thus seem to be realized, but the evidence calls for the use of combinations of instruments, for example price instruments in combination with efficiency improvements in order to limit any potential increases in consumption. Although the aim of our study is not to assess the actual water use reductions obtained, later on we will discuss some evidence from our data that lead us to consider the risk of a potential increase in water use as limited.

Another conclusion from previous studies is that households with different characteristics usually have different responses to the various policy instruments. In Southern California, households with lower income responded more to higher water prices than wealthier household groups (Renwick and Archibald, 1998). The impact of the rationing policies also differed among households, mainly depending on the size of their landscaped areas. Another study confirmed the differences in households' responses to price rises; when separating indoor and outdoor use from 11 urban areas in Canada and the United States over a two-week period in a dry, and also a wet season, households with the largest incomes and lot sizes are found to have the least price elastic outdoor demand, while households with the lowest incomes and smallest lots are the most price elastic (Mansur and Olmstead, 2007). These latter findings emphasize the importance to use household data in order to be able to control for heterogeneity in responses to DSM policies.

[9] Recent empirical estimates of the rebound effect take into account changes in the capital cost of the energy-using equipment, which significantly reduces the extent of the rebound effect. See Sorrell and Dimitropoulos (2008) for a recent review of different definitions of the rebound effect and a very useful discussion of their implications for empirical estimates.

3. Other factors influencing water conservation

Water conservation activities by households include behavioural change (turning off the shower when soaping up, only using dishwashers and washing machines with a full load) and installation of water-efficient devices (low water-use toilets, drip irrigation). In addition to price and non-price policies, both types of responses are influenced by the socio-demographic characteristics of the household, such as education, income, and home ownership, as well as by attitudinal variables, such as opinions about the environment in general. The few existing studies of adoption of water-efficient appliances have mainly controlled for socio-demographic variables, whereas the evidence on attitudinal variables mainly derives from studies of intentions to reduce water use by changing behaviour.

Socio-demographic variables

Analysis of a telephone survey of over 600 households after the California drought that began in the mid-eighties suggests that technological change (as exemplified by adoption of water-efficient devices), as compared to behavioural change, responded in a stronger manner to higher education, higher income, to the fact of having a garden or yard, and of being the owner of the home (Berk et al., 1993).

Renwick and Archibald (1998), in their analysis of household data from two communities in California, find a significant and positive effect of household income on the number of indoor water-efficient equipments (low-flow showerheads and low-flow toilets) while a higher income decreases the probability of using a water-efficient irrigation technology.[10] In the three models, the effect of home ownership is ambiguous: it is found positive but non-significant for the use of low-flow showerheads, negative and significant for low-flow toilets, and negative and non-significant for water-efficient irrigation technologies.

An analysis of census tract data in San Antonio, Texas, over the 1995-1997 period actually found that high income and high education are negatively correlated with conservation (De

[10] The two models describing adoption of indoor water-efficient equipments are estimated by OLS while the adoption of efficient irrigation technology is modeled as a Probit and estimated by Maximum Likelihood.

Oliver, 1999). This result may seem counterintuitive and may be related to the use of aggregate data.

Surveys of intentions to adopt a dual-flush controller for the toilet were conducted in Taiwan, Republic of China, in 2002 (166 residents) and later in 2004 on a different sample (210 residents).[11] Lam (2006) found that high income had a significant positive effect on intentions to adopt the equipment in one sample, and was insignificant in the other sample. Higher education positively affected intentions to adopt a dual-flush controller in one sample but not in the other. Age and gender were not significant in either of the two samples.

A cluster analysis of survey data on 1,265 households in Devon, England, found that households that are more likely to adopt water saving behaviour are older, tended to own their home, are more likely to have a degree, and are members of community groups (Gilg and Barr, 2006).[12] Four clusters of individuals are identified: i) committed environmentalists, ii) mainstream environmentalists, iii) occasional environmentalists, and iv) non-environmentalists. Committed and mainstream environmentalists have a strong commitment to water-saving behaviour, while occasional environmentalists are much less committed and non-environmentalists never undertake water-conserving behaviour. The cluster characterized as non-environmentalists tends to be male, on low income, with less education and less community involvement.

Finally, a telephone survey was administered to 532 households in the metropolitan region of Barcelona to examine water conservation behaviour as measured by the following practices: installing water-saving devices in taps, toilets, and showers, turning off running water while brushing teeth, purchasing water-efficient appliances, and comparing water consumption between periods (Domene and Sauri, 2006). The descriptive analysis of the data shows that consumer behaviour does not tend to depend on income, with the only exception being shower use, for which income had a positive effect.

The evidence so far on socioeconomic variables is thus quite mixed, and apart from a positive effect of home ownership (except in Renwick and Archibald, 1998) there are no conclusive results given the paucity of studies on the adoption of water-efficient equipment. The result

[11] The two samples differed significantly as concerns education and income.
[12] Gilg and Barr (2006) did not study the adoption of water-efficient equipment, only behavioural change.

that owners will tend to conserve water and install water-saving devices more readily than renters is not surprising knowing that owners usually pay their water bills (while this is not always the case for renters) and that only the owner will reap the long term benefits of the investment (that eventually may be capitalized into the real estate price).[13] There is no clear evidence on the impact of income on water conservation. The impact of income on the adoption of water-efficient equipment is ambiguous ex ante (Hausman, 1979). On the one hand, some equipment entails high investment costs that only richer households may be able to afford (in an incomplete credit market), but on the other hand, given the diminishing marginal utility of income, richer households may value the savings less than a poorer household. We would expect education to increase adoption of water-saving devices since households with higher education are more likely to understand/be aware of the nature of the water shortages and to understand/be informed about the water-saving options (Berk et al., 1993).

Attitudinal and behavioural factors

Efforts at measuring environmental attitudes and behaviour are limited by possible biases related to self-reported attitudes and behaviour: a socially desirable habit is more likely to be over-reported by households. Although positive intentions to reduce water use do not correspond to actual water use reductions, nevertheless we will summarize the research on behavioural intentions since this is what existing studies on environmental attitudes and water conservation analyze. Commonly, behavioural intention is assumed to depend on two variables: the individual's attitudes towards the behaviour and the individual's subjective norms relating to the perceived normative pressure to undertake the behaviour (Fishbein and Ajzen, 1975). Extended models also include the actor's perceived behavioural control - that is, the perceived difficulty of performing the behaviour, response efficacy, or perceived threat (severity of the water shortage). All these variables are typically measured by survey questions with answers on a 5- or 7-point Likert scale, indicating agreement or disagreement with a statement or question.

A perceived environmental threat, such as strong perceptions of the severity of a water shortage, has been found to be closely related to intentions to conserve water by changing

[13] The same type of arguments is found in most analyses of energy-efficiency appliances (Sutherland, 1991).

behaviour (Kantola, Syme and Nesdale, 1983; Gilg and Barr, 2006; Lam, 2006). In a survey of Kaoshiung residents (Taiwan), it was found that a strong perception of environmental threat, a strong belief in the efficacy of adopting a dual-flush controller compared to alternative strategies, a high estimation of the number of other residents that would take action to save water, and a high estimation of the monetary savings that could be obtained by adopting a dual-flush controller, significantly contributed to positive intentions to adopt a dual-flush toilet (Lam, 2006).[14] Gilg and Barr (2006) find that water savers are more likely to perceive an environmental threat and to be aware of a social norm to conserve water (the example of friends and neighbours), whereas non-environmentalists express greater belief in their rights to use water according to their own demand. Finally, in their analysis of water conservation behaviour, Domene and Sauri (2006) found that households with a higher score on the index measuring water conservation habits reduced their water use between 4.3 and 4.6 litres per capita per day.[15]

Metering

We are not aware of any study of the particular effect of metering on the adoption of water-efficient appliances, but scenario studies of the impact of individual metering in Southern England found evidence of greater willingness to conserve water when water use was known to be metered rather than unmetered (Van Vugt and Samuelson, 1999). The study also analyzed self-reported conservation behaviour of households in the same area but did not find any statistically significant effect between metered and unmetered households, though.[16] In Creedy et al. (1998), the effect of metering is examined with household data from Western Australia where most households are metered under a group system. Because of free-riding incentives, group metering is expected to result in more water use than single metering, other things being equal. The evidence gathered in the study does not, however, support the notion of excess water consumption or free-riding under group metering (Ferrara, 2007). Furthermore, Kenney et al. (2008) found that the introduction of Water Smart Readers, that give real-time feedback on water consumption, tended to increase households' water

[14] Two separate samples were studied. The variables that have been found significant vary from one sample to the other. For more details, see Lam (2006).

[15] The reduction was only statistically significant in the winter period, though, since no outdoor water-saving device was included in the measure and the climate tended to increase outdoor water use to a large extent during the summer season (because of gardens and swimming pools).

[16] This result may depend on the absence of control variables for the demographic differences between the samples of metered and unmetered households, or on possible self-reporting bias in the responses of the unmetered households.

consumption. They explain this unexpected result by the presence of block pricing and that the continuous feedback enabled the households to adjust their water consumption so as to take full advantage of the lower priced blocks, whereas earlier they had to use a safety margin to be sure not to enter into the higher priced block interval.

In the forthcoming empirical application, we will take advantage of the heterogeneity among the ten countries to measure the impact on adoption of water-saving devices of paying a volumetric charge and of being metered. We will not use a measure of the price of water per se because information on the price charged for water is missing or unreliable in most cases, either because households do not pay for water (or because water charges are part of the rent) or because they were not able to report this information at the time of the survey. Being unable to consider the price of water as a determinant for adoption is not a major drawback though, since economists and policy makers usually agree that households are rarely well informed about the price of water.[17] We expect that volumetric pricing and individual metering of water use, linked with individual billing, will reduce water use by imposing the marginal cost of water on the household, and by providing feedback on the efficacy of water reduction strategies.

Labelling

Empirical studies on consumer goods have shown that consumers are willing to pay a price premium for ecologically labelled products. For example, Danish consumers followed over the 1997-2001 period were willing to pay up to 10-17% in price premium for some products carrying the Nordic Swan label (Bjørner, Hansen and Russell, 2004). We have not found any empirical study on the impact of eco-labels on durable goods, such as water-efficient equipment. This particular question will be addressed in the forthcoming empirical application.

4. Data and descriptive statistics

4.1. The survey

[17] Domene and Sauri (2006), using a sample of 532 households from 22 municipalities in the metropolitan region of Barcelona, observed that almost half of the interviewed households did not look at the water bill or compared it with previous bills, and that most of customers did not understand the tariff schedule of their municipality.

The data come from an environmentally-related survey implemented in ten OECD countries (Australia, Canada, Czech Republic, France, Italy, Korea, Mexico, Netherlands, Norway and Sweden) in 2008. About 10,000 respondents have been surveyed using a web-based access panel, regarding a set of environmentally relevant activities including use of water and energy, recycling, transportation mode. Respondents were also asked a series of questions regarding characteristics of their household (age, income, composition, education, ownership status), housing characteristics, and behavioural attitudes or opinions regarding the environment in general. A selection of these questions as well as the specific questions on water use can be found in Appendix A1.

Web-based surveys are increasingly used as a means to implement targeted surveys at a relatively low cost compared to in-person interviews. Lindhjem and Navrud (2008) recently compared web-based surveys with in-person interviews in a controlled field experiment on the same panel of respondents and found no significant biases in the web-based survey compared to the interview survey. Kiernan et al. (2005) compared a web-based survey with a mail survey and found that the web-based survey had better response rates and the same question completion rate as the mail survey and that there was no evidence of evaluative bias. So far, the results thus seem quite encouraging as to the validity of this type of survey instrument.

4.2. Use of water-efficient devices: some descriptive statistics

In the survey, households were asked whether they had invested during the last ten years or were already equipped with (1) a water-efficient washing machine, (2) low volume or dual flush toilets, (3) water flow restrictor taps or low flow shower heads, and (4) water tanks to collect rainwater.[18] About half of the respondents (in the overall sample) are equipped with a water-efficient washing machine, low volume or dual flush toilets, and a water flow restrictor tap or a low flow shower head (Table 1). Fewer respondents are equipped with a water tank to collect rainwater. This share is 17% on the full sample, and varies from 4% in Norway to 34% in the Czech Republic. For indoor water-efficient equipment we can clearly see the impact of water scarcity constraints. The high adoption rates in Australia and Mexico reflect the

[18] We do not know how many equipments each household owns.

government sponsored programs to introduce such equipment in order to reduce water consumption. Water abundant countries, on the other hand, generally display lower rates of adoption. The Netherlands, the only country apart from Australia to have a separate water efficiency label, has a high rate of adoption of all three indoor water efficiency devices. The Czech Republic, that displays the highest rate of adoption of water flow restrictor taps, has experienced large water price increases over the last 10 years. The French rates of adoption of water-efficient washing machines and low volume toilets are also among the highest, and may reflect the fact that the French average price of water is the relatively highest by comparison with the other countries.

For the few countries where we could find statistics on households' installation of water-efficient equipment, the official statistics corroborate some of the numbers from the OECD survey. In 2007, 39% of Canadian households report having a low-volume toilet, whereas the corresponding figure is 40% in the OECD survey (Statistics Canada, 2009). In the same year, 54% of Canadian households reported having a low flow shower head (56% in the OECD sample, which also includes water flow restrictor taps). In Australia, the statistics from 2004 (Australian Bureau of Statistics, 2006) indicate that 73% of households used a dual flush toilet (75% in the 2008 OECD survey), and that 44% used a reduced flow shower head (the corresponding figure in the OECD survey is 63% but it also includes water flow restrictors in general).

4.3. Relevant variables to explain adoption

In addition to socio-economic and demographic variables (household size, home ownership status, household income) and variables describing characteristics of the dwelling (age of the building, number of rooms, surface, size of the garden/balcony/terrace), the survey included questions about households' attitudinal and behavioural factors measured on a five-point Likert scale. From these answers, we build three indices that correspond to the individual means computed from the "applicable/possible answers", i.e., we calculate the mean score for each individual only taking into account the sub-questions that she answered (see Appendix A2 for the calculation of these indices).[19] We have one such attitudinal index,

[19] See Lam (1999, 2006) for a similar approach. We also tried to build indices using Principal Component Analysis (PCA). The indices built following the sample mean approach were found to be more significant in

index_env_concern, that measures environmental concern in general (including among others concern about waste generation, air pollution, climate change, and water pollution), not just concerning water use, and could be interpreted as a proxy for the perception of a global environmental threat. We then have two behavioural indices: *index_green_prod*, that measures purchases of green products in general (not related to water), and *index_habit_water*, an index measuring the respondent's habits to conserve water (turning off the water while brushing teeth, taking showers instead of baths, plugging the sink when washing the dishes, among other examples).[20] For these three indices, a higher value of the index indicates a higher degree of environmental consciousness or commitment.[21] It is important to keep in mind that these indices are based on stated behaviour, and that we have no possibility to control whether respondents provided honest answers. We also include in the adoption models two dummy variables indicating whether the respondent devotes time to environmental organization (variable *i_time_orga*) and whether the respondent has donated money to such organizations (variable *i_member_orga*). The list of explanatory factors that are used in the econometric analyses and the sample mean of each variable (for the entire sample and for each country separately) are given in Appendix (Table A1 and Table A2 respectively).

Two variables that measure policy directly will be included in the analysis, one accounts for being charged for water or not (with a distinction between being metered or not for those households paying for water), another considers environmental labels. We build a categorical variable that distinguishes respondents that are not charged for water, those that are charged for water but not metered, and those that are charged for water and metered. On the full sample, 63% of the households are charged and metered for their water use, 13% are charged a flat fee (not metered) and 24% are not charged at all for their water use (see Table A2).

general. Factor analysis is another possible technique for aggregating answers measured on a Likert scale (Gilg and Barr, 2006).

[20] We also started out by including a fourth index created from the survey and representing attitudes towards the solutions of environmental problems – for example, whether the individual household can contribute, or whether governmental policies addressing environmental problems should not entail supplementary costs to the household - but this index was never significant and was excluded in the final estimation that is presented here.

[21] These three indices will be treated as continuous variables, which relies on the underlying assumption that the ordering is linear: for example, if possible answers are "never", "occasionally", "often", and "always", we assume that moving from "never" to "occasionally" is equivalent to a move from "often" to "always". Instead, one could have considered separately the answer to each separate item and build dummy variables corresponding to each answer and each item. For example, regarding the index measuring households' habits to conserve water, we could have built four dummy variables to describe whether the respondent would turn off the water while brushing teeth: "never", "occasionally", "often", or "always", and the same for "taking showers instead of bath", "plugging the sink when washing the dishes", etc. However, such a procedure would have increased significantly the number of parameters in the adoption models as well as the risk of multicolinearity.

There are large differences between countries, with the lowest proportion of metered households occurring in countries known as “water-abundant”: Norway, Sweden and Canada.

The labels included are either EU, Nordic or national eco-labels, according to the specific country, or specific water efficiency labels, if applicable. We construct a variable that measures whether the household takes the labels into account in its purchasing decisions (all kind of purchasing decisions, not only water-efficient devices). There are important differences between countries, with the highest reported impact of the labels in Sweden and Norway, followed by Australia. National water labels exist only in Australia and in the Netherlands, and a higher percentage of households state that they take the specific water efficiency label into account in Australia (66%) than in the Netherlands (12%).

Some households in our sample may have benefited from some government support to invest in water-efficient devices. Unfortunately, only households who first declared owning a water-efficient equipment were questioned about subsidy programs. The information on government support is thus incomplete and cannot be used as an explanatory factor in the adoption models. Simple statistics indicate that 8% of the households who own a water-efficient washing machine benefited from some government support. For low-volume or dual flush toilets, water flow restrictor taps and low flow shower heads, and water tank, the corresponding figures are 7%, 9%, and 10%, respectively. A closer look at the data shows that in all ten countries some households benefited from government support to invest in a water-efficient device. However, government support seems to be more frequent in Australia, Canada, Italy, and Mexico.

5. Estimation procedure and results

5.1. Econometric model

The underlying model assumes that each household will take the decision to adopt equipment *j* (*j*=1,…,4) as long as its expected indirect utility with adoption over the lifetime of the equipment, $V_j^1(.)$, is greater than its expected indirect utility without adoption, $V_j^0(.)$. Under the assumption that the indirect utility function $V_j^k(.)$ can be written as the sum of a deterministic component $V_j^k\left(\mathbf{x},\boldsymbol{\beta}_j^k\right)$, *k=0,1*, where $\mathbf{x}$ is the vector of observable factors that drive the household's decision, and a random term of mean 0, ε_j, the household will choose to adopt equipment *j* if and only if:

$$V_j^*(\mathbf{x}) = V_j^1 - V_j^0 = \mathbf{x}'(\boldsymbol{\beta}_j^1 - \boldsymbol{\beta}_j^0) + \varepsilon_j^1 - \varepsilon_j^0 = \mathbf{x}'\boldsymbol{\gamma}_j + \omega_j > 0 . \quad (1)$$

We define a dichotomous variable ADOPT_j (for adoption of equipment *j*) which is equal to 1 if $V_j^* > 0$ and 0 otherwise. Under the assumption that ω_j follows a standard normal distribution of variance 1, we obtain the following Probit type model:

$$\text{Prob}(\text{ADOPT}_j = 1 \mid \mathbf{x}) = \text{Prob}(\mathbf{x}'\boldsymbol{\gamma}_j + \omega_j > 0 \mid \mathbf{x}) = \Phi(\mathbf{x}'\boldsymbol{\gamma}_j) \qquad j=1,\ldots,4 \quad (2)$$

where Φ is the standard normal distribution function. Under the assumption of normality of the residuals, the Maximum Likelihood method provides consistent and efficient estimates (Greene, 2003).

We estimate four such Probit models of a household's probability of investing in the four different equipments in the survey: water-efficient washing machines (Model 1), low volume or dual flush toilets (Model 2), water flow restrictor taps or low flow shower heads (Model 3) and water tanks for collecting rain water (Model 4). We do the estimations first on the pooled data controlling for country-specific effects, and next, we also undertake the same estimations country by country. The country-specific effects may capture country-specific behaviour / consciousness related to water use, water-specific policies that have been put in place by the national governments, or may reflect the supply side of the market for water-efficient devices (water-efficient equipment may be cheaper or easier to find in some countries than in others). For example, among the countries in the sample, Australia and Mexico have implemented specific programs in situations of extreme water shortage whereby government sponsored the installation of water-efficient devices.

The dependent variable takes the value 1 if the household has invested in the equipment during the last 10 years or was already equipped. If this approach seems reasonable for the case of the water tank or the low flow shower head for which technology may not have really changed over the past 10 years, the performance of water-efficient washing machines may have significantly improved in 10 years. For this reason, we will test the robustness of our results by considering a slightly different definition of the dependent variable (Model 1bis): the dependent variable is set equal to 1 if the household has invested in a water-efficient washing machine during the last 10 years and 0 if he has not or if he was already equipped.

5.2. Results

The three models describing adoption of indoor water-efficient equipments are estimated using 9,439 observations while the model describing adoption of water tanks is estimated using 9,437 observations.[22] A large number of variables are found to be significant in the four models and the percentage of correct predictions varies between 65% (in the model describing adoption of water flow restrictor taps and low-flow shower heads) and 84% (in the model describing adoption of water tanks).

We report in Table 2 the estimated marginal effects obtained from application of the Maximum Likelihood estimator on Models 1 to 4, on the pooled data. Among the socio-economic and demographic variables, ownership status, the size of the household, and income are always significant at a 10 percent level (see Table 2). Education level is never significant, and is not included in the final estimation, for the main reason that education level is correlated with income. Ownership status always has a positive impact on adoption of water-efficient equipment, which is in line with theory and expectations but opposite to Renwick and Archibald's (1998) findings. The marginal effect (on the probability of adoption) of being an owner varies between 0.06 and 0.10, and is among the highest marginal effects in the four models. All else equal, the probability of adopting the water-efficient equipment is thus higher by 0.06 – 0.10 points if the household owns its residence. The second largest marginal effect among the socio-economic and demographic variables is household size, which has a positive effect on adoption of all four equipments. Household size can be interpreted as an indicator of water use, and thus potential water savings from adopting water-efficient equipment. Maybe surprisingly, a higher income decreases the probability of buying a water tank. This result

[22] We consider all households in the fourth model and not only households with a garden, balcony or terrace since water tanks can also be installed on the roof. In our sample, 110 respondents declare having no garden/terrace/balcony and at the same time using a water tank to collect rainwater.

could indicate that households who get equipped with a water tank do so for monetary savings purposes. But, it should be noted that the marginal income effects, though significant, are always close to zero. This is similar to the result obtained in Renwick and Archibald (1998), the only other adoption study on household data that we are aware of. The characteristics of the dwelling – number of rooms, size of the garden/balcony/terrace - clearly have a positive significant impact on the probability to adopt the equipment, except, logically, for water tanks, for which the external surface is the only variable to have a significant positive effect on adoption together with the age of the dwelling. By contrast, the age of the dwelling has a negative significant impact on the adoption of indoor water-efficiency equipment, which may seem counter-intuitive.

The main contribution of our paper is to assess the relative impact of socio-economic, attitudinal, behavioural, and policy variables. As concerns the variables measuring attitudes and behaviour, the results are quite strong. Environmental commitment as displayed by the index of purchases of green products or the index of water conservation habits affect adoption of water-efficient equipment to the same extent as ownership. More precisely, a marginal increase in the index of purchases of green products increases the probability of adoption of indoor water-efficient equipment by 0.09 on average. As for the index of water conservation habits, its marginal effect on the probability of adoption varies from 0.04 in the case of water tanks to 0.12 in the case of the water flow restrictor taps / low flow shower heads. By comparison, the index representing environmental attitudes in general is only significantly positive for the adoption of water flow restrictor taps, but it has a much smaller impact than the index representing environmental purchase habits. These results are in line with the degree of commitment expressed by each index, since purchasing environmentally friendly products represents a stronger level of commitment than simply expressing positive environmental attitudes, although one would expect a correlation between the two. The behavioural variables are thus some of the strongest factors for adoption. With caution due to the fact that these results rely upon stated behaviour, we find a clear pattern: the impact on the adoption of water-efficient equipment increases with the degree of commitment expressed by each index. This result, in addition to the fact that few households (8-10%) benefited from government support when investing, indicate that any potential rebound effect from the adoption of water-efficient equipment should be limited. The households had to incur some (monetary) effort to obtain the equipment and the ones that do so state that they follow water conservation habits in their daily life and are thus likely to take more care in their water consumption.

Community involvement by devoting time to environmental organizations increases the probability of adopting water flow restrictor taps or water tanks, whereas money donations contribute positively to explaining the adoption of water-efficient washing machines and water tanks. Compared to the indices on green product purchases and water-saving behaviour, there is no clear pattern, though, and the impact is much smaller.

The policy-related variables display a different impact according to type of equipment, with a clear distinction between indoor and outdoor water-efficient equipment. Households that are both charged and metered for their individual water use are more likely to adopt indoor water-efficient equipment, whereas the impact on the adoption of water tanks to collect rainwater is not significant. The marginal effect of being charged for water and metered varies from 0.07 to 0.10 for the three indoor equipments, and is higher than the marginal effect of being charged but non-metered (from 0.03 to 0.06). These findings confirm that the price of water has an effective signalling role on the value/scarcity of the resource but also that this signal will be even more effective if the household is charged based on its consumption. These results thus confirm the effectiveness of individual metering to encourage water conservation.

If the respondent took the appropriate environmental label into account in her purchasing decisions, this increased the probability of adopting indoor water-efficient equipment, but had no effect on the adoption of water tanks. The impact of the labels is the most important for the adoption of water-efficient washing machines and water flow restrictor taps. The marginal effect of labels is comparable to the marginal effect of being charged for water with a flat fee (0.03-0.06).

Specific country effects are controlled for by country dummy variables, where the reference is the country with the highest percentage of adoption (Australia for water-efficient washing machines and low volume or dual flush toilets, and the Czech Republic for water flow restrictor taps/low flow showerheads and water tanks). As concerns water-efficient washing machines, the dummy representing the Netherlands has a positive impact on the probability of adoption, whereas the impact is significant and negative for the Czech Republic, Korea, Norway, Canada and Sweden. For low volume toilets, a location in Korea, Italy, Norway and Canada have the largest negative impact on the probability to adopt compared to the reference country Australia. For this particular equipment, the results may be taken as cautious evidence of a smaller probability of adoption in water abundant countries. For water flow restrictor taps, the Netherlands (a country with a specific water efficiency label) and Norway display no different impact than the Czech Republic. Concerning the other country-specific effects for this equipment, the most negative significant impact comes from a household location in France, Korea, Mexico, Australia, Sweden and Italy. As for water tanks, a location in Norway, Italy, Mexico, Sweden, Canada or Korea has the largest negative impact on the probability of adoption by comparison to the reference case – the Czech Republic. Culture and historical features may account for some of these results and the country dummies are not easily interpretable.

In order to account for the shorter economic lifetime of water-efficient washing machines, we also consider another definition of "adopters" for this particular equipment: the dependent variable is set equal to 1 if the household has invested in a water-efficient washing machine and 0 if he has not or if he was already equipped (model 1bis – not presented here). The results are quite robust with respect to this modification. The indices of water conservation habits and of green product purchases decrease somewhat in size, but remain at the same level of statistical significance. The impact of household size increases. The percentage of correctly classified decisions slightly decreases, though, so we prefer the standard Model 1 for the adoption of water-efficient washing machines. We next turn to the specific estimations performed on each individual country sample.

Each of the four models is then estimated separately for each of the ten countries. We will only comment on the main driving factors of adoption, namely ownership status and the behavioural variables.[23] The country-by-country analysis confirms the important role of ownership status: being an owner always has a positive impact on the probability of adoption of the four water-efficient equipments across countries, even if not significant in some cases. In each country, this variable is at least significant for one type of equipment. The index of water conservation habits is always positive and significant except for Canada, the Czech Republic and Sweden in explaining the adoption of water-efficient washing machines, Sweden for low volume toilets, and Italy, Norway and Australia for water tanks. Likewise, the index for purchasing environmentally friendly products is always significant and positive for all equipment, except for the Czech Republic and Korea for water-efficient washing

[23] The full country specific results are available from the authors upon request.

machines, the Czech Republic and Australia for low volume toilets, Italy and Australia for water flow restrictor taps, and the Netherlands, France, Italy, the Czech Republic, and Korea for water tanks. By comparison, the index of environmental concern (perception of environmental threat) is only significant in the Netherlands for the purchase of water-efficient washing machines, in France and Mexico for the purchase of low volume toilets, in Mexico and Italy for the adoption of water flow restrictor taps, and in the Netherlands and the Czech Republic for the installation of water tanks.

6. Conclusion and policy implications

Using unique survey data of approximately 10,000 households from 10 OECD countries, we assess the relative impact of socio-economic, attitudinal, behavioural, and policy variables on household adoption of water-efficient equipment. The results indicate that the adoption of water-efficient equipment is the most strongly affected by ownership status, by being metered and charged a volumetric charge on water consumption and by behavioural factors. In particular, we find that a strong commitment to environmental values, such as displayed in the index of purchases of green products, or the index of water consumption behaviour, increases the probability to adopt indoor water-efficient equipment by 0.09 on average. This is the same order of magnitude as for ownership status that has a marginal effect ranging from 0.06-0.10. The index of water consumption habits increases the probability of adoption from 0.04 in the case of water tanks to collect rainwater to 0.12 in the case of water flow restrictor taps and low flow shower heads.

Adoption is of course also strongly affected by socio-economic variables. Apart from ownership status, that encourages adoption to the largest extent, we find a significant positive effect of household size for all four equipments studied in the survey. Somewhat surprisingly, we find very small – although significant - effects of household income. Other variables, though, like the number of rooms of the residence, that may be proxies to household wealth, have a larger impact on adoption, but never as large as ownership.

In terms of policy variables, we assessed the impact of the water charging system, i.e., whether the household is charged for its water consumption and whether it is metered individually, and thus pays a volumetric fee, or whether it pays a flat fee, and the impact of applicable environmental labels. In general, households display bad knowledge of their water bill. This suggests that the price of water as such is not sufficient to explain the adoption of water-efficient equipment. On the other hand, we find a clear-cut result of *the structure of water charging* in terms of metering or not. Households that were both metered and charged for their water individually (volumetric fee) have a much higher probability to invest in the three types of indoor water-efficient equipment studied in the OECD survey compared to households that are not charged for their water (the estimated marginal effect varies from 0.07 to 0.10), or, to a smaller extent, compared to households that are charged but not metered individually for their water (flat fee). The effect was not significant for water tanks to collect rainwater. These results would strongly indicate the need for more information, both in terms of more widespread introduction of individual metering – and the introduction of volumetric charges - and in terms of more information on water uses on the water bill.

The other policy variable assessed here is labelling, when the respondent indicated that they took labels into account in their purchase decision. Our estimation results suggest that the marginal effect of a label on the adoption of water-efficient washing machines and water flow restrictor taps is slightly smaller than the effect of moving from not being charged for water to being charged a flat fee for water (the marginal effect of labelling ranges from 0.04 to 0.06 for the three indoor water equipments).

In policy terms, our results clearly indicate the importance of introducing volumetric charging of water consumption in order to encourage the adoption of water-efficient equipment. Other non-price policies, such as eco-labels, do induce adoption of such equipment but to a smaller extent. We also conclude that the households that voluntarily adopt such equipment are the ones that display strong environmental values by already purchasing environmentally friendly products or stating water-saving habits. This last result is important since it suggests that the households that invest in such equipment are less likely to increase their water consumption following adoption, given that they are the households that already display care in their water use. Any potential rebound effect from the adoption of water-efficient equipment should thus be small.

Future research could extend the analysis in different ways. Due to the construction of the survey used here, we could not assess the relative effectiveness of direct regulation (water use restrictions) on the adoption of water-efficient equipment. The relative efficiency of economic variables versus direct regulation on the adoption of water-efficient equipment is thus an open issue. Nor could we assess the effectiveness of public subsidies on the adoption of water-efficient equipment, since the question was only asked to the households that had invested in such equipment. An analysis including these additional factors would be a topic for future research on household adoption data.

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Tables

Table 1. Share of respondents owning water-efficient equipment, by country

Country	Water efficient washing machine	Low volume or dual flush toilets	Water flow restrictor tap / low flow shower head	Water tank to collect rainwater
Australia	0.66	0.75	0.63	0.29
Canada	0.49	0.40	0.56	0.13
Czech Republic	0.28	0.67	0.67	0.34
France	0.62	0.61	0.43	0.27
Italy	0.58	0.42	0.58	0.12
Korea	0.31	0.31	0.40	0.11
Mexico	0.61	0.66	0.49	0.14
Netherlands	0.63	0.63	0.64	0.18
Norway	0.45	0.34	0.59	0.04
Sweden	0.44	0.40	0.48	0.13
OECD (10)	0.52	0.51	0.54	0.17

Table 2. Estimated marginal effects from the four Probit models – pooled data

	Model 1 **Water efficient washing machine**	Model 2 **Low volume or dual flush toilets**	Model 3 **Water flow restrictor tap / low flow shower head**	Model 4 **Water tank to collect rainwater**
Variable[(a)]	Marginal effect[(b)]	Marginal effect	Marginal effect	Marginal effect
Economic variables				
i_owner	0.061***	0.097***	0.103***	0.085***
Income	8.83E-07***	8.01[E]-07**	8.37E-07**	-1.11E-06***
Demographic variables				
hh_size	0.015***	0.008*	0.010**	0.010***
Characteristics of the dwelling				
size_resid (log)	0.033***	0.019	0.004	-0.005
size_outside (log)	0.006**	0.004*	0.006**	0.026***
age_resid (log)	-0.028***	-0.061***	-0.017**	0.014***
nb_rooms (log)	0.067***	0.056***	0.040***	0.005
Attitudinal and behavioural characteristics				
index_habit_water	0.071***	0.075***	0.125***	0.045***
index_env_concern	0.008	0.010	0.019**	0.008
i_time_orga	0.027	0.009	0.047**	0.047***
i_member_orga	0.040**	0.018	0.025	0.043***
index_green_prod	0.097***	0.083***	0.086***	0.032***
Policy variables				
i_nocharge (reference)	-	-	-	-
i_non-metered	0.055***	0.032*	0.033*	-0.015
i_metered	0.073***	0.098***	0.072***	-0.002
i_label	0.059***	0.035**	0.049***	0.004
Country dummies				
i_Australia	-	-	-0.172***	-0.057***
i_Canada	-0.111***	-0.290***	-0.145***	-0.109***
i_Czech	-0.293***	0.008	-	-
i_France	0.023	-0.105***	-0.314***	-0.054***
i_Italy	-0.041	-0.313***	-0.158***	-0.126***
i_Korea	-0.251***	-0.378***	-0.259***	-0.102***
i_Mexico	-0.005	-0.093***	-0.253***	-0.121***
i_Netherlands	0.072***	-0.036	-0.046	-0.092***
i_Norway	-0.117***	-0.306***	-0.052	-0.146***
i_Sweden	-0.080***	-0.205***	-0.163***	-0.112***
Number of observations	9,439	9,439	9,439	9,437
Percentage of correct predictions	66%	67%	65%	84%

Notes: (a) The prefix _i indicates a 0/1variable. (b) *, **, *** indicate significance at the 10, 5, and 1% level, respectively.

Appendix

A1. Selected questions from the survey

Part on attitudinal and behavioural characteristics:

Q22. How concerned are you about the following environmental issues?
Please select one answer per row

RANDOMISE ITEMS

	Not concerned	Fairly concerned	Concerned	Very concerned	No opinion
Waste generation					
Air pollution					
Climate change (global warming)					
Water pollution					
Natural resource depletion (forest, water, energy)					
Genetically modified organisms (GMO)					
Endangered species and biodiversity					
Noise					

Q31. For each of the following categories, how often does your household choose to use the products listed, rather than the alternatives? GRID
Please select one answer per row

	Never	Occasionally	Often	Always	Don't know
Paper with recycled content (e.g. stationery)					
Products with reduced toxic content (e.g. environmentally friendly cleaning products)					
Refillable containers (e.g. bottles, washing detergents)					
Reusable shopping bags					

Part on water:

Q87. Is your household charged for water consumption in your primary residence?

1. Yes
2. No

3. Not sure

IF Q87=2, ASK Q88
Q88. What would best describe your situation in your primary residence?

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

IF Q87=1, ASK Q89
Q89. How is your household charged for water consumption?

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

ASK IF Q87 not equal to 2
Q90. Approximately how much was the total annual cost for water consumption for your primary residence?
Please indicate if possible amount in $ and corresponding annual consumption in m³
NOT OBLIGATORY

Amount in $ per year *Please provide answer to the nearest dollar* OPEN END	Volume of water consumed in m³ OPEN END
NOT OBLIGATORY	NOT OBLIGATORY

97. Don't know EXCLUSIVE

Q91. How often do you do the following in your daily life?
Please select one answer per row

	Never	Occasionally	Often	Always	Not applicable
Turn off the water while brushing teeth					
Take showers instead of bath specifically to save water					
Plug the sink when washing the dishes					
Water your garden in the coolest part of the day to reduce evaporation and save water					
Collect rainwater (e.g in water tanks) or recycle waste water					

Q92. Has your household invested in the following appliances/devices in the past 10 years in your current primary residence?
If these measures would need to be carried out by the landlord, select "Not possible".

	Yes	No	Already equipped	Not possible (code 96)
Water efficient washing machines				
Low volume or dual flush toilets				
Water flow restrictor taps / low flow shower head				
Water tank to collect rainwater				
Water purifier for drinking water				

Q93. For which of the following has your household benefited from government support to make this investment (for instance grants and incentives)?
Please select all that apply

1. Filter items 1-4 selected in the “yes” column in Q92

97. Don’t know
98. None of the above

A2. Construction of the behavioural and attitudinal indices

a) Index measuring households' habits to conserve water (variable name: *index_habit_water*)

This index is built from the respondents' answers to the following question:

Q91. How often do you do the following in your daily life?

- *Turn off the water while brushing teeth.*
- *Take showers instead of bath specifically to save water.*
- *Plug the sink when washing the dishes.*
- *Water your garden in the coolest part of the day to reduce evaporation and save water.*
- *Collect rainwater (e.g. in water tanks) or recycle waste water.*

Possible answers were Never (1), Occasionally (2), Often (3), Always (4), or Not applicable (5).

For each household, we compute the index as the sample mean on the answers coded from 1 to 4. We do not consider in the computation the case of answers equal to 5. For example, a household living without any garden or balcony cannot answer the question "How often do you water your garden in the coolest part of the day to reduce evaporation and save water"? For example, a household who respectively answered "never", "occasionally", "often", "always", and "always" to the five questions would be attributed an index of (1 + 2 + 3 + 4 + 4)/5 = 2.8.

Note however that we consider a slightly different definition of this index in the model describing the probability that households own a water tank to collect water (see Table 2, Model 4). We exclude the answer to the 5th question in Q91 in the survey (which is directly about rainwater collection) in order to avoid endogeneity bias at the estimation stage.

b) Index measuring households' habit to purchase "green" products (variable name: *index_green_prod*)

This index is constructed in a similar manner based on Q31.

c) Index measuring households' concern about environmental problems (variable name: *index_env_concern*)

This index is constructed in a similar manner based on Q22.

A3. List and definition of the explanatory factors

Below is the list of the explanatory variables that have been used in this article. Variable names with prefix "i_" indicate variables taking only values 0 or 1. Variable names with prefix "index_" indicate indices representing respondents' attitudinal characteristics (see notes at the end of Table A1 and Appendix A2).

Table A1. List of explanatory factors used in the various models

Variable names	**Variable definitions**
Characteristics of the dwelling	
nb_rooms[(a)]	Number of rooms
size_resid[(b)]	Size of primary residence
size_outside[(b)]	Size of garden/balcony/terrace
age_resid	Age of primary residence
Economic variables	
i_owner	Equal to 1 if the household owns its residence
income	Household's income (EUR)
Demographic variables	
age	Age of the respondent
i_female	Equal to 1 if the respondent is a female
hh_size[(c)]	Household size
i_pgrad	Equal to 1 if the respondent holds a post graduate degree
Behavioural and attitudinal characteristics	
index_env_concern[(d)]	Index of concern about environmental issues
index_habit_water[(d)]	Index measuring the respondent's habits to conserve water
index_green_prod[(d)]	Index of purchase of "green products"
i_time_orga	Equal to 1 if the respondent has invested some personal time to support or participate in an environmental organization
i_member_orga	Equal to 1 if the respondent is currently a member of, or contributor/donator to, any environmental organisations
Policy variables	
i_nocharge	Equal to 1 if not charged for water
i_non-metered	Equal to 1 if charged for water but non-metered
i_metered	Equal to 1 if charged for water and metered
i_label[(e)]	Equal to 1 if the household takes labels into account in purchasing decisions

Notes:

(a) In the survey, "number of rooms" was a categorical variable with the last category defined as "twelve and more rooms". We decided to transform this discrete variable into a continuous variable and we considered a number of 12 rooms for households who chose the highest category.

(b) There were some missing observations for the answer on the size of the residence and the size of the property outside the residence. In order to avoid losing observations, we replaced the missing data by the average size of the residence and the average size outside the residence in the corresponding country and zone of residence (urban, peri-urban, rural).

(c) In the survey, “household size” was a categorical variable with the last category defined as “five and more members”. We decided to transform this discrete variable into a continuous variable and we considered a number of 5 members for households who chose the highest category.

(d) See Appendix A2 for details on the computation of indices.

(e) We consider any “environmental label”, including applicable national eco-labels, Nordic eco-labels, the European Union eco-label and water-specific labels.

Table A2. Sample mean of socio-economic, demographic, attitudinal and policy variables, overall and by country

Variable	OECD (10)	Australia	Canada	Czech Rep	France	Italy	Korea	Mexico	Netherlands	Norway	Sweden
i_owner	0.65	0.58	0.63	0.66	0.58	0.80	0.72	0.74	0.48	0.78	0.49
nb_rooms	4.88	6.02	6.24	4.00	4.75	5.27	3.46	5.31	4.20	5.30	3.85
size_resid (m^2)	101.18	93.33	115.03	89.74	95.54	109.71	91.61	106.30	88.97	120.68	94.14
size_outside (m^2)	77.58	120.35	61.22	83.35	122.29	57.30	21.41	37.27	67.60	120.92	90.35
age_resid	31.85	27.53	34.24	40.59	39.57	32.13	12.29	18.67	37.44	35.65	42.19
income (EUR)[(a)]	30,258	34,981	38,548	11,710	32,349	30,735	24,912	6,782	28,467	58,627	28,743
age	42.15	43.90	43.21	39.51	45.74	43.52	38.61	34.77	45.05	43.52	42.07
i_female	0.52	0.55	0.51	0.51	0.50	0.52	0.51	0.49	0.53	0.48	0.56
hh_size	3.89	3.87	3.63	4.02	3.57	4.12	4.70	4.81	3.30	3.56	3.31
i_pgrad	0.10	0.07	0.06	0.10	0.13	0.07	0.09	0.12	0.05	0.26	0.03
index_env_concern	3.03	3.06	3.05	2.95	3.04	3.18	3.30	3.54	2.59	2.76	2.74
index_habit_water	2.99	3.41	3.00	2.92	3.25	3.03	2.56	3.02	3.17	2.55	2.91
index_green_prod	2.86	3.03	2.99	2.87	2.97	2.93	2.71	3.00	2.78	2.59	2.74
i_time_orga	0.10	0.07	0.07	0.07	0.05	0.11	0.08	0.27	0.04	0.06	0.15
i_member_orga	0.14	0.15	0.11	0.08	0.09	0.13	0.18	0.15	0.25	0.08	0.17
i_nocharge	0.24	0.22	0.52	0.10	0.13	0.08	0.10	0.03	0.08	0.49	0.67
i_non-metered	0.13	0.04	0.13	0.10	0.10	0.13	0.04	0.23	0.11	0.35	0.08
i_metered	0.63	0.73	0.35	0.80	0.77	0.79	0.86	0.75	0.81	0.16	0.25
i_label	0.37	0.67	0.25	0.49	0.24	0.09	0.18	0.00	0.29	0.70	0.91

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